POWERING DISCOVERIES!
The Institute of High Performance Computing (IHPC), as a research institute under Singapore’s Agency for Science, Technology and Research (A*STAR), provides leadership in high performance computing as a strategic resource for creating scientific breakthroughs and industry development.

IHPC’s main mission since its establishment in 1998 is to support research partners -- both within A*STAR and externally -- and industry players to advance science and technology through computational modelling, simulation and visualisation.

IHPC’s key research areas are covered by six departments, each staffed by highly qualified and experienced researchers who are focused on pushing the state-of-the-art and creating innovation through new discoveries powered by high performance computing. IHPC researchers are domain experts in several scientific disciplines and are highly experienced in tackling industry challenges that require scientific and engineering solutions.

IHPC’s R&D projects have benefited industry partners in many sectors, including aerospace, infocomm, marine, maritime and offshore, urban planning, personal care and medical technology. IHPC seeks to contribute to R&D efforts that transform Singapore into an innovation economy.

The Computing Science (CS) Department develops techniques that draw out the efficiency, insight and intelligence in computing to empower scientific discovery and technological advances over a wide spectrum of real-life applications. The capabilities offered by the CS Department can enhance the performance of software codes, scale up computing throughput of applications, process of a wide variety of data types, provide value and insight into data, create intelligent systems that can interact in a socially-appropriate manner, and provide methods for understanding complex interactions between systems.

The CS Department is composed of six Capability Groups:

**High Performance Computing**
The High Performance Computing group develops tools and algorithms for enhancing computing performance using accelerators (such as GPU, Multi-Core and Many-Core processors) to achieve high throughput and productivity for applications in the computational science domain as well as HPC deep learning and text mining domains.

**Distributed Computing**
The Distributed Computing group establishes new computing paradigms to handle large scale computing and big data analytics in distributed computing infrastructures such as clusters and cloud computing.

**Cross-Disciplinary Data-Intensive Analytics**
The Cross-Disciplinary Data-Intensive Analytics group develops capabilities to handle the challenges brought about by big data. This is crucial for today’s companies, who are keen to extract and derive insight from these data in order to gain competitive advantage and move up the value chain.

**Geometrical Modelling**
The Geometrical Modelling group develops computational methods, algorithms and software platforms to deliver computational geometry, mesh generation, digital modelling and image processing capabilities to varied domains such as computational science and biomedical engineering.

**Intuitive Interactive Technologies**
The Intuitive Interactive Technologies group develops novel human-machine interfaces and machine learning algorithms that enable intuitive interaction, verifiable system execution, and scalable end-user programming.

**Complex Systems**
The Complex Systems group develops mechanism-based models to probe and understand cities, socio-technical and economic systems and complex networks. The group aims to leverage on these capabilities in advancing tools to understand, design, manage and evaluate various urban systems using Singapore as a use-case scenario.
The mission of the Electronics and Photonics (EP) Department is to advance the fields of photonics, plasmonics, and radio frequency/microwave science and technologies by leveraging and developing novel computational modelling techniques.

The EP Department encompasses the following three Capability Groups:

**Photonics and Plasmonics**
The Photonics and Plasmonics group advances lightwave technologies in micro and nanostructures for society and economy, which covers applications in high-speed communication, healthcare, lighting display and energy harvesting.

**Radio Frequency Engineering**
The Radio Frequency Engineering group empowers electromagnetics for industry and humanity. It focuses on enabling technologies for wireless communication, electromagnetic compatibility and electronic packaging.

**Emerging Algorithms and Models**
The Emerging Algorithms and Models group develop and apply novel non-linear electromagnetic algorithms and chaotic analysis techniques in emerging research areas, such as urban living and sustainability to improve the quality of life of urban residents.

The mission of the Fluid Dynamics (FD) Department is to develop new modelling and simulation methods for fluid mechanics, thermal management and fluid related multi-physics phenomena. The research focuses on advancement of the fluid physics and discovery of new fluid behaviour as well as to support industry innovation and technology through simulation and optimisation.

The following three research areas form the core focus of the Capability Groups in FD Department:

**Environmental Modelling**
The Environmental Modelling group conducts research and supports industry over a myriad of environmental issues, focusing on the urban heat island impact, urban sustainability, energy efficiency solutions and the national green-mark building thrust.

**Fluid Structure Interaction**
The Fluid Structure Interaction group focuses on the interaction of movable or deformable structures with an internal or surrounding fluid flow through new modeling methods and algorithms.

**Multiphase Flow**
Multiphase Flow is a complex flow phenomena of materials with different states or phases occurring in natural and industrial processes. The Multiphase Flow group develops new algorithms and models to solve interfacial flow dynamics, bubbly flow, phase change with mass/heat transfer, liquid drop and substrate interaction, and microfluidics applications.

The Engineering Mechanics (EM) Department aims to advance science and technology in the fields of mechanics, mechanical and thermal properties of materials and mechanical and thermal engineering by using and developing novel computational models, methods and tools. Key to this is the use of computer simulations to discover the new fundamental understandings in mechanical and thermal science, mechanical and thermal engineering and their coupled fields, and to solve engineering problems in relevant industries in order to enhance their competitiveness and productivity.

These are the key Capability Groups in the EM Department:

**Engineering Systems**
The Engineering Systems group employs modeling and simulation to analyse the mechanical properties (e.g. strength, toughness, ductility and fatigue life) of engineering systems, and provide design strategies to avoid their mechanical failures as well as practical solutions to extend their lifespans.

**Nano Mechanics**
The Nano Mechanics group employs computer modelling and simulation as tools to investigate the mechanical properties of nanomaterials and nanostructures, and provide design strategies to improve their performance.

**Mechano-Electronics**
The Mechano-Electronics group investigates the coupled (mechanical, electronic and thermal) properties of novel materials in important science and engineering problems, and establish core capabilities based on atomistic simulations to provide design strategies to improve materials performance.

**Soft Matter**
The Soft Matter group aims to understand the mechanical behaviour of soft materials and design flexible structures for various novel engineering applications, such as biomedical devices, flexible electronics and mechanical energy conversion and harvest.
The Materials Science and Engineering (MSE) Department aims to use modelling and simulation techniques to advance materials science and target leading edge applications relevant for industry especially the consumer care, chemical, aerospace, electronics, oil and gas, and marine and offshore industries. MSE researchers combine atomistic simulations with other methods including informatics, CALPHAD and phasefield methods to understand bulk properties.

There are four key Capability Groups in the MSE Department:

**Functional Materials**
The Functional Materials group is working to develop new materials for electronics, photonic and energy conversion through first-principle calculations of electronic, optical, thermodynamic, and magnetic properties.

**Interfaces**
The Interfaces group solves problems in the consumer care, maritime and chemical industries using both ab initio and classical dynamics methods to study reaction pathways, interfacial properties and polymer configurations.

**Microstructure**
The Microstructure group uses a multiphysics/multiscale approach to understand and optimise material properties by adjusting processing conditions and especially controlling microstructure.

**Applied Thermodynamics**
The Applied Thermodynamics group uses thermodynamics and kinetic modeling combined with multi-scale modeling to predict compositions and suggest appropriate process parameters.

The Social and Cognitive Computing (SCC) Department aims to develop adaptive technological capacities for the new social era. The research programmes are grounded in multi-disciplinary research and advanced engineering domains in psychological measurement, data analytics, computational modelling, machine cognition, human-machine interactions, ubiquitous sensing and data storage.

SCC Department’s four research thrusts are:

**Psychometrics and Decision Science**
The Psychometrics and Decision Science group develops methods to access psychological traits and predict preferences and behaviour, and refines theoretical and computational models of human decision-making.

**Consumer and Social Intelligence**
The Consumer and Social Intelligence group uncovers consumer and social sentiments, prevailing emotions and emerging behavioural trends, by using information from various sources in conjunction with psychographic analysis.

**Cognitive and Social Systems Modelling**
The Cognitive and Social Systems Modelling group develops computational models to study the complex social interactions and decision-making between entities in the real and virtual space, in particular the dynamics and impact of social influence, the mechanisms driving social contagion, and the emergence of crowd-level behaviour.

**Communicative Thinking and Technologies**
The Communicative Thinking and Technologies (CT²) group applies methods from psychology, linguistics and cognitive science to investigate meaning and knowledge building in order to design technology solutions toward enhancing communication, collaboration, as well as creative and innovative thinking.