The Guiding Framework for EPSRC ICT Applicants

EPSRC remit for applications in ICT can be extremely broad, and we continue to support research across the full spectrum and remit of ICT, both fundamental and applied, as well as interdisciplinary, intradisciplinary and multidisciplinary projects. With this in mind, we have co-developed, together with our Strategic Advisory Team (SAT) and other key academic stakeholders, the following guiding framework, encompassing seven core portfolios and related cross-cutting themes.

Some research areas falling predominantly within other EPSRC theme remits intersect with our guiding framework, including fundamental AI, quantum technology, advanced materials, engineering (including space technology and robotics), manufacturing and circular economy research, as well as resilience, security and cryptographic aspects of ICT.

Throughout we encourage applicants to consider how they enable inclusion and a welcoming environment to expand and grow the talent base, supporting discipline hopping as appropriate, allowing the leaders of the future in ICT to flourish, and leading to societal and economic growth.

The Seven Portfolios of ICT

These portfolio areas were developed as a reaction to the ever-changing research landscape in the UK and worldwide, as well as in response to changes to various UK Government strategies and directions, with implications across ICT.

EPSRC ICT team wanted to simplify the existing 26 distinct research areas and create wider portfolios that would be inclusive of all the research that we fund as well as have an element of future proofing, for longevity. These are designed to help applicants better understand the breadth of, and the potential interconnectivity across, the ICT remit.

I. Fundamentals of Computing

This area explores the fundamental, foundational, and theoretical aspects of computers and computation. A central theme is the design and analysis of algorithms, data structures and their computational complexity and efficiency in computational time and energy. It also encompasses research into the design, implementation, maintenance, analysis, and adaptation of software systems, including empirical and responsible software engineering, its best practices and body of knowledge.

It covers design of programming languages, including domain-specific languages and natural languages for programming, development of the relevant mathematical theories, the processing of these, and the generation of code.

It covers supporting work on increasing the likelihood that systems are correct, covering both formal and software verification approaches and developing and using software under uncertainty.

Additionally, this portfolio intersects with mathematical topics such as logic and discrete mathematics and numerical methods, and with the fundamental digital security and resilience space as well as theoretical computer science, cryptography and cryptological approaches to trustworthy distributed systems. Addressing these fundamental questions in their application to areas of other themes within the portfolio (verification and correctness for data science or programming language design and foundational analysis for AI, for example) is an area of overlap.

While this portfolio focuses on the fundamental questions of effective computation, these have domain-dependent aspects, and domain-specific questions touching on these areas are in scope, including, but not limited to, areas such as:

- Physical computing (built environment, embedded devices, internet of things)
- Biocomputing (health, software as a medical device)
- Digital twins (simulation software, model-based control)
- Compliance, software in regulated and certified environments
- Quantum computing

II. Artificial Intelligence Technologies

This area covers advances in artificial intelligence, machine learning and deep learning to benefit society, provide skilled employment and deliver significant economic growth.

AI describes a suite of computational technologies and tools that aim to reproduce or surpass abilities of humans to undertake complex tasks like learning and problem solving. It enables us to use and make sense of data. Its use has grown with the increase in computing power, the rapid rise in the availability of data, and the need to process increasingly large and complex datasets.

III. Data Science

Research around pulling out meaningful insights including visualisations from data, using a predominantly interdisciplinary approach spanning computer science, statistics, algorithms and information systems as well as biological informatics. This also covers the management, retrieval and representation of information and knowledge, as well as the theoretical foundations of databases and research into data management systems, distributed information management and query languages.

The area also includes Natural Language Processing – the exploration of computational techniques to learn, understand and produce human language content.

IV. People, Interaction and ICT

People's lives are increasingly affected by complex, interconnected and data-intensive technologies. These span the numerous direct and indirect interactions with digital systems we have as individuals every day, and impact the social, cultural and economic structures we build over time. This highly diverse, interdisciplinary portfolio encompasses research that supports richer understanding of the opportunities and risks for individuals and communities arising from increasingly pervasive and ubiquitous computing technologies. It seeks to ensure inclusive, usable, sustainable and beneficial design and development of those technologies. Applicants for funding in this theme are strongly encouraged to centre human needs and capabilities in their research, making use of user-inspired and co-created approaches. Research methods and outcomes should consider and target positive individual experiences with ICT in daily lives, including human computer interactions, together with social, legal and ethical aspects of computing in our world.

V. Audio, Vision, Speech and Senses

This area covers aspects of audio (speech, music and other natural and artificial sounds – from understanding and synthesis of human speech to how systems recognise and generate the sounds of language), vision (theory and fundamental underpinning of Image and Vision Computing in both 2D and 3D, across the electromagnetic spectrum) and the synthesis and manipulation of visual content, including immersive technologies (VR to AR as well as haptics and experimental psychology) as well as novel ways of visualising data and supporting explainability and interpretability of data and algorithms. It also includes studies of the biology and psychology of human vision, hearing and other senses to underpin design/implementation of human-computer interfaces.

VI. Communications Systems

This area covers both wired (copper, fibre, waveguides, etc.) and wireless (radio frequency technologies (RF), free-space optical etc.) communication systems, from terrestrial scales down to inter-device communication. It encompasses the full communication and networking stack across the physical layer, protocols, network software (including network management software, control software, etc.) and virtualisation. Research in this area will help to realise efficient, resilient, secure and trustworthy communication systems which help to meet sustainability and NetZero ambitions.

It covers the fundamentals of communication systems, including information theory, signal processing, and emergent communication approaches and challenges. Research may apply systems-thinking approaches leading to the end-to-end convergence of technologies and services, target specific application domains (for example, but not limited to, healthcare, transport, smart cities, immersive living, manufacturing), undertake experimentation at scale, and lead to potential impacts in translation and standardisation. Advances in AI will enable research into more intelligent communication systems, and developments in communications will support network-enabled AI computational tools and services.

The area also includes future network architectures and the future Internet, cyber physical systems and pervasive computing/sensing systems, including distributed sensing, timing and control, and integrated sensing and communication.

VII. Semiconductors – electronics and photonics

Electronics and photonics are now completely ubiquitous across society and essential for the delivery of communications, energy, utilities, transport, finance, entertainment, national security and healthcare.

This area covers all aspects of the system stack in delivering electronic and photonic devices and systems including design (design tools and methodologies, architectures, intellectual property, AI devices, sensors, etc.), materials and epitaxy (group IV, compound, etc.), fabrication, homogeneous and heterogeneous integration (including hardware/software co-design, more than Moore) and packaging.

It includes micro- / nano-electronic systems and devices (logic, memory, low power, high power, high frequency, neuromorphic, etc...), photonic components (lasers, LEDs, photodetectors, modulators, etc...), photonic integrated circuits, computer architecture (high performance, chiplets, edge computing, AI engines, real-time operating systems) and emerging semiconductor and photonic technologies.

The area also includes design and technology considerations regarding resilience, security, towards net zero approaches, reuse, sustainability (low power, energy efficient, etc.), national security, international linkages and the global supply chain.

The Cross-Cutting Themes for ICT

These cross-cutting themes were developed in the context of the ever-changing research landscape in the UK and worldwide, as well as in response to changes to various UK Government strategies and directions, with implications across ICT. They are designed to highlight themes that applicants may want to consider that sit outside of traditional ICT research areas, often involving inter-, intra- and multidisciplinary research (e.g. including elements of sociotechnical, socioeconomic, environmental science, etc.).

We encourage applicants to consider these themes as they develop their research projects and contemplate approaches and methodologies that they might use to enable the impact of their research. We recognise that these themes overlap and that each can inform progress or direction in others.

1. Enabling research for societal benefit

As ICT becomes ubiquitous throughout society, underpinning much of today's physical and information infrastructure, systems as well as communication platforms and networks need to positively impact wider society to mitigate social division, inequality and adverse distribution of power within the digital economy. Applicants should aim to generate knowledge and solutions that directly benefit society, by incorporating principles of equitability, sustainability and social good.

Projects should consider how digital technology and ICT advances can address local, national and global challenges that improve social outcomes and ensure that everyone, regardless of background, is respected, valued and able to contribute and benefit to society. When actively considered, ICT advancements can enhance social inclusion and accessibility, civic engagement and governance, economic development, job creation and security and privacy.

2. Building a multidisciplinary research ecosystem

Inter-, intra- and multidisciplinary research is an essential component that allows researcher to meet the interconnected challenges facing ICT and develop new and updated solutions that take on the complexities of society, resilience and security.

Properly developed, these ideas can be genuinely disruptive, drawing upon meaningful collaboration with expertise in areas such as, the creative industries, social sciences (including economics and new business model development), ethics and environmental science, amongst others. Maximising cross-disciplinary approaches improves creativity whilst working with typically non-scientific disciplines and incorporating methods, theories and perspectives that cross fields, can lead to novel approaches that deliver improved insights and strengthen research outcomes.

Delivering for the next generation will require greater reliance on cross-disciplinary skills. Project outcomes will be strengthened by building collaboration between experts in software, architecture, programming languages and hardware as well as actively engaging and partnering with experts from the wider research landscape.

3. Enabling and underpinning creative research

In our ultra-connected world, cross-disciplinary research, encompassing skills beyond the traditional scientific base, is increasingly important to ensure technology and innovation can remain agile and meet the future security, economic and social needs of the world. Projects should consider how drawing from the arts, medical or economic fields could strengthen research outcomes. Creative Industries can bring new ideas that transform the role of ICT in driving innovation and enable breakthroughs and innovative approaches to stay ahead of evolving threats.

Maximising the use of human-computer interaction research as well as software tools (such as AI and Machine Learning) and more visual content can deliver interfaces that feel natural and intuitive, cater to diverse user needs and build more equitable access to technology. Likewise integrating ethical challenges into ICT developments by drawing on creativity in algorithm design can widen the user input beyond traditional scientific boundaries.

4. Supporting future sustainable technologies

ICT drives sustainability by enabling industry to optimise processes and resources to improve capacity and equity in access and services across society. Considerations across all three pillars of sustainability (environmental, social and economic) are crucial in ensuring ICT can meet current needs without compromising the ability of future generations to meet theirs. Solutions need to ensure ICT research acts as both an enabler of sustainable solutions but also considers the balance of size, weight, power and cost (SWaP-C) in delivering energy efficient technology and hardware without compromising functionality.

ICT solutions should consider sustainability throughout and beyond the project lifecycle and encompass the impact of technology, e-waste management, smart solutions, the circular economy, net zero, accessibility and sustainable software development.

5. Unlocking the potential of user centred, user co-created research

ICT enables modern society through information and communications system as well as allowing immediate interaction with users directly through AI, the internet of things and digital society. In developing projects, there is a need to understand the behaviours, needs, challenges and motivations of users and be mindful in how we actively engage with users to influence the direction and outcomes of the research.

The application of user co-created solutions within research, such as but not limited to optimisation and AI techniques, requires stronger consideration of ethics and accessibility at all stages of project development and technology readiness level (TRL) as well as manufacturing readiness level MRL), with the objective of maintaining integrity, transparency and trustworthiness in the outcomes. Projects should consider end user needs, adopting a people-centred or user co-created approach that considers both “what we can do” and “should we do this?”.

6. Enabling the push towards commercialisation

The translation of research into tangible products or commercial technologies benefits society and the economy by enhancing the pace of development and improving social outcomes whilst offering increased funding to the research community and driving interdisciplinary collaboration and job creation.

A push to commercialisation should not limit exploratory, curiosity-driven research. However, researchers should aim to take a longer-term view where relevant, considering bridging the gap between fundamental research and translation of ideas into practical applications of products or technologies. Indeed, consider the next steps to proof of concept, up front and a have a plan for what next. By deepening partnerships with stakeholders, including users, community groups, industry and policymakers, researchers can ensure that the project outcomes have commercial application and meet the needs of the intended market.

7. Supporting research to enable resilient, secure and trustworthy ICT

ICT is central to the resilience, security and trustworthiness of all infrastructure, platforms, networks and whole systems embedded across society. It is essential that the systems and the components in the systems can operate under uncertain or adverse conditions and are designed to withstand disruptions, recover quickly and maintain functionality in difficult circumstances.

Ethical considerations are paramount. They must maintain user confidence in technology, empower industry, government and society, protect critical systems from cyber and physical threats and ensure that society's growing reliance on ICT infrastructure is trusted to perform safely, with integrity and ethics.

8. Building in the ethical, responsible research and innovation (RRI) as well as trusted research & innovation (TR&I) considerations

Researchers should recognise that research and innovation can both positively and negatively affect society. Projects must take a rigorous approach to fully consider the responsible research for innovative implications – identifying and mitigating the negative impacts, whilst maximising the positive impacts. Appropriate checks including ethical evaluations should be incorporated into the project planning to maintain trustworthiness and remove ethical barriers to future uptake at a commercial level.

Applicants have a legal obligation to comply with the National Security and Investment (NSI) act 2021 and UKRI trusted research and innovation policy. Applicants must consider how they will protect the UK intellectual property, sensitive research and data, as well as people and infrastructure when engaging with external and international partners.

See more information on Ethical research and innovation – UKRI and Trusted research and innovation – UKRI