



Security capabilities



The future of security
starts with Cranfield

Security capabilities at Cranfield

Cranfield, a global leader in security and defence education, research, and consultancy, is trusted by security services, governments, armed forces and industry worldwide.

At Cranfield we envision a future where innovative solutions meet security challenges, transforming the pursuit of knowledge into a force for change. In navigating the complexities of the modern world, our goal is to build a secure and innovative future, where security is not just a concept but a driving force for positive transformation.

We provide a global perspective on security issues, transcending UK-based discussions and staying aligned with evolving customer needs. Our academic and research community includes technologists and social science experts with a range of security clearances, focused on application-oriented challenges and supporting the security agenda beyond traditional definitions. We encompass areas such as environmental and food security, materials and manufacturing, with a commitment to tackling vulnerabilities in energy security, economic security and democratic resilience.

Our academics work collaboratively to break down silos and enhance information sharing, promoting pan-university and industry collaboration on courses and research. We have security-focused academics as well as those with broader interests, creating a dynamic mix that allows us to see things from multiple perspectives. The emphasis is always on impact and concrete outcomes.

Cranfield has a rich history and heritage in defence and security, with world-class, state-of-the-art facilities, including at the Ministry of Defence site at Shrivenham. A £7 million investment in the latest forensic science technology at our Cranfield campus has created a centre of excellence that is unmatched in the UK, including crime scene investigation rooms, a crime scene house, and a simulated mass grave excavation site. From laboratories investigating radar systems, to Cranfield Ordnance Test and Evaluation Centre (COTEC) testing materials and weapons, our facilities are unparalleled.

Our education offer

Cranfield has an extensive range of postgraduate courses, apprenticeships and short courses dedicated to advancing knowledge and expertise in the field of security. We also offer bespoke programmes.

Taking a consultative approach, we will work with you to interpret your needs at the organisational, team and individual levels to design a transformative, customised programme to suit your organisation.

Specialising in science, technology, engineering, systems thinking and management, we work with key UK and international government entities, including the national security community, government departments such as the Home Office, Ministry of Defence and Ministry of Justice and the U.S. Department of Defence.

Through education and research we address critical aspects such as security engineering, forensic science, cyber security, resilience, counterterrorism, organised crime, systems thinking and management skills. The applied approach to research, coupled with access to secure test and evaluation facilities, means that we are able to make a significant impact on the security sector in the UK and beyond.

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Policing

Cranfield Forensic Institute (CFI) stands as a testament to our commitment to innovation and excellence. Recent investment in CFI has transformed it into a hub of cutting-edge facilities, making Cranfield a leader in forensic education. As a world-class teaching centre, CFI excels in various fields, including ballistics, explosives and material science. We promote a hands-on approach, using unique facilities such as Cranfield Ordnance Test and Evaluation Centre (COTEC) for explosive investigation.

Cranfield University has been synonymous with the domain of digital forensics since the early 2000s, focusing on identifying, acquiring, processing, analysing and reporting on electronically stored data. We play a crucial role in diverse scenarios, gathering intelligence, preventing crimes and assisting in criminal cases ranging from murders to domestic violence.

Our Counterterrorism programmes address the complex issues surrounding terrorism, counterterrorism, risk management and resilience. The Counterterrorism, Intelligence, Risk and Resilience Group conducts groundbreaking research on issues like radicalisation, risk assessment and de-radicalisation, contributing to shaping effective counterterrorism strategies.

The Centre for Computational Engineering Sciences has a proven track record in the development of software for security and surveillance, from threat detection using human pose estimation and object recognition to sophisticated analysis of visual data.

The Advanced Vehicle Engineering Centre (AVEC) is a specialist research and development facility. AVEC focuses primarily on the development, application and evaluation of advanced vehicle technologies to improve communication systems and help make vehicles more capable, safer and more efficient. In addition, Cranfield's accident investigation laboratory supports the work that is carried out in the Safety and Accident Investigation Centre. The laboratory is unique in teaching establishments outside of the United States and complements our renowned full-scale field exercises.

Cranfield's crime scene house: A milestone in forensic education

On the 25th anniversary of Cranfield Forensic Institute, we unveiled our specialist crime scene house facility, with investment from Leica Geosystems Ltd. Externally resembling an ordinary family home in a tranquil neighbourhood, the crime scene house holds a different world within its walls. Inside, meticulously crafted crime scenes await, featuring blood splatters, fingerprints, damaged property and various forensic evidence scenarios. These settings provide a realistic and controlled environment for students, industry partners, researchers, police forces and professionals to hone their investigative, evidence collection and forensic analysis skills.



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Cyber security and computing

Cranfield's cyber security research plays a pivotal role in guiding governments and industries through the complexities of cyber threats, emphasising strategic and executive-level responses at an organisational level. Our approach covers vital areas, including the human aspects of cyber security, ethical hacking, securing operations management, data science and cyber-physical systems. The integration of a unique blend of human and technical aspects is evident in our apprenticeship at MK:U, where a special focus is placed on fostering positive security behaviours.

Cranfield has pioneered cutting-edge technologies, particularly in high-performance computing (HPC), where we merge computer science and mathematics to create efficient algorithms and software for solving large or time-intensive problems. Our expertise extends across sectors like aerospace, transport systems and financial modeling, where HPC facilitates algorithm development and simulation.

Exascale computing enables the resolution of computationally intensive problems but also integrating with quantum computing, unlocks new possibilities in encryption-breaking techniques.

Cranfield is at the forefront of developing trustworthy artificial intelligence (AI) and robotics, contributing to the development and exploration of technologies that prioritise reliability and ethical considerations. The use of open-source software is integral to our approach, fostering collaboration and transparency in the development of advanced systems. We have initiatives looking into the ethical dimensions of surveillance and AI, ensuring responsible and transparent development and deployment of these technologies.

The Centre for Computational Engineering Sciences has a proven track record in the development of software for security and surveillance. We have developed algorithms designed to enhance the effectiveness and efficiency of security systems. Our experience in computer vision supports the sophisticated analysis of visual data, significantly improving surveillance operations by identifying suspicious activities or individuals in real-time.

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Geospatial and remote sensing

Understanding landscape change in support of remote opium monitoring in Afghanistan

Cranfield's innovative remote sensing methods have enhanced the counter narcotics efforts in Afghanistan, the primary source of heroin trafficked to the UK.

Collaborating with the United Nations Office on Drugs and Crime (UNODC), Cranfield's approach, using medium-resolution imagery and very-high-resolution satellite data, addressed discrepancies in opium cultivation estimates. This method offers more accurate and timely insights, allowing the UNODC to identify opium production locations, optimise eradication efforts and expose misreporting.

By monitoring the entire Afghan landscape throughout the growing season, we can detect real-time changes in agricultural practices, enabling targeted counter-narcotics operations and providing unprecedented access to data in remote regions. This refined methodology significantly improves the effectiveness of counter narcotics campaigns, minimising the need for on-the-ground surveys and enhancing overall strategic decision-making.



Cranfield Resilience and Security Institute

Cranfield Resilience and Security Institute (CRSI) is a leader in addressing global challenges relating to resilience, sustainability, and security. Against the backdrop of the climate crisis and escalating geopolitical instability, CRSI recognises the complex and interconnected nature of risks that threaten sustainable development.

By fostering collaboration across disciplines in technology and management, CRSI actively engages with policymakers and practitioners to tackle resilience and security challenges at various levels – local, regional, national and international.

CRSI emphasises both proactive and reactive strategies. While most entities focus on resilience post-crisis, CRSI underscores the urgency of proactive measures, addressing challenges such as climate change, diversity, poverty and unforeseen disruptions like terrorism, cyber-attacks, extreme weather events and pandemics.

Cranfield has a unique multi-domain, interdisciplinary resilience network spanning Aerospace, Defence and Security, Energy and Sustainability, Environment and Agrifood, Manufacturing and Materials, Transport Systems, Water and the School of Management. This distinctive positioning enables CRSI to deliver cutting-edge thinking and innovative solutions, enhancing society's resilience to a spectrum of threats – be they acute, insidious, malicious or non-malicious.

CRSI encourages government agencies, industry partners and academia to engage in collaborative efforts. Through this inclusive approach, we leverage diverse expertise and contribute significantly to creating a more secure and resilient world.

Resilience Reimagined: A practical guide for organisations

Cranfield, working with the National Preparedness Commission (NPC) and Deloitte, has produced *Resilience Reimagined: A practical guide for organisations*. The result of extensive research involving over 50 C-suite individuals across FTSE 100 companies and major infrastructure organisations looks at the complexities of organisational resilience.

In an era marked by heightened uncertainty, the report underscores the critical need to fortify resilience in order to navigate unforeseen challenges. Drawing lessons from resilient organisations, it offers actionable insights for leaders. By tapping into the experiences of business leaders, policymakers and resilience professionals, the guide serves as a roadmap to enhance organisations' ability to thrive amid constant change and uncertainty.



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Manufacturing and materials

Cranfield is at the forefront of addressing security challenges through its pioneering work in manufacturing and materials. Our research interests span critical areas such as digital twins, life cycle optimisation, data modeling, non-destructive testing, ontologies, uncertainty quantification and augmented reality. We actively seek manufacturing and materials-related opportunities to engage with the security sector, emphasising digitalisation, AI, digital twins, cyber security (including blockchains) and asset management.

In materials science, our capabilities include analysing tool marks, gas chromatography-mass spectrometry, explosives analysis, metallic component analysis, creating biological profiles for skeletal remains, biomechanics studies and advanced imaging for security screening. These capabilities contribute significantly to security challenges, including criminal and terrorist activities. Cranfield is an associate partner of the Henry Royce Institute, leading state-of-the-art research in materials and coatings for extreme environments.

Energetic materials, ordnance and weapon systems testing are undertaken at Cranfield Ordnance Test and Evaluation Centre (COTEC), providing a robust platform for trials. COTEC's capabilities extend beyond explosives, serving as a testing ground for various materials and equipment.

Research into novel ways of developing body armour for police and security services are integral components of Cranfield's expertise. Renowned for our proficiency in armour systems, including terminal ballistics and body armour ergonomics, we conduct practical experimentation and testing using instrumented indoor ballistic ranges and impact testing machines. The University's ISO9001 approval for mechanical and ballistic testing solidifies its standing as one of the primary light armour test facilities globally.

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LightArmour project – pioneering lightweight body protection

The LightArmour project, part of the £10 million Dual Use Technology Exploitation (DUTE) innovation cluster, is poised to transform body protection solutions with innovative lightweight and flexible armour. Co-funded by the Government and industry, the initiative aims to revolutionise ballistic protection by introducing cost-effective, adaptable materials for various applications.

Traditional armour is often heavy and rigid – LightArmour seeks to overcome these challenges using self-reinforced polymer composites and lightweight ceramics. The research focuses on developing unique, flexible, or articulated mouldings tailored for diverse applications, providing protection against threats ranging from light firearms to improvised explosive devices (IEDs).



Infrastructure

The Advanced Materials for Protective Engineering: Blast and Ballistics research group (AMPEG) is a global leader in protective engineering for both ballistic impact and blast, addressing conventional and non-conventional threats. Our focus encompasses target responses for military, police, NGOs, industry and government, emphasising cost-effective and sustainable protective measures.

AMPEG looks at diverse materials such as tissue surrogates, glass, composites, metals and metamaterials, providing bespoke training courses on threats, advanced materials and personal protective equipment (PPE) to police forces nationwide. Engaging in national and international working groups, we advise on policy to enhance protection standards.

Collaborating with industry and the Ministry of Defence, we offer sustainable solutions for protecting structures, extending beyond traditional terrorism threats to address challenges like domestic hydrogen fuel infrastructure. Our research aligns with the UK's net zero agenda, contributing to achieving a carbon-neutral defence and security infrastructure.

Our analyses of critical national infrastructure vulnerabilities cover power stations and the national grid. Ongoing research explores the use of natural materials, including blast-absorbing materials, with a focus on applications in the demining community and advancing PPE development.

Through application of material science, we look to develop and test the next generation of vehicle protection against blast, fragmentation and ballistic threats, both experimentally and computationally.

The Chemical, Biological, Radiological, Nuclear (CBRN) team has extensive knowledge in threats, effects, resourcing and response, supported by physical assets like radiological sources, detectors and versatile operating spaces.

Our work in banking security involves financial modeling, data mining and credit scoring, while collaborations with national crime agencies on AI-related topics enhance our commitment to addressing evolving security challenges. We also engage in predictive trend analysis using the Black-Scholes equation.

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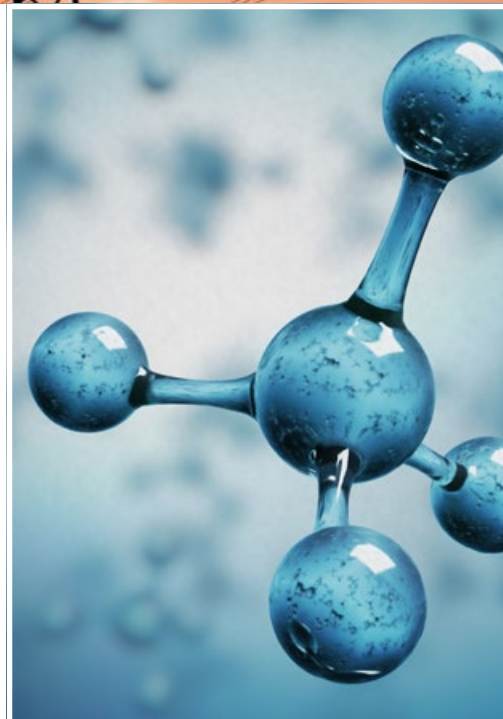
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Enhancing hydrogen transition in natural gas infrastructure

As the UK Government targets a hydrogen transition in its gas infrastructure by 2035, Cranfield's research focuses on the unique dynamics of pure hydrogen transport. Unlike previous studies on hydrogen-methane mixtures, this project explores shifts in gas distribution parameters.

Using analytical and computational models, the study compares hydrogen and methane flow in pipes concerning pressure loss, considering variables like pipe material and diameters. The findings suggest that hydrogen must travel at a higher velocity than methane for comparable flow.

The study provides crucial insights for optimising the transition from methane to hydrogen in existing gas infrastructures, anticipating hydrogen's role in domestic heating applications by 2035.



Working in partnership

At Cranfield, we foster collaboration with experts in security and resilience across academia and industry, addressing Government challenges and helping ensure our skills, expertise, knowledge and facilities make a difference within society.

Network for Security Excellence and Collaboration (NSEC) – connecting government, industry and academia to protect the UK.

Cranfield is leading the refresh and diversification of the Network for Security Excellence and Collaboration (NSEC) (formerly known as Academic RiSC); a network of academics delivering expertise and counsel to the Government on the UK's ongoing security and resilience needs. With a network spanning 60+ UK universities, NSEC benefits from Home Office oversight and is recognised and supported by Government departments plus industry as a vital conduit to expertise in the field. Cranfield has been leading this network since September 2019.

Working with the Joint Security and Resilience Centre (Home Office) and supported by the Government Chief Science Adviser community, NSEC seeks to enhance collaboration between academia, industry, and Government. NSEC's objectives include synthesising knowledge, skills, and experience, fostering early career researchers and identifying and addressing policy needs. The ongoing partnerships being developed include networks like the National Cyber Security Centre's Academic Centres of Excellence (ACEs), SPRITE+, RBOC+ and CREST plus the Home Office's Accelerated Capability Environment.

Innovative research for safer environments: The Future Biodefence Technologies Hub

Cranfield is an integral part of an initiative aimed at expanding research capabilities in biodefence technologies against harmful airborne pathogens. Led by the University of Hertfordshire, the initiative seeks to develop safer, healthier and more resilient environments against bioaerosols, including bacteria, viruses, fungi, pollen and toxins.

Leveraging our expertise in characterising bioaerosol emissions, Cranfield is a key contributor to the interdisciplinary Aerobiosense Research Group, dedicated to developing novel technologies.

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"The Future Biodefence Technologies Hub will drive innovation and technology for the early detection of biological hazards to improve the UK's resilience to a broad spectrum of biodefence and biosecurity threats. Our £13.5 million award is the sole collaborative project funded through Research England's current round of E3 funding. My involvement in the Academic RiSC network provided a unique opportunity to identify and unite a team of academic collaborators at Cranfield, Leeds and Manchester, with Governmental and industrial partners with interests in bioaerosol monitoring, sampling and sensing."

Professor Ian Johnston, Professor of Microfluidics and Biodefence, University of Hertfordshire

Environmental security

We operate within an increasingly complex environment shaped by climate change and societal responses to this global challenge. Cranfield's expertise spans the impact of climate change, policy implications and their direct connection to security considerations, both present and future.

A critical area of expertise is the impact of the climate emergency on infrastructure, society and food and water security. Cranfield's expertise on infrastructure, urban systems coupled to water availability, food production and logistics systems presents a unique capability that allows us to address these complex and interrelated risks.

Cranfield Environment Centre plays a pivotal role in navigating the changing environmental landscape and understanding its implications for people, long-term resilience and sustainability of systems. Here we employ a systems approach, integrating sensor and measurement technology, systems modeling, environmental informatics, data and decision science. Research includes air quality, climate change, soil systems, crop growth and monitoring, natural capital, resilience and ecosystem goods and services.

The nexus between societal resilience, environmental security and food/water security and how this changes into the future is a focal point of our research. Our capabilities focus on understanding current systems resilience, scanning future trends and risks, and developing effective solutions to ensure that societal systems have the capacity and capability to adapt and mitigate the challenges presented by climate change.

For five decades, Cranfield has been committed to enhancing ecological resilience and natural capital and contributing to global food system resilience. Through technological innovation, coupled with effective data sharing and robust risk management, we can address both immediate and long-term environmental pressures, ensuring a more secure and sustainable future.

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Enhancing infrastructure resilience in the face of climate change

Cranfield Environment Centre's research focuses on enhancing the resilience of critical physical infrastructure, such as railway lines and communication systems, in the face of climate change. Studies address the escalating challenges posed by temperature fluctuations, intensified winds, and altered precipitation patterns, leading to disruptions like heightened flooding, storms, and heatwaves. Collaborating not only with Network Rail but also with various UK Government agencies, the Centre identifies and maps out key vulnerabilities anticipated in tomorrow's climate. The academics also formulate strategic measures to mitigate these vulnerabilities, ensuring the steadfast security of essential societal systems.



Transport security

Cranfield's global research airport provides a unique setting for groundbreaking aerospace research, positioning us as a leader in the field. As one of the few universities in the world with our own dedicated airport, we tackle the challenges of digital aviation, reimagining the future of airports, airlines, airspace management, and aircraft. Security is a primary focus, involving the integration of drones into civilian airspace, establishing secure shared airspace with robust data communication, and enhancing aircraft and airport safety.

At the forefront of UK digital aviation technology, the Digital Aviation Research and Technology Centre (DARTeC) serves as an experimental airport terminal, addressing critical challenges in transport systems, aerospace, manufacturing and materials. Cranfield's research emphasises AI-based solutions for adaptable and resilient air traffic infrastructure against emerging cyber-physical threats.

The Seamless Emergent Network for Security (SENSeC), an offshoot of DARTeC, fosters collaboration among security stakeholders, focusing initially on aviation security. Cranfield, funded by Security Technology Research and Innovation Grants and the Future Aviation Security Solutions programme, conducts pivotal research on drone detection to enhance aviation security.

A joint venture being pioneered by Cranfield and Nottingham Trent University is investigating the use of X-ray signatures to identify illicit items such as drugs and explosives at airports. Halo, a revolutionary X-ray security scanner, uses scattered X-ray signals to identify materials, enabling quick and precise identification of illicit items such as drugs and explosives at airports.

Cranfield is a leader in astronautics and space engineering, conducting research spanning various areas, including Earth observation, radar systems, space debris mitigation, and space-based surveillance using CubeSats.

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Antifragility for secure air traffic control

Academics at Cranfield are conducting a study addressing the vulnerability of the UK's critical national infrastructure, with a specific focus on air traffic management. The UK has one of the world's busiest airspaces and with the rise of autonomous aircraft, the imperative is to ensure secure air traffic control with robust, resilient, and self-adaptive measures against diverse threats.

This research programme proposes to develop AI-based antifragile solutions that can complement existing mitigation strategies. The aim is to make the system adaptively resilient using the past experiences of the cyber-physical attacks. The innovative approach combines expert-informed fragility features with active learning of new experiences. The long-term impact will examine how we can integrate antifragile solutions into existing air traffic control systems and other critical infrastructure.



Improving preparedness in an evolving technical security landscape

Our research with the UK National Authority for Counter-Eavesdropping (NACE) within the Foreign, Commonwealth & Development Office is addressing the dynamic security landscape and facilitating greater alertness to technical security threats. Employing our bespoke horizon scanning tool, a 360-degree scan of changes in the security landscape was carried out, drawing on expertise at Cranfield and across Government to interpret early (weak) signals of change and persistent trends:

- New attack vectors arising from scalable IoT environments;
- Race to acquire quantum encryption/decryption capabilities;
- New forms of insider threat, corporate espionage;
- Developments in State Surveillance;
- Loopholes in procurement systems;
- Changing work landscape (flexible, remote, hybrid) and new security risks;
- Worker surveillance;
- Digital competencies and security awareness.

The imperative is to gain insights into the evolving technical security landscape's impact on national security, people, assets, and sector-specific vulnerabilities. Research outputs are intended to inform the development and direction of the UK National Technical Security Strategy and help shape NACE's strategic plans.



People, skills and leadership

Cranfield tackles emerging security challenges, prioritising human-centric risks for enduring resilience in security systems, operations, people and institutions. Our expertise spans future skills, workforce attitudes, resourcing, and the impact of AI on work methods and infrastructure.

Transforming the skills landscape, shaping workforce composition, diversity, and modernisation are crucial for long-term resilience in security systems. In the dynamic landscape of cyber and technical security skills, we ensure preparedness for technological advancements, considering digital competency and security implications amid changing work dynamics. Our research extends to procurement systems, addressing economic and corporate espionage and exploring the dynamics of surveillance capitalism. Embracing next-gen quantum technologies places us at the forefront of anticipating and mitigating emerging security challenges.

The ever-changing external climate we now find ourselves in has changed how organisations work and their decision-making process. Systems thinking has become critical to success; organisations need to focus on their systems and the need for adaptability and resilience like never before. This work extends beyond conventions, developing sociotechnical solutions across government, military, commercial, and the third sector.

The International Security and Law group advances global security and peace, collaborating with states, international organisations, NGOs, and think tanks. Projects span human augmentation, GDPR, and security data management, addressing evolving priorities, legal frameworks, ethics and equality.

Our Gender, Leadership and Inclusion Centre (GLIC) pioneers research on equity, diversity, and inclusion, influencing power dynamics for a more representative workforce. The Centre's impact extends across security systems, operations, people, and institutions, strategically addressing policy horizons.

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Shrivenham



Explosives formulations facility



Explosives research detonation area



Explosive test house
Hazard testing explosives



Ground-based synthetic aperture radar laboratory
Remote sensing techniques for future airborne and spaceborne intelligence gathering platforms



Simulation and synthetic environment laboratory



Microscopy facilities

Salisbury Plain



Cranfield Ordnance Test and Evaluation Centre (COTEC)
Materials and weapons testing and evaluation

Cranfield campus, Bedfordshire



Global research airport
Europe's only university with its own fully operational airport, aircraft, including the Saab 340B flying laboratory and air navigation service provider on campus



Multi-User Environment for Autonomous Vehicle Innovation (MUEAVI)
Instrumented transport corridor



Intelligent Mobility Engineering Centre (IMEC)
Vehicle electrification and autonomous vehicle research capabilities



Digital Aviation Research and Technology Centre (DARTEC)
Passenger experience, air traffic management and communications laboratories and a state-of-the-art Aveillant drone detection radar



UKCRIC National Research Facility for Water and Wastewater Treatment



Railway innovation test area



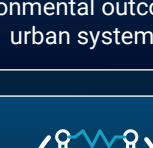
Living laboratory
A testbed for transformative technologies to deliver enhanced social, economic and environmental outcomes in urban systems



Centre for Antenna and Communications Technology Innovation (CACTI)



Forensic research facilities
Including a virtual reality autopsy table, crime scene investigation rooms, crime scene house and a simulated mass grave excavation site



Pilot scale energy research facilities



Accident investigation facilities



Hydrogen and sustainable aviation fuel production, transport and storage research and development facilities



Secure facilities for collaborative working



Environmental security facilities
Plant growth facility, World Soil Survey Archive and LandIS soil information system

Our facilities

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