2022 List of Critical Technologies in the National Interest

Consultation Paper

August 2022

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Introduction

The Australian Government is committed to backing critical and emerging technologies to provide the country with a clear competitive advantage, accelerate productivity growth, and create well-paying jobs and secure supply chains.

The Government has announced an investment of $1 billion in the form of a Critical Technology Fund as part of the broader National Reconstruction Fund. This fund is an investment in building strategic capability in Australia, powering economic growth and creating jobs. It will support home-grown innovation and value creation in areas like AI, robotics and quantum. The government has also committed to a goal of 1.2 million tech-related jobs by 2030. The Government is also committed to fostering resilient global supply chains for critical technologies as they are essential to the prosperity, security and well-being of our nation. Critical technology development and ongoing research and development can help our nation address future challenges across all sectors and for all citizens. To reach our critical technology potential, our whole nation needs to identify and understand what our critical technologies are, where our strengths lie and any gaps. *The List of Critical Technologies in the National Interest* (the List) provides that focus and forms the basis for further discussions around investment and collaboration across all sectors of the economy.

Therefore we are consulting widely on Australia's *2022 List of Critical Technologies in the National Interest*. The List underpins all our efforts to:

- Promote Australia as a secure nation of excellence for investment, research, innovation, collaboration and adoption of critical technologies – globally and in our region
- Ensure secure critical technologies supply chains
- Reach our goal of 1.2 million tech jobs by 2030
- Maintain the integrity of our research, science, ideas, information and capabilities – enable Australian industries to thrive, and maximise the value for our nation from critical technologies.

Government is committed to an open and transparent consultation approach that ensures all stakeholders have an opportunity to provide input and views. During the 6-week public consultation period we will be seeking comments from all stakeholders with an interest in critical technologies, including government, jurisdictional and international partners, industry, and academia. This paper provides some background information on the development of the inaugural List, and specific questions stakeholders may wish to focus on. We look forward to engaging with and hearing from stakeholders regarding critical technologies in the national interest.

What are critical technologies?

Critical technologies are current and emerging technologies with the capacity to significantly enhance or pose risk to our national interest.

Australia's ability to harness the opportunities created by critical technologies has significant impacts on our economic prosperity, national security, and social cohesion. Technological advances drive increased productivity, growth, and improved living standards; but also have the potential to harm our economic and national security interests and undermine our democratic values and principles.

The 2021 List

The inaugural List was developed in collaboration with the Defence Science and Technology Group (DSTG), utilising their technology foresight capabilities and advanced analytical skills to ensure an evidence-based approach to identifying critical technologies. Following the data-driven identification of technologies, refinement of the List then drew on a wide variety of expertise from within Australia and internationally and underwent two rounds of extensive consultation across government, prior to consultation with the research sector and industry in 2021.

The inaugural List features 63 current and emerging technologies with the capacity to significantly enhance or pose risk to Australia's national interest, including our economic prosperity, social cohesion, and national security. This inaugural List is at Attachment A.

Purpose of the List

The List is a signal to government, industry and academia of the critical technologies that may have national interest implications. Technologies included on the List are either critical for Australia today or have the potential to become critical for Australia within the next ten years.

The List does not imply any prescribed or proscribed actions in relation to the listed technologies – inclusion of a technology on the List does not imply guaranteed prioritisation or that there is a real or perceived risk to national security from that technology. Conversely, technologies not on the list are not automatically excluded from consideration nor is the implication that they are not important. The List is intended to serve as a summary of identified critical technologies that stakeholders should be aware of when undertaking their activities.

The *List of Critical Technologies in the National Interest* is an overarching list, which is separate to other government lists with a technology focus that have been developed to address specific policy or regulatory matters. In addition to the *List of Critical Technologies in the National Interest*, there will be an ongoing requirement across government to have lists of technologies for specific purposes, for example the *Defence and Strategic Goods List* (DSGL) – the legislative instrument that specifies the goods and technology that are regulated under Australia's export control legislation.

Technologies on the List are not presented in order of importance or national significance, rather they have been grouped together with other like technologies into seven categories. The List represents only one tool in the suite of materials being developed to assist in the management of critical technologies across all sectors in Australia.

Since its publication, the List has been used to identify areas for policy development and potential collaboration with international partners and in discussions with like-minded partners on policy matters related to critical technologies.

The List, and associated Critical Technology Profiles, have also been used to inform discussions across government and with stakeholders such as the university sector about both the promotion and protection of critical technologies. The Critical Technology Profiles have advanced understanding of critical technologies and the key role they play across Australia's national interest, as well as providing information on potential future applications of the technologies to inform policy development.

The List has also provided a basis for discussions with state and territory governments on the promotion of critical technologies across Australia.

The List	
Does	***Is Not***
• Provide a central list of critical technologies to assist with consistent decision making across sectors • Provide an indicator of technologies that may require increased focus to promote or protect our national interest • Provide guidance on technologies where additional risk management might be required • Provide guidance on technologies where additional development or understanding may be required	• Static. It is intended to be updated biennially • A list of technologies that will be, or should be, additionally regulated or controlled • A list of technologies where the Government intends to prevent or limit collaboration with international research partners • Intended to override or replace other specific government technology lists, e.g., DSGL

Issues raised during the 2021 consultation

The development of the 2021 List underwent two rounds of consultation, with the first round providing clear feedback that the List needed to be developed with a consistent level of granularity of technologies. In the second round of consultation many stakeholders provided input and suggestions, which were picked up in the final List that was published in November.

Several underpinning technology enablers, systems and/or business models were raised during the 2021 consultation such as software as a service, social media platforms and the internet of things. These systems are not represented on the 2021 List as it focused on the component technologies, for example, component technologies used in social media platforms such as AI algorithms and advanced data analytics are included. Similarly for the internet of things, miniature sensors and advanced communication technologies are included on the List. In addition, some areas considered critical infrastructure such as electricity networks were not included on the 2021 List. And lastly, there were a range of very specific technologies that some stakeholders raised, which were considered but may not have been specifically mentioned on the List where they were already included under a broader technology.

Critical Technology Profiles

Alongside the List, government has also published a series of 29 Critical Technology Profiles, which each provide a readily accessible snapshot of Australia's comparative strengths and the applications of the technology, as well as the opportunities and risks. The Profiles include detailed scientometric analysis examining Australia's international ranking for research impact, as well as venture capital investment metrics and patent family data. As part of this consultation, we are also seeking stakeholders' feedback on the content of the Critical Technology Profiles which can be found here.

The 2022 List

We are now providing stakeholders with the opportunity to provide feedback on the inaugural List. As well as consulting with stakeholders, we will be drawing on the outputs of government technology foresight activities and new technologies that have been suggested elsewhere, including by government and international partners. In addition to the content of the List, we are also interested in stakeholder views on the frequency of updates to the List going forwards. While it is proposed that a biennial frequency may be appropriate, alternative proposals will be considered.

How to participate

The consultation will be open for 6 weeks, closing early October. A public consultation portal will be open throughout this period for individual stakeholders to provide feedback. In addition, an open virtual session will be chaired by the Critical Technologies Hub, as well as a series of in person, virtual and hybrid roundtable discussions. Please refer to the website for details of how to sign up for these sessions.

At the conclusion of the consultation period, we will analyse the feedback received and in collaboration with partners across government work to revise the List for publication in mid-November 2022.

Question for stakeholders

1. Are there technologies that should be considered for inclusion or removal from the original List? What are your reasons for the suggestion?
2. Do you have any comments on the individual technology definitions?
3. Do you have a view on the frequency of updates to the List?
4. Do you have any feedback on the content of the Critical Technology Profiles?
5. Has the List influenced decisions in your organisation about technology investment or adoption?

Related consultation

Defence Science and Technology Group (DSTG) is undertaking a related consultation on Analytics and Metrics for Critical Technologies. The DSTG consultation is considering indicators to better understand critical technologies and Australia's place in the world, which are featured in the Critical Technology Profiles.

For information about this consultation or to participate, please contact techfutures@dst.defence.gov.au.

Attachments

A: 2021 List of Critical Technologies in the National Interest

Attachment A: 2021 List of Critical Technologies in the National Interest

The technologies on this list are current and emerging technologies that have been identified to have a significant impact on our national interest (economic prosperity, national security, and social cohesion). Many of the technologies on this list have implications for defence and security, but also often have broader applications.

Advanced materials and manufacturing

AI, computing and communications

Biotechnology, gene technology and vaccines

Energy and environment

Quantum

Sensing, timing and navigation

Transportation, robotics and space

Advanced materials and manufacturing

Additive manufacturing (incl. 3D printing)

Manufacturing physical objects by depositing materials layer by layer according to a digital blueprint or 3D model. Additive manufacturing systems use a variety of techniques to print objects in various sizes (from nanoscale to room-sized) and materials (including plastics, ceramics and metals). Applications for additive manufacturing include rapid prototyping and making custom or small quantity components.

Advanced composite materials

New materials created by combining two or more materials with different properties, without dissolving or blending them into each other. Advanced composite materials have strength, stiffness, or toughness greater than the base materials alone. Examples include carbon-fibre-reinforced plastics and laminated materials. Applications include vehicle protection, signature reducing materials, construction materials and renewable energy wind turbine components.

Advanced explosives and energetic materials

Materials with large amounts of stored or potential energy that can produce an explosion. Applications for advanced explosives and energetic materials include mining, civil engineering, manufacturing and defence.

Advanced magnets and superconductors

Advanced magnets are strong permanent magnets that require no or few critical minerals. Applications for advanced magnets include scientific research, smartphones, data storage, health care, power generation and electric motors.

Superconductors are materials that have no electrical resistance, ideally at room temperature and pressure. Applications for superconductors include creating strong magnetic fields for medical imaging, transferring electricity without loss, and hardware for quantum computers.

Advanced protection

Clothing and equipment to protect defence, law enforcement and public safety personnel and defence platforms from physical injury and/or chemical or biological hazards. Examples include helmets, fire-retardant fabrics, respirators, and body armour.

Continuous flow chemical synthesis

Systems that produce fine chemicals and pharmaceuticals using continuous-flow processes, rather than batches. Compared to batch chemistry, flow chemistry can make fine chemicals and pharmaceuticals faster, more consistently and with less waste products.

Coatings

Substances applied to the surface of an object to add a useful property. Examples include anti-biofouling coatings that prevent plants or animals growing on ships or buildings, super-hydrophobic coatings that repel water from solar panels or reduce drag on the hulls of ships, electromagnetic absorbing coatings that make airplanes and ships less visible to radar systems, thermal coatings that reduce heat loss and increase energy efficiency, and anti-corrosion coatings that prevent rust.

Critical minerals extraction and processing

Systems and processes to extract and process critical minerals safely, efficiently and sustainably. Australia has an abundance of critical minerals and has the opportunity to be a global leader in the ethical and environmentally responsible supply of key critical minerals.

High-specification machining processes

Systems and devices that can cut and shape raw materials into complex and highly precise components. Examples include computer numerical control (CNC) mills, CNC lathes, electron discharge machining, precision laser cutting and welding, and water jet cutting. Applications for high-specification machining processes include making aerospace parts, and components for other manufacturing devices.

Nanoscale materials and manufacturing

Materials with essential features measuring less than 100 nanometres and technologies for their manufacture. Applications for nanoscale materials include, paint, pharmaceuticals, wastewater treatment, data storage, communications, semiconductors, and nanoscale tracking markers for critical materials.

Novel metamaterials

New synthetic materials that have properties that do not occur naturally, such as the ability to bend light or radio waves backwards. Applications for novel metamaterials include energy capture and storage, radio antennae, and adaptive camouflage.

Smart materials

Smart materials are materials that have properties that change in response to external action. Examples include shape-memory alloys that change shape when heated and self-healing materials that automatically repair themselves when damaged. Applications for smart materials include clothing, body armour, building materials and consumer electronics.

AI, computing and communications

Advanced data analytics

Systems, processes and techniques for analysing large volumes of data (i.e. 'big data') and providing useful and timely insights, usually with limited human intervention. Applications for advanced data analytics include medical diagnosis and treatment, acoustic analytics, regulatory compliance, insurance, climate monitoring, infrastructure forecasting and planning, and national security.

Advanced integrated circuit design and fabrication

Systems and processes to design and fabricate sophisticated integrated circuits using process nodes below 10 nanometres. Examples include systems-on-chip (SoC), field programmable gate arrays (FPGAs), stacked memory on chip and specialised microprocessors for defence industry.

Advanced optical communications

Devices and systems that use light to transfer information over optical fibre or free space (i.e. air or the vacuum of space) and use laser technologies, adaptive optics and optical routing to transfer information faster, more reliably, more efficiently and/or using less energy. Applications for advanced optical communications include high-speed earth-satellite communications, short-range visible light communications (i.e. 'Li-Fi'), narrow-beam laser communications and multi-gigabit broadband and corporate networks.

Advanced radiofrequency communications (incl. 5G and 6G)

Devices and systems that use radio waves to transfer information over free space (i.e. air or the vacuum of space) and use novel modulation techniques, advanced antenna designs and beamforming technologies to transfer information faster, more reliably, more efficiently and/or using less energy. Applications include communications satellites, cellular networks (e.g. 5G and 6G), wireless local area networks (e.g. Wi-Fi), short-range wireless communication (e.g. Bluetooth), sensor networks, connected vehicles, implantable medical devices and mobile voice and data services for public safety and defence.

Artificial intelligence (AI) algorithms and hardware accelerators

Artificial intelligence (AI) algorithms are computer algorithms that perform tasks normally requiring human intelligence. Applications for artificial intelligence algorithms include personal and workplace virtual assistants, process automation, virtual and augmented reality, creating more realistic video game environments and characters, public transport planning and optimisation, crop and livestock management, and defence.

Artificial intelligence hardware accelerators are computer hardware optimised and purpose built to run artificial intelligence algorithms faster, more precisely or using less energy than is possible using non-optimised general-purpose computer hardware. Applications for artificial intelligence hardware accelerators include processing on board smartphones, portable virtual and augmented reality systems, and low power internet of things (IoT) sensors.

Distributed ledger

A distributed ledger is a database that is consensually shared and synchronized across multiple sites, institutions, or geographies, accessible by multiple people. Blockchains are one type of distributed ledger that stores information in blocks that are chained together using mathematical principles that are very hard to forge or corrupt. Because anyone can mathematically verify and audit transactions recorded in a blockchain, multiple participants can contribute to, or rely on, a shared blockchain to store information—such as timestamped cryptocurrency transactions—without needing to trust either each other or a mutual third party (like a bank or stock exchange). Applications for distributed ledgers include cryptocurrencies, verification of supply chains such as for product provenance and emissions monitoring and verification, tracking recoverable and recyclable product content, land records, and share trading.

High performance computing

Computer systems that exceed the performance capabilities of consumer devices (i.e. widely available desktop and laptop computers) by an order of magnitude. High performance computers—such as supercomputers—can process large volumes of data and/or perform complex calculations that are impossible or impractical using consumer devices. Applications include climate modelling, computational chemistry and high quality computer graphics for film and television.

Machine learning (incl. neural networks and deep learning)

Computer algorithms that automatically learn or improve using data and/or experience. Machine learning is a type of artificial intelligence. Applications for machine learning include computer vision, facial recognition, cybersecurity, media creation, virtual and augmented reality systems, media manipulation (e.g. deepfakes), content recommendation systems, and search engines.

Natural language processing (incl. speech and text recognition and analysis)

Systems that enable computers to recognise, understand and use written and/or spoken language in the same ways that people use language to communicate with each other. Natural language processing is a type of artificial intelligence. Applications for natural language processing include predictive text, language translation, virtual assistants and chat bots, summarising long documents, sentiment analysis, and making technologies more accessible and inclusive.

Protective Cyber Security Technologies

Systems, algorithms and hardware that are designed to enable a cyber security benefit. Applications for cyber security technologies include but are not limited to; operational technology security, trust and authentication infrastructures, protection of aggregated data sets, protection of AI systems and supply chain security.

Biotechnology, gene technologies and vaccines

Biological manufacturing

Processes that use living cells to make useful chemicals or materials. Examples include fermentation products, biologic medicines such as antibodies and enzyme replacement therapies, and enzymes for environmental remediation and recycling plastics.

Biomaterials

Natural or synthetic materials that can safely interact with biological systems (e.g. the human body) to support medical treatment or diagnosis. Applications for biomaterials include medical implants, such as artificial joints and heart valves, scaffolds to promote bone and tissue regrowth, biosensors and targeted drug delivery systems.

Genetic engineering

Tools and techniques for directly modifying one or more of an organism's genes. Existing techniques include CRISPR gene editing and molecular cloning. Applications for genetic engineering include making crops that are more nutritious or require less water or pesticides, treating genetic diseases by replacing faulty genes with working copies and cell therapies that treat diseases by extracting, modifying and reimplanting patients' own cells.

Genome and genetic sequencing and analysis (Next Generation Sequencing)

Tools and techniques for quickly sequencing (i.e. 'reading') the genetic material of human beings, other living organisms and viruses, and for analysing and understanding the functions of those sequences. Applications for genomics and genetic sequencing and analysis include identifying the genes associated with particular diseases or biological functions, identifying new communicable diseases, crop and livestock breeding and predicting how effective drugs will be for different patients.

Nanobiotechnology

Devices, tools and techniques that use the special properties of nanostructures to monitor or modify living organisms. Applications for nanobiotechnology include more targeted pesticides, biosensors that can detect and count flu viruses, and bioactive nanocapsules that can deliver drugs to where they are needed and nowhere else, reducing side effects and enabling doctors to use more powerful drugs.

Nanoscale robotics

Nanoscale machines made from components like DNA. Applications for nanoscale robotics include targeted drug delivery, identifying cancer cells and moving molecules to assemble drugs or other nanoscale robots.

Neural engineering

Systems and devices that directly monitor, or interact with, the brain or nervous system. Applications for neural engineering include biofeedback monitoring, sensory prosthetics and devices to supplement or replace damaged nerves.

Novel antibiotics and antivirals

Systems for identifying or designing new types of antibiotic and antiviral drugs that can treat bacterial and viral infections in humans and animals safely and effectively. New antibiotic and antiviral drugs must be continually developed and tested to ensure there are drugs available to treat both new infectious diseases and existing bacterial and viral diseases that become resistant to existing drugs.

Nuclear medicine and radiotherapy

Nuclear medicine uses radioactive substances to diagnose or treat diseases. Applications for nuclear medicine include imaging internal organs and tissues, viewing biological processes and using radiopharmaceuticals to treat cancers and other diseases.

Radiotherapy uses ionizing radiation to treat diseases by damaging the DNA in targeted cells, killing those cells. Applications for radiotherapy include treating some types of cancer and treating other diseases caused by overactive cells.

Synthetic biology

Designing and constructing biological systems and devices that have useful functions not found in nature. Applications for synthetic biology include creating microorganisms that can clean-up environmental pollutants and recycle plastics, manufacturing animal-free meat and dairy products, and biological computers.

Vaccines and medical countermeasures

Tools and techniques to quickly develop and manufacture vaccines, drugs, biologic products and devices used to diagnose and treat emerging infectious diseases and medical conditions caused by exposure to harmful chemical, biological, radiological, or nuclear substances. Applications for vaccines and medical countermeasures include public health emergencies, industrial accidents and defence.

Energy and environment

Biofuels

Solid, liquid or gas fuels produced from biological or organic sources. Examples include biogas and biodiesel derived from plant biomass, and bioethanol from crops such as corn and sugar cane.

Directed energy technologies

Systems and devices that transfer energy between two points in free space. Applications for directed energy technologies include powering consumer electronics, recharging electric vehicles, powering aerial drones, ground-space energy transfer, wireless sensor networks and internet of things devices, and advanced weapons.

Electric batteries

Devices that produce electricity from stored electrochemical energy and tolerate multiple charge and discharge cycles. Electric batteries utilise various materials and chemistries (e.g. lithium-ion (Li-ion), nickel metal hydride battery (Ni-MH)) and form factors (e.g. flow batteries for stationary grid storage, polymer electrolytes for vehicles and personal devices). Applications for electric batteries include electrified road and air transport, smartphones and personal electronic devices, medical devices and grid energy storage.

Hydrogen and ammonia for power

Sustainable production, storage, distribution and use of hydrogen (H2) and ammonia (NH3) for heat and electricity generation. Hydrogen and ammonia are potential low or zero emission, zero-carbon alternatives to fossil fuels and electric batteries. Applications for hydrogen and ammonia include energy storage and as a fuel source for aviation and marine transport, long distance road transport and heating.

Nuclear energy

Electricity generation using the energy released when the core of an atom (called the atomic nucleus) splits into two or more lighter atomic nuclei. Applications include energy production for self-contained and/or remote uses, such as space travel, submarines, scientific research and medical isotope production.

Nuclear waste management and recycling

Processes to safely dispose of, or reuse or reprocess for useful purposes, radioactive waste products from medical, industrial and research practices. Examples include converting radioactive liquid waste into synthetic rock to minimise leeching and reprocessing spent radioactive fuel for use in long-life, low-power batteries. Applications include environmental protection and extending the useful life of nuclear material.

Photovoltaics

Devices that convert solar energy into electricity using layers of semiconductor materials. Applications for photovoltaics include low-emissions power stations, rooftop solar power, spacecraft and personal electronics.

Supercapacitors

Electrochemical devices that can store large amounts of energy in small volumes. Supercapacitors store less energy and for shorter durations than rechargeable batteries (hours or days, rather than months or years), but can accept and deliver charge much faster than rechargeable batteries, and tolerate many more charge and discharge cycles than rechargeable batteries before performance degrades. Applications for supercapacitors include regenerative braking, smartphones and personal electronic devices, grid energy storage and defence.

Quantum

Post-quantum cryptography

Mathematical techniques for ensuring that information stays private, or is authentic, that resist attacks by both quantum and non-quantum (i.e. classical) computers. The leading application for post-quantum cryptography is securing online communications against attacks using quantum computers. Because quantum computers can efficiently solve the 'hard' mathematical problems we currently rely on to protect online communications, Australia needs post-quantum cryptography to ensure communications stay secure once quantum computers are available.

Quantum communications (incl. quantum key distribution)

Devices and systems that communicate quantum information at a distance, including cryptographic keys. Applications for quantum communications include transferring information between quantum computers and sharing cryptographic keys (which are like secret passwords) between distant people in a way that means it is impossible for anyone else to copy.

Quantum computing

Computer systems and algorithms that depend directly on quantum mechanical properties and effects to perform computations. Quantum computers can solve particular types of problems much faster than existing 'classical' computers, including problems that are not practical to solve using even the most powerful classical computers imaginable. Applications for quantum computing systems include accurately simulating chemical and biological processes, revealing secret communications, machine learning and efficiently optimising very complex systems.

Quantum sensors

Devices that depend directly on quantum mechanical properties and effects for high precision and high sensitivity measurements. Applications for quantum sensors include enhanced imaging, passive navigation, remote sensing, quantum radar, and threat detection for defence.

Sensing, timing and navigation

Advanced imaging systems

Imaging systems with significantly enhanced capabilities, such as increased resolution, increased sensitivity, smaller devices, faster image capture or otherwise novel and useful capabilities. Applications include healthcare, creative industries, surveillance, and scientific research.

Atomic clocks

Devices that keep time by measuring the frequency of radiation emitted or absorbed by particular atoms. Atomic clocks are the most accurate timekeeping devices known and are used (directly or indirectly) for tasks where measuring time with precision and consistency is essential. Applications for atomic clocks include active and passive navigation systems, processing financial transactions and synchronising telecommunications networks.

Gravitational-force sensors

Devices that detect minute changes in Earth’s gravitational field. Applications for gravitational-force sensors include passive navigation enhancement and detecting mineral deposits, concealed tunnels and other subsurface features that create tiny variations in Earth’s gravitational field.

Inertial navigation systems

Systems and devices that can calculate the position of an object relative to a reference point without using any external references. Applications for high precision inertial navigation systems include replacing or augmenting other navigation systems that require external references—like GPS—in places where external signals can be blocked or corrupted; e.g. underground or in cities with narrow streets and tall buildings.

Magnetic field sensors

Devices that can detect and measure the strength and/or direction of magnetic fields. Applications for magnetic field sensors include passive navigation, imaging for health, metallurgy, scientific research and threat detection for defence.

Miniature sensors

Miniature devices (generally smaller than 10 mm3) that can detect and record or communicate changes in their environment, such as temperature, radiation, vibration, light, chemicals or moisture. Applications for miniature sensors include ‘smart dust’ wireless sensor networks to monitor environmental conditions in agriculture or near possible sources of pollution.

Multispectral and hyperspectral imaging sensors

Multispectral imaging sensors capture data across several discrete ranges across the electromagnetic spectrum, such as red, green, blue and near infrared light; hyperspectral imaging sensors further this approach by capturing hundreds of much smaller ranges across the electromagnetic spectrum. Applications for multispectral and hyperspectral imaging sensors include healthcare, defence, agriculture, manufacturing and machine vision for autonomous vehicles and robots.

Photonic sensors

Devices that use light to detect changes in the environment or in materials. Applications for photonic sensors are broad, ranging from mainstream photography, through to sensors for environments where electrical or chemical based sensors are impractical or unreliable, such as laser-based gas sensors to detect explosive materials or flexible photonic sensors embedded inside the human body to monitor bodily processes.

Radar

Systems that listen for radio waves and microwaves reflected off objects and surfaces—such as people, buildings, aircraft and mountains—to 'see' how far away and how fast those objects are moving. Active radar systems send their own radio signals to reflect off objects; passive radar systems listen for radio signals sent by targets or reflections of signals already present in the environment (e.g. television signals). Applications for radar include weather forecasting, situational awareness, connected and autonomous vehicles, virtual and augmented reality systems, and defence.

Satellite positioning and navigation

Networks of satellites that broadcast precise time signals and other information, which Earth-based devices can use to calculate their location and for navigation. Advanced systems enable greater location accuracy and faster location finding, and greater resistance to unintentional signal interference and intentional jamming or spoofing.

Scalable and sustainable sensor networks

Sensor devices and systems than can be cost-effectively deployed in large numbers and over large areas to monitor physical conditions and communicate findings to one or more locations. Applications for scalable and sustainable sensor networks include smart electricity grids, intelligent transportation systems and smart homes.

Sonar and acoustic sensors

Systems that listen for soundwaves created by, or reflected off, objects—such as boats, submarines, fish and underwater mountains—to identify those objects and/or 'see' how far away and how fast those objects are moving. Applications for sonar and acoustic sensors include monitoring marine wildlife, and threat detection, identification and targeting for defence.

Transportation, robotics and space

Advanced aircraft engines (incl. hypersonics)

Engine technologies that enable greater speed, range, and fuel-efficiency for aerial vehicles. Examples include hypersonic technologies such as ramjet and scramjet engines that allow aircraft and weapons to travel beyond Mach 5 (i.e. flying more than five times the speed of sound).

Advanced robotics

Robots capable of performing complex manual tasks usually performed by humans, including by teaming with humans and/or self-assembling to adapt to new or changed environments. Applications for advanced robotics include industry and manufacturing, defence and public safety, and healthcare and household tasks.

Autonomous systems operation technology

Self-governing machines that can independently perform tasks under limited direction or guidance by a human operator. Applications include passenger and freight transport, un-crewed underwater vehicles, industrial robots, public safety and defence.

Drones, swarming and collaborative robots

Un-crewed air, ground, surface and underwater vehicles and robots that can achieve goals with limited or no human direction, or collaborate to achieve common goals in a self-organising swarm.

Small satellites

Satellites with relatively low mass and size, usually mass under 500 kg and no larger than a domestic refrigerator or washing machine. Applications include lower-cost earth observation constellations and wide area communications networks.

Space launch systems (incl. launch vehicles and supporting infrastructure)

Systems to transport payloads—such as satellites or spacecraft—from the surface of the Earth to space safely, reliably and cost-effectively.