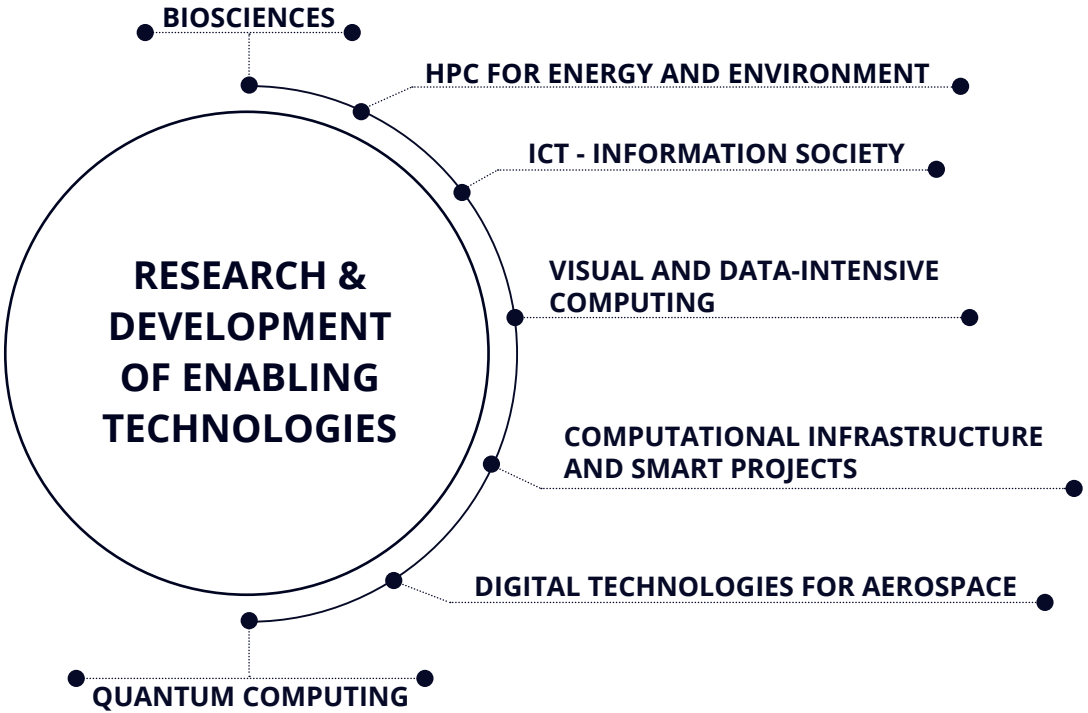
SARDIGNA CHIRCAS
SARDEGNA RICERCHE

CENTER FOR ADVANCED STUDIES, RESEARCH AND DEVELOPMENT IN SARDINIA


CRS4
IDEAS BECOME LIFE

CRS4, Centre for Research, Development and Advanced Studies in Sardinia, was established by the Region in 1990. It is currently a limited liability consortium whose sole shareholder is the regional agency Sardegna Ricerche that manages the Sardinian science and technology park, where the Centre's legal office is located.



BIOSCIENCES

The research activities focus on the acquisition and modelling of large amounts of biomedically relevant data and the development of experimental protocols for the sequencing data acquisition. The Biosciences sector analyses large volumes of heterogeneous biological and biomedical data and develops modelling techniques for clinical and biomedical research, with applications to human health and various other areas of the life sciences. The group operates one of the largest New Generation Sequencing platforms in Italy, used for complex genetic analysis and sequencing of genomes, transcriptomes, exomes and targeted resequencing.

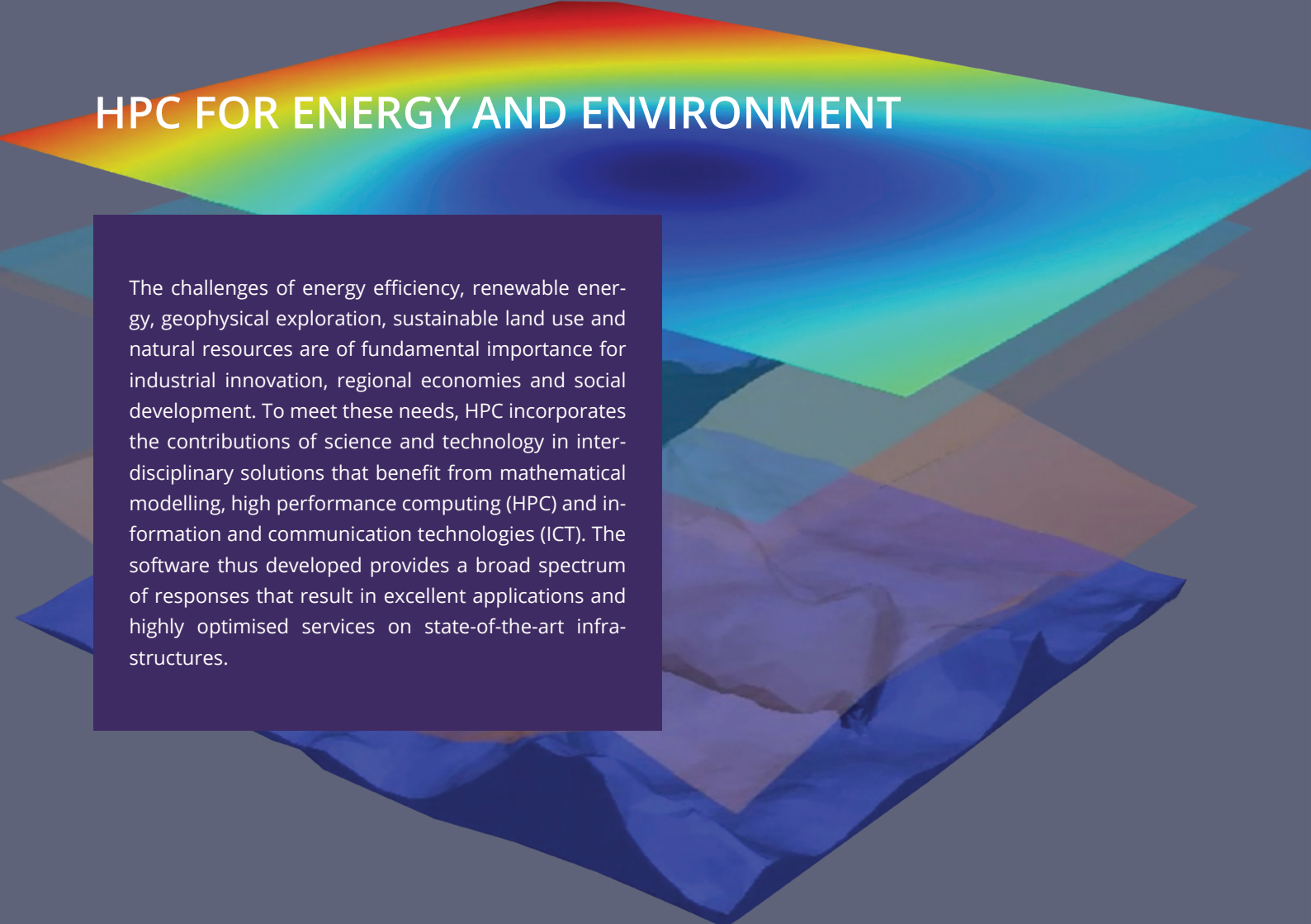
MODELING, SIMULATION AND DATA ANALYSIS

The program activity is based on the application of scientific techniques and methods to solve biological, biotechnological, biomedical and pharmaceutical problems. The multidisciplinary approach to these issues has its roots in physics, mathematics, chemistry and life sciences. Over the years, extensive skills have been developed in modeling and simulating cell growth and proliferation processes, in molecular dynamics and structural properties of proteins and in the application of artificial intelligence techniques for the prediction of the material properties.

NEXT GENERATION SEQUENCING CORE

The Programme manages the Next Sequencing platform and works with the aim of enabling state-of-the-art computational and experimental platforms for life sciences research applications, in collaboration with leading research centres and hospitals in Italy and abroad. It also works with an extensive network of specialised centres and healthcare facilities for the implementation of Next Generation Sequencing (NGS) approaches for personalised medicine and life sciences applications.

HPC FOR ENERGY AND ENVIRONMENT



The challenges of energy efficiency, renewable energy, geophysical exploration, sustainable land use and natural resources are of fundamental importance for industrial innovation, regional economies and social development. To meet these needs, HPC incorporates the contributions of science and technology in interdisciplinary solutions that benefit from mathematical modelling, high performance computing (HPC) and information and communication technologies (ICT). The software thus developed provides a broad spectrum of responses that result in excellent applications and highly optimised services on state-of-the-art infrastructures.

DIGITAL AGRICULTURE

The programme focuses on the use of data from remote or field sensors as input for decision support tools, on the exploitation of high-performance numerical computing technologies for the development of large-scale machine learning models and on the study of artificial intelligence techniques for service robotics in agriculture, based on the use of the latest hardware solutions for edge computing.

IMAGING AND NUMERICAL GEOPHYSICS

The research focuses on the development of innovative mathematical models and numerical algorithms, combined with advanced software engineering techniques, for the implementation of high-performance industrial applications in the field of imaging sciences and geophysical natural resources prospecting. This team, whose skills cut across the disciplines of physics, mathematics, engineering and computer science, has achieved a historic objective of CRS4: the transfer of knowledge, with financial returns, from scientific research to industry.

ENVIRONMENTAL SCIENCES

By using high-performance computing architectures, the research programme implements software based on complex numerical models to solve problems related to the management of environmental resources and applies them to real case studies. Activities include the simulation and analysis of atmospheric data and the assessment of related meteorological and climatological risks, from regional to small scale, through the development of physical-statistical post-processing techniques.

SMART ENERGY SYSTEMS

The Programme is involved in research applied to energy technologies for industry, services and consumers. The activities contribute to regional, national and European objectives for the reduction of GHG emissions in production technologies and energy conversion applied to the design of conventional and innovative plants with high environmental sustainability, and to artificial intelligence systems for distribution networks.

ICT - INFORMATION SOCIETY

The sector carries out R&D activities for innovative applications and technology transfer, in collaboration with universities, research centres and industry. The transversal competences of the sector cover wide application fields, both in the professional and consumer sectors: tourism, transport, culture, territory, agri-food, didactics, natural and multisensory interaction, augmented reality, digital content and new media, artificial intelligence, deep learning for medical diagnostics, internet of things, semantic web and more generally the whole world of ICT and Information Society.

COLLABORATIVE AND SOCIAL ENVIRONMENTS

The programme investigates Human Computer Interaction and Interaction Design in order to improve the quality of computer-mediated human interactions. The focus is on user-centred interactive environments, including the development of new prototypes and industrial products, such as computer vision and data analysis algorithms, visualisation and multi-projection systems, augmented and virtual reality, immersive and modal, tangible, manipulative and gestural interfaces, interaction technologies, multi-sensorial systems and interactive surfaces. The research activities are applied in various fields (culture, tourism, communication, etc.) through research and industrial projects.

INTERNET OF THINGS AND ENERGY EFFICIENCY TECHNOLOGIES

The programme develops tools for accessing the services of public administration and private companies, thanks to the opportunities offered by IOT technologies, artificial intelligence and vision, distributed computing architectures and energy monitoring and efficiency. In collaboration with regional bodies, it also promotes the social inclusion of people with disabilities through the use of IT tools and methods for the improvement of the life quality. A further field of application concerns precision agriculture, the enhancement of agri-food supply chains as well as animal and plant welfare, with the testing of new organic agro-pharmaceuticals, essential oils and hydrolysates from mainly native officinal plants.

CONTENT TECHNOLOGIES AND INFORMATION MANAGEMENT

The programme develops technological solutions for the audiovisual industry through the design and testing of algorithms and prototypes for the acquisition knowledge from audiovisual content. The projects cover: territorial monitoring (detection of the density and flow of people and vehicles by analysing aerial photographs in real time); medical diagnostics (classification of X-rays and ultrasound scans using artificial neural networks); business analytics (detection of customer habits and behaviour in the retail sector by the analysis of video footage). For these activities a scalable edge-computing platform (for the parallel analysis of video streams using deep learning techniques) and a Digital Asset Manager extensible through artificial intelligence models are used.

EDUCATION TECHNOLOGIES

The programme activities focus on the study, development, adaptation and integration of innovative technologies and methodologies for education, training on demand and orientation. Pedagogical strategies are developed for teachers and trainers interested in the critical application of innovation, through the study of innovative environments and adaptation to precise areas of knowledge. Activities also include remote access to scientific and technical experiments for teaching using Artificial Intelligence.

NATURAL INTERACTION AND KNOWLEDGE MANAGEMENT TECHNOLOGIES

These research activities focus on models for applications and services based on natural, verbal and non-verbal interaction technologies. The program defines models and methods for the automatic classification of documents, reputation management, opinion mining and for the development of conversational engines. Prototypes for gestural and tactile interaction with verbal interaction are also designed and tested, which are useful for the improvement of human perceptual-sensory abilities. These prototypes can be used in the field of accessibility for the sensorially disabled, in the museum-exhibition, tourism, cultural and educational fields.

VISUAL AND DATA INTENSIVE COMPUTING

This sector is dedicated to the research, development and application of innovative solutions for the acquisition, creation, processing, distribution and exploration of complex and massive datasets and real-world environments. Activities are focused on: general purpose enabling technologies for scalable computing and analysis (big data, data analytics, automation, machine learning, distributed computing); visual computing methods and systems (computer graphics, scientific and information visualisation, machine vision, image processing, innovative displays and user interfaces); specialised solutions for data acquisition, integration, sharing and analysis in industrial processes, healthcare and biomedical research (data modelling and management, interoperability, traceability and reproducibility, provenance).

SCALABLE COMPUTING AND ANALYTICS

The research focuses on the study and application of state-of-the-art techniques of distributed computing, automation and machine learning, combined to extend the possibilities of collecting and using available data in a reproducible way. The work of the group finds important application contexts in the fields of urban computing, bioinformatics and clinical informatics - thanks also to the synergies and close collaborations with other groups in the sector and various other actors at national and international level - while remaining transversally applicable.

DIGITAL HEALTH

Through the research, development and testing of scalable models, tools and technologies, the programme is committed to improving the acquisition, sharing and analysis of complex and heterogeneous data generated by biomedical care and research processes. Activities include: modelling of data and processes using open and international formalisms; technical and semantic interoperability between clinical domains; creation of scalable systems for collaborative analysis and reuse of available information, with a specific focus on traceability and reproducibility of each process step. The group collaborates with leading hospitals, research centres and companies specialised in the healthcare sector, and is working on the definition of standards and guidelines for clinical informatics in the framework of the main international reference bodies (such as IHE, HL7, OME and openEHR).

VISUAL COMPUTING

The aim of the programme is to create new scalable technologies to acquire, create, distribute, explore and analyse complex objects and environments by integrating these technologies into interactive visual simulations and virtual environments. Research activities cover many aspects of visual computing and include topics such as computer graphics, scientific and information visualisation, computer vision, image processing, display and user interface design, human-computer interaction, geometric processing, and massive models.

ACQUISITION, PROCESSING AND VISUALISATION LAB

The aim is to develop, apply and integrate sensors, computational resources and specialised instrumentation for CRS4 activities in the field of visual and data-intensive computing. The group interfaces with the facilities of the centre, and manages hybrid CPU/GPU systems directly connected to interaction and visualization devices. Acquisition devices include camera arrays, 3D scanners, custom multi-light multi-spectral acquisition devices and environmental sensors. Visualisation tools range from high-resolution multi-touch systems to experimental light-field displays for interactive quasi-holography. Activities concern smart cities and cultural heritage, with large-scale acquisition campaigns and the development of large-scale interactive museum installations.

COMPUTATIONAL INFRASTRUCTURE AND SMART PROJECTS

The sector manages and develops CRS4's IT systems and platforms to guarantee high-performance computing (HPC) and ICT services with the aim of meeting the multiple needs of the research community, inside and outside the Science and Technology Park of Sardinia. Activities are focused on the study of next-generation infrastructures, Urban Computing and high-performance networks. The main objective is to develop innovative projects and platforms connecting the world of research and business with state-of-the-art technological solutions. Research focuses on the efficient management of operational scenarios in a wide range of topics, such as Smart Cities, public safety and emergency management.

HIGH PERFORMANCE COMPUTING

The program provides support to researchers, external users and industry in terms of computing services. High-performance computing platforms enables the use of techniques for numerical modelling, making a significant contribution to the advancement of the knowledge base and the creation of technologically advanced products and processes. The infrastructures make it possible to design, study, reproduce and visualise complex natural phenomena and engineering systems with great accuracy. High-performance computing is used for meteorology, geophysics, fluid dynamics, the study of matter in chemistry, the development of molecules for new drugs, the analysis of proteins in medicine and genetic data.

SECURITY AND NETWORKS

Digital Security plays a key role in protecting user data and those ones resulting from research and industrial projects. To guarantee data security, the group applies the most consolidated and recognised best practices and the latest technologies available on the market. The program is also in charge of the design and implementation of networks dedicated to projects with specific needs in terms of latency, bandwidth or other specific characteristics, thanks to the experience gained in the management and development of complex networks, from the computer centre to the latest wireless networks, providing high bandwidth capacity, as well as in optical transport networks, based on xWDM technology.

IT SERVICES

The programme designs, manages and develops the IT service delivery platforms with the aim of fulfilling the various needs of the centre's users, providing first and second level IT support to CRS4 researchers and administrative staff. The IT services take care of the proper functioning of the e-mail, the versioning services, the data backup platform, the storage servers hosting the employees' data and the infrastructure necessary to connect the workstations to the internal and external network. The programme is also engaged in maintaining the state-of-the-art infrastructure and the continuous updating of server and workstation software to protect against cyber attacks.

SMART PROJECT DEVELOPMENT

The purpose of the programme is to develop innovative projects and platforms to create a link between research and the business world and to transfer the technological expertise to industry by offering state-of-the-art smart solutions, in order to stimulate the growth process within SMEs. The research focuses on the efficient management of operational scenarios that cover different areas, such as Smart Cities, public safety and emergency management.

DIGITAL TECHNOLOGIES FOR AEROSPACE

Aerospace technologies for Earth observation (satellite and aerial recognition) enable significant scale economies for the implementation of territorial monitoring systems and decision support tools in active development policies. Innovative solutions are offered in a number of economically relevant areas of the ecosystem: environment, mobility and logistics, cultural heritage, tourism, agrifood. Moreover, starting with some technologies of interest for space missions (artificial intelligence, robotic systems, autonomous navigation), the sector intends to initiate a technology transfer process aimed at the subsequent establishment of technology-intensive precision manufacturing development poles.

GEOGRAPHIC INFORMATION SYSTEMS

The activities focus on the application of GIS (Geographic Information Systems) technologies to a range of domains: urban planning, industry, environment, health, tourism and culture, and on the development of Decision Support Systems using georeferenced data. In addition, through the study and development of methods for processing and analysing satellite data for studying the Earth, the program is developing new remote sensing survey methodologies, applied to the fields of forest management, precision agriculture and cultural heritage.

SMART ENVIRONMENTS AND TECHNOLOGIES

The program operates in the Smart environment and technologies area, while developing its activities in connection with the local production system, in terms of knowledge and technology transfer and sharing. Through the involvement of industrial, entrepreneurial and institutional actors, projects are carried out on Smart Cities mobility, logistics and environmental modelling. Activities cover the Internet of Things, WebGIS and environmental modelling, with applications in agriculture, cultural heritage and tourism. Aerospace research integrates knowledge and skills acquired in the field of digital technologies with aerospace ones, related in particular to satellites.

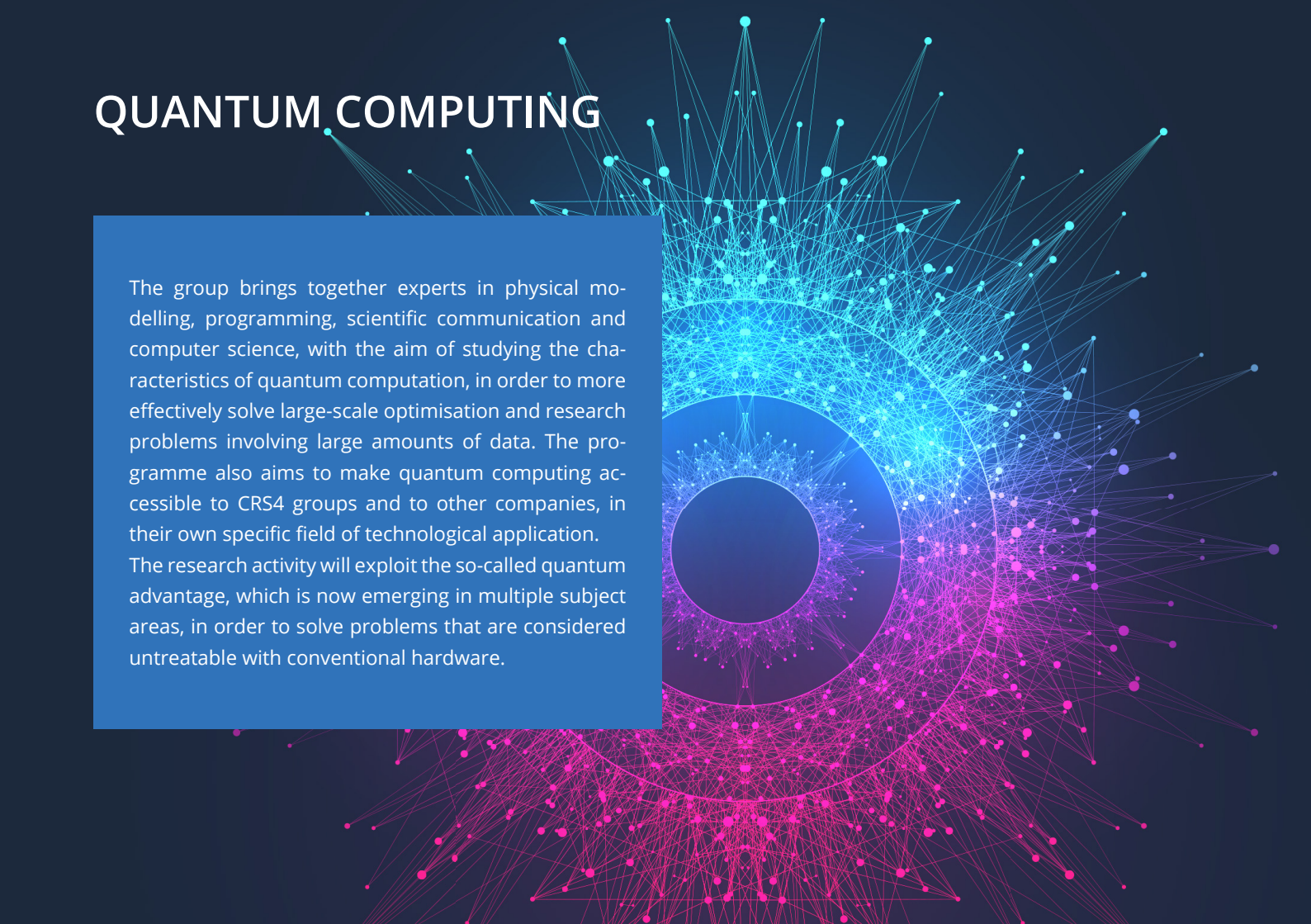
GAME-BASED INTERACTION AND TECHNOLOGIES

The research focus is to investigate the topic of gaming in order to explore how technologies, methodologies and algorithms, directly taken from this field, can be profitably applied in other contexts. Topics include artificial intelligence, robotics and immersive interaction. Activities focus on innovative approaches and solutions in the following areas: rapid prototyping of interfaces and control devices; human-robot-environment interaction systems; design of new media communication tools based on technologies derived from the world of videogames (virtual/augmented/mixed reality); gaming and its derivations (gamification) to conduct research in other sectors (e.g. tourism, training, edutainment, marketing).

QUANTUM COMPUTING

The group brings together experts in physical modelling, programming, scientific communication and computer science, with the aim of studying the characteristics of quantum computation, in order to more effectively solve large-scale optimisation and research problems involving large amounts of data. The programme also aims to make quantum computing accessible to CRS4 groups and to other companies, in their own specific field of technological application.

The research activity will exploit the so-called quantum advantage, which is now emerging in multiple subject areas, in order to solve problems that are considered untreatable with conventional hardware.



HIGH PERFORMANCE COMPUTING SERVICES

CRS4 offers high-performance computing support to the scientific community and industry through the its constantly updated computing center.

the latest investment includes:

* next generation computing cluster with 6000 cores
* artificial intelligence systems with CPGPU accelerators
* nodes for computing, 3D graphics, Machine Learning and Big Data
* new performance storage system for data enhancement and security of the computing

HYBRID AND STANDARD HPC CLUSTER	> 400 NODES FOR COMPUTING	LOW LATENCY NETWORK AND HIGH SPEED
X86_64, Nvidia GPU, Intel Phi, AMD GPU	> 8000 CORES	STORAGE 5 PB

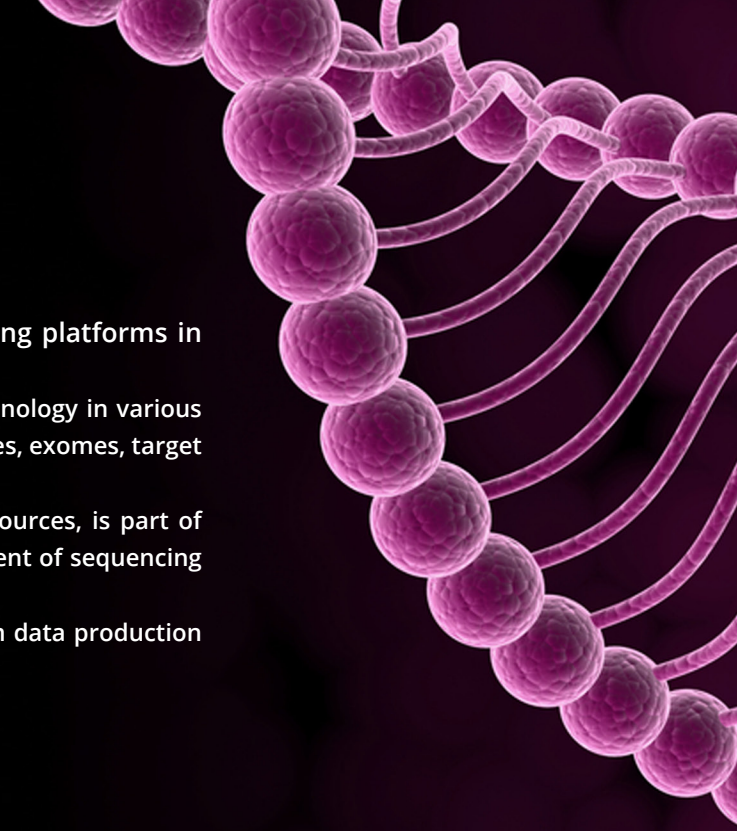
NEXT GENERATION SEQUENCING CORE

CRS4 hosts one of the largest New Generation Sequencing platforms in Italy.

The NGS Core Facility has a long experience with Illumina technology in various application areas, including the complete sequencing of genomes, exomes, target regions, transcriptomics and identification of DNA binding sites.

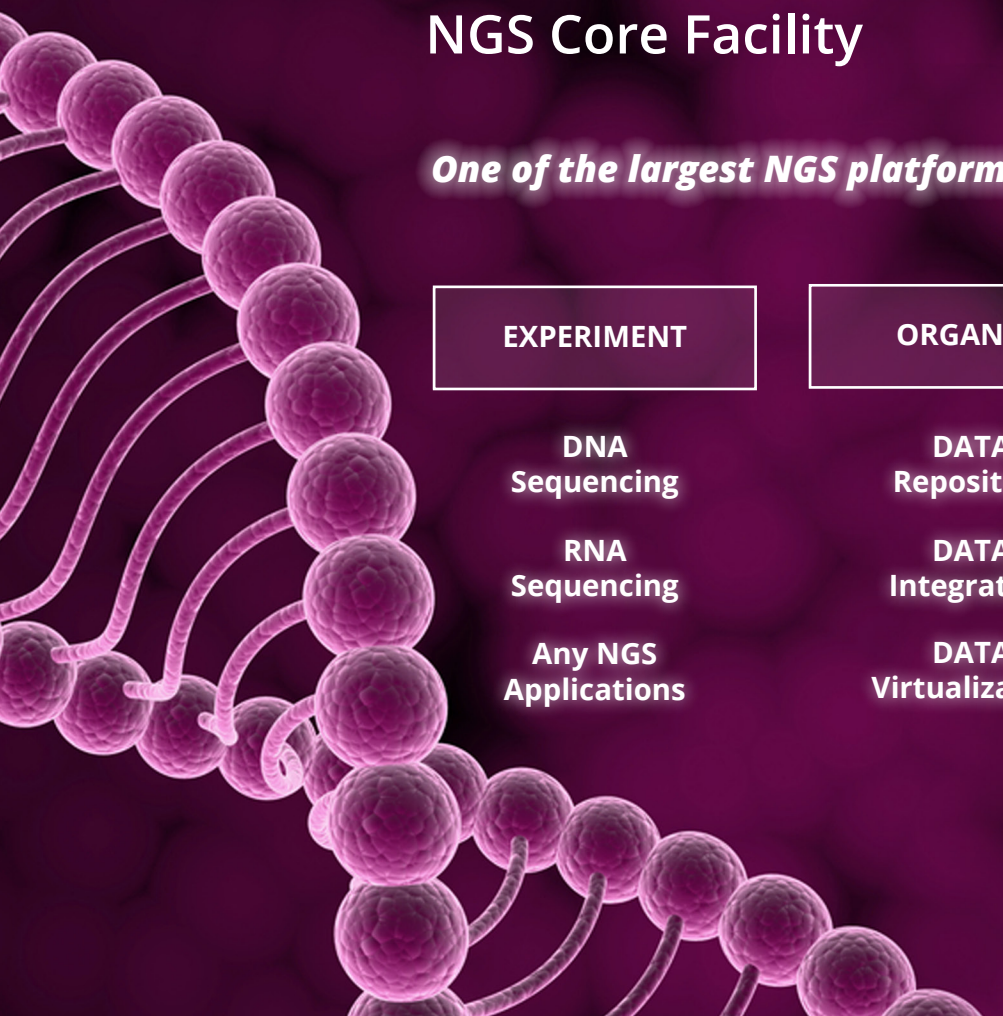
The NGS Core Facility, connected to CRS4's computational resources, is part of an integrated infrastructure for the fully automated management of sequencing data.

This synergy allows CRS4 to carry out large-scale projects, from data production to analysis.



NGS Core Facility

One of the largest NGS platform in Italy

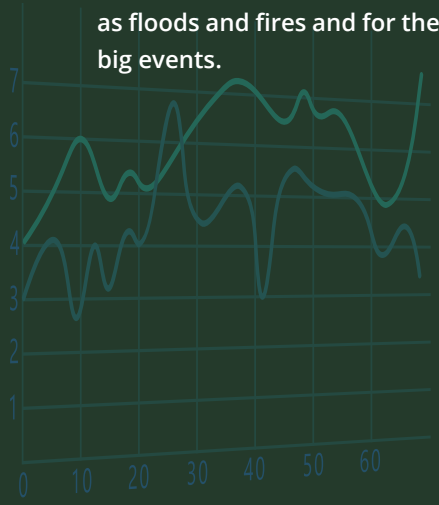


EXPERIMENT	ORGANIZE	ANALYZE
DNA Sequencing	DATA Repository	Genomics
RNA Sequencing	DATA Integration	Transcriptomics
Any NGS Applications	DATA Virtualization	Any data analysis workflow

UbiDP

Ubiquitous Digital Platform

UbiDP is CRS4's digital operating platform that can manage large amounts of data (images, sounds, videos) from different sources (public, sensors, internet, etc.) and transform them into images and graphics for the management and monitoring of events and critical situations, using specially developed software technologies. The platform is functional for the coordination of the territory logistics in case of possible emergencies, such as floods and fires and for the traffic and parking management, as well as for the control of people flow during big events.

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