CLUSTER 4. DIGITAL, INDUSTRY AND SPACE

Areas of intervention

Manufacturing Technologies	**Key digital technologies, including quantum technologies**
Advanced Materials	
Next Generation Internet	**Artificial Intelligence and Robotics**
Circular Industries	**Advance computing and Big Data**
Space, including Earth Observation	**Low Carbon and Clean Industry**
Emerging Enabling Technologies	
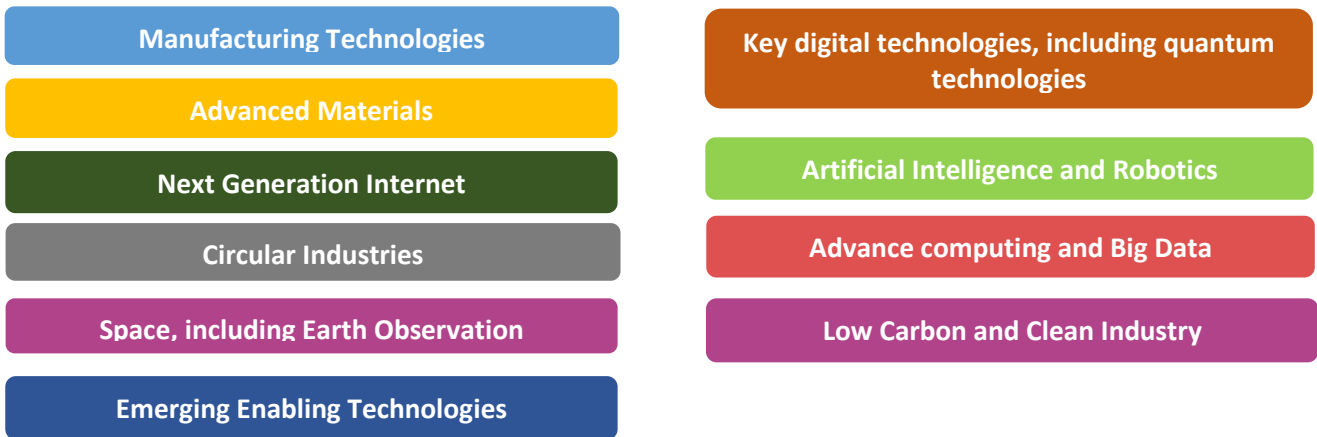
EU Policy Objectives

Cluster 4 addresses the following EC priorities:

- An Europe fit for the Digital Age – Competitiveness: for a European industry with global leadership in key areas, fully respecting planetary boundaries, and resonant with societal needs – in line with the renewed EU Industrial Policy Strategy; promoting an ecosystem of technology infrastructures, catering for industry, including SMEs and start-ups, establishing a European data ecosystem, in conjunction with the **Digital Europe Programme**;
- a stronger Europe in the world - Autonomy: ensure a secure, sustainable, responsibly-sourced supply of raw materials and increased autonomy in critical ones;
- a European Green Deal - climate-neutral, circular and clean industry: reducing energy consumption, decarbonise production processes, protect the environment and enable a circular economy;
- an Economy that Works for People – inclusiveness: not leaving anyone behind – and a human-centred approach in technology development, including AI.

Primary UN – SDGs addressed by Cluster 4:   Secondary UN – SDGs addressed by Cluster 4:

Missions relevant to the activities addressed in Cluster 4:

Targeted impacts

Digitising and transforming industry, Increased sovereignty in **key enabling technologies** and **digital technologies**, in strategic value chains, and a secure and sustainable supply of **raw materials**

A European approach, involving a **human-centred and ethical development** and use of new technologies

Industrial leadership in key enabling, digital and space technologies and uptake of new technologies, and **space services and data**, through **technology infrastructures** and increased autonomy in strategic value chains

Achieving increased **autonomy in critical raw materials**, through substitution, resource efficiency and recycling and primary production, world-leading European technologies for climate neutrality and circularity

Greening ICT, for instance by developing low energy consumption components and combination of approaches, to enhance the efficiency of computing by several orders of magnitude.

Space services contributing to climate mitigation and environmental protection, mobility and security
Increased **inclusiveness**: helping industry provide attractive and creative jobs in Europe; a two-way engagement in the development of technologies; a human-centred approaches; promoting **social innovation**; helping foster skills and **empower the young** in digital and advanced manufacturing areas

Key R&I Orientations

| MANUFACTURING TECHNOLOGIES

- Technology-driven innovations; emerging technologies as AI and human-robot collaboration;
- digital industrial platforms, benefitting automotive/aerospace, health/food processing;
- digital transformation for productivity and shorter innovation cycles;
- circular economy, "zero-waste" manufacturing, de- and re-manufacturing;
- bio-integrated manufacturing through biomachining, biomimetics, biomechanics, bio-inspired;
- a "new way to build", for construction with lower environmental footprint.

| KEY DIGITAL TECHNOLOGIES

- Electronics and photonics components and systems, software technologies and connectivity platforms;
- New materials (such as graphene, flexible substrates);
- Low-power electronics and alternative processing concepts, like neuromorphic, that map cognitive processes into electronic circuits, quantum information processing and open-source hardware;
- Distributed intelligence, integrated smart multisensor-based systems (body, home, automotive etc.);
- Edge computing, advances in modelling and simulation (e.g. digital twins), low-energy computation;
- Artificial Intelligence and big data analytics, novel materials and drugs, smart energy systems;
- Embedded security, reliability and usability, easier programmability, throughout products and services life-cycles, for citizens' confidence in digital technologies.

| ADVANCED MATERIALS

- Disruptive materials science providing solutions at the industrial scale, e.g. in the form of catalytic systems;
- Lightweight, functional, smart materials to mimic biological functions for commercial product applications;
- Advanced materials for challenges related to health, fire performance and sustainability of building materials;
- "Innovative materials by design" to answer the consumer and for artefacts of cultural heritage protection;
- Innovation ecosystem of materials technology infrastructures (open innovation testbeds and pilot lines);
- Safe, sustainable and competitive new materials within the circular economy, including regulatory and standardisation aspects.

| EMERGING ENABLING TECHNOLOGIES

Early development (at low TRLs) of a limited number of new enabling technologies by scouting for transformative research themes, building also on the results of Pillars I and III. Success depends on the combination of disciplines, from fundamental research in natural sciences to engineering, manufacturing and computer learning. Examples of technologies include, but are not limited to:

- Future and emerging materials by design;
- Enhanced information-based technologies inspired by the laws of nature and biology;
- The convergence of the "digital" and the "physical" and entirely new forms of digital technologies.

| ARTIFICIAL INTELLIGENCE AND ROBOTICS

- AI for traffic optimization and autonomous driving AI-based systems to support in specific tasks and improving working conditions;
- AI-based solutions to optimise the resources lifecycle and make it more environmentally and economically sustainable
- Powerful data-intensive machine learning to assist Medical doctors in diagnostic and therapy decisions;
- Robots to support firefighters in approaching hazardous intervention zones;
- AI and robotics supporting European industrial competitiveness and for the reduction of environmental footprints;
- AI and autonomous behaviour in complex, safety- and time-critical systems, such as large transport networks;
- Human-centric, ethical, explainable and trustworthy AI and a trademark for AI developed in Europe;

- Foundational algorithms and hardware research;
- Smart, collaborative, safe and efficient robots and autonomous systems;
- Common AI platforms, sharing tools and resources for research and innovation.

| NEXT GENERATION INTERNET

- Key technologies and infrastructures for the Internet of tomorrow, for a human-centric trustworthy internet promoting core European values;
- Smart Networks and Services (including IoT and edge computing infrastructures) and Content platforms;
- Vertical applications supported by platforms including large-scale pilots, use of AI along a continuum of novel data infrastructures and services;
- Trustworthy internet technologies, including open source components and Universal Design;
- Interactive Technologies, immersive technologies and language technologies, combined with AI, for a Next Generation Internet;
- Distributed ledger technologies, for an EU data space empowering citizens, public services and businesses.

| ADVANCE COMPUTING AND BIG DATA

- Next generation low power processors and accelerators, novel computing architectures and hybrid/modular systems;
- Novel neuromorphic architectures, quantum computing components, 3D and interposer/chiplet computing architectures;
- Co-designing software, algorithms, programming models, simulations and tools for their integration in novel computing systems for large-scale and industry-led pilot applications and public services;
- Advancing the state-of-the-art of extreme performance data analytics and prediction methods for Big Data processing;
- Methodologies and tools for data interoperability and to track provenance, quality and completeness of data sets;
- Federation of data supporting the creation of a European Health Data Space;
- Reduce the carbon footprint and improve the energy efficiency of ICT processes and technologies, including hardware, software, sensors, networks, storage and data centers;
- Provide metrics and methodologies to measure in a standardised way the carbon footprint and energy efficiency of data processing and transmission chains.

| A GLOBALLY COMPETITIVE SPACE SECTOR REINFORCING EU SOVEREIGNTY

- Ultra-high throughput telecommunication, integration of satellites in 5G networks, advanced navigation signals and high-resolution earth observation, supporting the EU space programme components;
- Production of cost-effective space systems including constellations, hybrid, smart and reconfigurable satellites, which can be assembled and serviced directly on-orbit, with a de-orbiting capacity;
- Reducing the production and operation cost such as reusability of launcher components, low cost, high thrust and green propulsion, micro launchers, new types of payloads and space routes;
- Opportunities for in-orbit validation ("IOV") and in-orbit demonstration ("IOD") to de-risk new technologies, concepts and applications operating from modern and flexible launch facilities; new technologies for space traffic management;
- Contribute to critical technologies, space science and missions and outreach and education activities;
- Promote downstream applications and synergies with non-space sectors, including manufacturing technologies, digital technologies, advanced materials, AI and Robotics, advanced Computing and Big data;
- Quantum technologies in space infrastructure and for space-based services, ensuring of security, efficiency and reliability.

| CIRCULAR INDUSTRIES

- Design of circularity enabled products, implementation of circular supply chains and systematic cradle-to-cradle life cycle assessment both for new and existing products;
- Product life extension through predictive maintenance, repair, re-use, and refurbishment leading to value loops at European scale;
- Advanced solutions and conditions for the sustainable exploration, extraction and processing of raw materials; and also their substitution, recycling and recovery in industrial symbiosis settings;
- New automated technologies to sort, dismantle and remanufacture or recycle products; efficient processes to handle mixed waste sources;

- Digital and industrial technologies like robotics, artificial intelligence, and digital platforms for energy-intensive industries leading e.g. to fully fledged cognitive plants;

The focus will be on sectors, products and materials that have the highest impacts and the greatest potential for enhanced circularity.

| LOW-CARBON AND CLEAN INDUSTRIES

- Innovative technologies for process and heat electrification, switch to decarbonised energy and feedstock, usage of hydrogen, CO_2 capture and usage, catalysis and artificial photosynthesis, waste heat recovery, materials for re-use and recycling;
- Integration across value chains and new business models, processes and technologies for avoiding waste and emissions or recover valuable resources;
- Co-located plants and industrial symbiosis amongst plants, adapting production to energy and resource flows;
- Closed-loop system, based flows of resources, energy and information supported by AI-based technologies;
- "Hubs for Circularity", industrial and public facilities achieving circularity and carbon neutrality in resources use.

| NEW SERVICES FROM SPACE FOR THE EU SOCIETY AND ECONOMY

- R&I for the next generation and applications of European Global Navigation Satellite Systems (Galileo/ EGNOS) for intelligent mobility, lowering CO_2 emissions, connectivity and infrastructures, a non-dependent and sustainable supply chain, and integration with 5G;
- Support core services of the European Union Earth Observation System (Copernicus) and develop new service elements or products, cross-cutting applications and products and information in areas as climate mitigation, monitoring GHG, environment, including Arctic regions, agriculture and urban planning, security;
- developments in sensors technologies and data processing and new services for Space Surveillance and Tracking (SST),
- Research on space traffic management, space weather and near Earth objects necessary to ensure the security of critical infrastructure both in space and on Earth for Space Situational Awareness (SSA);
- Support user equipment and system solutions for space and ground infrastructure for Satellite communications for EU governmental actors (GOVSATCOM) and applications for citizens and businesses;

Synergies between Galileo/Copernicus will be reinforced, and the availability of space assets and data from other organizations (e.g. EUMETSAT, ESA) better exploited.

European Partnerships

 - Made in Europe; - Key Digital Technologies; - Photonics; - Artificial Intelligence, data and robotics; - Smart Network and Services; - HPCT; - Circular and Climate-neutral industries; - Clean Steel; - Metrology; - Globally Competitive Space Systems; - Geological Service for Europe (candidate partnership). The cluster is also closely related to EIT Raw Materials, EIT Manufacturing and EIT Digital.