Barcelona Supercomputing Center – Centro Nacional de Supercomputación (BSC) is the leader in supercomputing in Spain and a reference center this field internationally.

BSC Missions

Supercomputing services to Spanish and EU researchers

R&D in Computer, Life, Earth and Engineering Sciences

PhD programme, technology transfer, public engagement

We are a Severo Ochoa Center of Excellence, a Singular Scientific and Technical Infrastructure (ICTS), first-level members of the PRACE (Partnership for Advanced Computing in Europe) European research infrastructure, we manage the Spanish Supercomputing Network (Red Española de Supercomputación) and we support the biomedical community coordinating the Elixir and INB-ISCIII Infrastructure.

Created in 2005 from the experience of successful collaborations between public administrations and private companies, such as CEPBA and CIRI, we have grown rapidly from 60 to more than 500 staff members, thanks to our ability to attract competitive funds from institutions and companies, and we have already installed four consecutive versions of the MareNostrum supercomputer.

Nowadays, BSC is a public consortium made up of:
Where we are, where we are going

Mateo Valero and Josep M. Martorell
Director and Associate Director of BSC

2018 was a year that stood out mainly for the setting up of the EuroHPC Joint Undertaking, the tool that the European Commission is using to make the major, ambitious European initiative to support supercomputing possible.

EuroHPC has two cornerstones in which BSC plays an outstanding role: on the one hand, it is intended to promote the development of European computing technology and, on the other hand, it will co-fund the acquisition and operation of the new large European supercomputers that will come into operation from 2021 onwards.

At BSC we aspire to MareNostrum 5 being among these future large European supercomputers. In 2018 we laid the foundations for our candidacy to house that computer, together with our patrons and the Portuguese government with which a cooperation agreement for advanced computing has been reached.

It is also a year in which, due to the change in governments, we have had new representatives on our Board of Trustees and have been pleased to welcome the heads of Spanish and Catalan scientific policy, Spanish Government Minister, Pedro Duque, and Catalan Government Minister, Àngels Chacón, as well as senior European officials, such as the Vice President of the European Commission Andrus Ansip, the Director General Roberto Viola and the Director for Artificial Intelligence and Digital Industry, Lucilla Sioli.

As for infrastructure, we have begun the third and final stage of our corporate building, which we hope to start using in 2020, and we have remodelled new parts of Torre Girona, where we have built a new computer room and new offices for researchers. We should also point out the arrival of the first of the MareNostrum 4 emerging technologies clusters, based on Power9 and Volta GPU, and especially suitable for artificial intelligence.
In the scientific area we have also had noteworthy results. We have confirmed the addition of a new Icrea researcher, been successful in the call for EC Centres of Excellence, started making use of two new ERC grants, and the first post-docs from the Stars program, co-funded by Marie Skłodowska Curie Actions, have arrived. This all comes within the framework of more than 200 competitive projects in progress and the creation of three new spin-offs.

We have also completed the complex process to become an "instrumental own resource" of the Spanish civil service, which has allowed us to strengthen our collaboration with AEMET, the meteorology Spanish agency, and become coordinators of the National Language Technologies Plan, which consolidates our leadership in language technologies and AI.

Putting all of these projects into operation means the centre now has 600 employees from 47 countries, 489 of whom are research staff. The overall budget is around €42 million, including investments. We are the fourth Spanish institution (and the second in Catalonia, only behind our university) in terms of research funds received.

And we certainly have not overlooked our outreach mission, which is strongly focused on inspiring new technological vocations with a particular focus on girls. One of the most successful projects we began in 2018 is "We are young women researchers", a program offered in primary schools promoted by music from Les Macedònia. Thanks to this initiative, among others, 2018 has again been a record year for the Chapel: more than 14,000 people have visited our iconic facilities.

We have been able to share all of these figures with the members of our Scientific Advisory Board, chaired by Dr. Paul Messina (Argonne National Laboratory, USA), which has recognised our excellent results with special emphasis on our unique character as a centre that combines infrastructure and research. We have put various recommendations to our Board of Trustees to make it easier to fulfil our missions in the future.

We do not want to end this brief summary of 2018 without thanking our patrons and sponsors, who trust in us just as some of them have done since BSC was set up fifteen years ago. That helps us overcome our challenges, year by year. You can read about some of our successes on the following pages.
The three shareholders institutions of BSC have appointed the new representatives in BSC Board of Trustees

Rafael Rodrigo  
President  
Secretary General of Scientific policy Coordination

Francesc Xavier Grau  
Vice President  
Secretary General for Universities and Research

José Ignacio Doncel  
Deputy Director General of Large Scientific and Technical Facilities

Benjamín Sánchez  
Deputy Director General of Science and Innovation Internationalization

Joan Gómez Pallarès  
Director General of Research

Iolanda Font de Rubínat  
Deputy Director General of Research

Francesc Torres  
Rector

Gabriel Bugeda  
Vice Rector for Research

BSC Scientific Advisory Board highlights data and AI as major challenges

The BSC Scientific Advisory Board held its periodic meeting in 2018 and highlighted dependency on data systems and its position as the natural Spanish AI leader as the major challenges for the center. The SAB stated that BSC is a “European jewel” for the quality of work carried out there and asserted that “the integration of the supercomputing center’s activities with research departments is a major asset and a rare one”. BSC SAB is chaired by Dr. Paul Messina, Argonne National Laboratory’s Computational Science Division director.

BSC gratefully acknowledges the support of
**BSC in numbers**

**RESEARCH**

- **46** Research groups
- **4** ERC Projects in progress
- **6** ICREA researchers
- **79** Researchers with personal fellowships/grants
- **105** H2020 projects in progress
- **39** H2020 projects begun in 2018
- **11** H2020 projects coordinated by BSC

**Fourth Spanish entity receiving founds from the H2020 Program**

- **185** Articles in peer-reviewed journals
- **109** In Q1
- **90** Articles in conference proceedings
- **24** In A and A* conferences
- **145** Open access publications
- **22** Book chapters
- **20** Doctoral theses

**TECHNOLOGY TRANSFER**

- **28** Patents approved or pending approval
- **2** Patents
- **9** Software
- **4** Spin-offs created
- **22** Bilateral collaboration with companies
- **2** In progress
- **3** Joint centers with companies
- **2** Started in 2018
Infrastructure and services

From the handcrafted telescopes used by Galileo to the particle accelerator in Geneva, scientific instruments have undergone huge technological advances.

As a consequence, the types of questions that science tries to answer have also changed. We want answers to questions about phenomena that can no longer be observed by a simple view nor with the help of optical instruments.

What is supercomputing?

Supercomputing enables scientific experiments by simulating “in silico” the behaviour of the object under study. Bringing together all the knowledge about the object of a computer simulation and experimenting with it can reduce costs, avoid suffering and enable experiments to be conducted that could not be performed in the real world, because they would be too expensive, too dangerous or simply impossible.

Supercomputers are also needed to analyze large amounts of data, such as those provided by scientific instruments (e.g. particle accelerators, large telescopes, interferometers or genome sequencing platforms) and the ever-growing number of devices that make up the Internet of Things.

High-performance computing has already become a great accelerator of science and engineering. It is used, and is increasingly being considered essential by the majority of scientific disciplines.

MareNostrum participates in the richest star map of our galaxy- and beyond

European Space Agency’s Gaia mission has produced the richest star catalogue to date, including high-precision measurements of nearly 1.7 billion stars and revealing previously unseen details of our home Galaxy. A multitude of discoveries are on the horizon after this much awaited release, which is based on 22 months of charting the sky. BSC is one of the data processing centers that participates in this project.
MareNostrum 4 Supercomputer

More than $13 \times 10^{15}$ floating-point operations per second (13.7 petaflops)

Visit us and learn more about MareNostrum - Book your visit: visits@bsc.es

14,133 visitors from schools, universities, research centers and companies in 2018.

MareNostrum is the generic name that BSC uses to refer to the different updates made to its most emblematic supercomputer.
MareNostrum 4 CTE POWER9 racks begin operation with high expectation for artificial intelligence-based research

The MareNostrum 4 supercomputer has brought three racks of the latest IBM POWER technologies with a peak performance of 1.5 petaflops into production. BSC is thus exploring the high expectations for this technology to accelerate artificial intelligence-based research.

With the POWER9 – Volta GPU racks, BSC has become the first supercomputing center in Europe to offer access to the same technologies as Summit, the supercomputer with which the US, in June 2018, wrested the title of the most powerful supercomputer in the world from China.

The new machine is Europe’s “greenest” supercomputer

The POWER9 cluster has emerged as the “greenest” machine in Europe and the eighth in the world, according to the November 2018 Green500 ranking, which scores the world’s fastest supercomputers for energy efficiency. In the Top500 list, which evaluates supercomputers for their speed in executing the Linpack program, BSC’s POWER9 cluster is placed 411th. The MareNostrum 4 general-purpose block is 25th.

StarLife, a new IT infrastructure to boost biomedical research

StarLife, new IT infrastructure designed to give impetus to the biomedical research carried out in Barcelona, has now been installed. This infrastructure is a joint initiative by the Center for Genomic Regulation, the Institute of Biomedical Research of Barcelona and BSC and receives financial support from the Catalan Government, with ERDF funds, and the “La Caixa” Banking Foundation.

StarLife has emerged from the desire of the three research centers to build a joint platform for large-scale biomedical projects that require architecture specifically designed for the manipulation and exploitation of large volumes of biological data.
The final phase of the new corporate building is under way

The final phase of the construction work for the new BSC corporate building began in the last half of 2018. It includes offices and staff facilities and the new BSC computer room located in the lowest floors. Moving of BSC staff to the new facilities is planned to take place in the first half of 2020. The computer room will be ready to host a pre-exascale supercomputer (MareNostrum 5) and forthcoming technologies. The Torre Girona chapel will remain in operation, hosting crucial parts of MareNostrum 5. The Fundación Repsol has collaborated with the financing of the new corporate building.

New computing room brings BSC infrastructure together

A new hall was built in the basement of Torre Girona in 2018, bringing together different BSC computational infrastructures. The new data center hosts, among others, the Nord 3 cluster (8 racks of MareNostrum 3 with computing power of 270 teraflops and main memory of 28 terabytes), StarLife (the new infrastructure for biomedical research), MinoTauro (a heterogeneous cluster with GPUs) and long term storage growing from tens of petabytes to hundreds of petabytes.

Spain and Portugal to create the Iberian Advanced Computing Network

The Spanish and Portuguese governments have pledged to work together to create the Iberian Advanced Computing Network, which will be launched in 2019. The agreement also includes a joint application for BSC to host one of the two pre-exascale supercomputers in the EuroHPC program in 2021 and for BSC to support the development of HPC initiatives in Portugal, such as the Minho Advanced Computer Center and the AIR_DataNet project.

New High-Level Support team and Data Management group to support users

The BSC operations department has set up two support services for BSC infrastructure users. David Vicente leads the new High-Level Support team, included in PRACE, to support application performance, code optimization, and porting and application recoding. Nadia Tonello is the manager of the new Data Management Support group for BSC data services, including not only data storage, but also data management, data citation, data curation and data preservation.

CIONET Award for digital leadership in the public sector awarded to the BSC operations director

Sergi Girona has received an award recognizing him as the 2018 Best CIO in the Public Sector for digital achievements in 2017, the year in which BSC updated its most emblematic supercomputer, MareNostrum. During the award ceremony, the BSC operations director expressed his gratitude for this award, which was “thanks to the effort of all the BSC team” and “the trust placed by our Trustees in supercomputing as a tool of scientific progress.”
Europe bets on HPC

2018 was an important year for boosting supercomputing in Europe. As the year began, the European Commission unveiled its proposal for the EC and member states to commit to HPC by jointly investing a billion euros until 2020 to build world-class European supercomputing infrastructure.

The EuroHPC Joint Undertaking started operating in November. This is a legal and funding entity with the aim of:

a) Buying and deploying two supercomputers that will be among the top 5 in the world and at least two others that would today rank in the global top 25, for Europe’s private, public, scientific and industrial users.

b) Developing a European supercomputing ecosystem, stimulating a technology supply industry and providing supercomputing resources for many application areas.

BSC, which has long argued that Europe should invest in HPC technology, is highly supportive of this initiative. The center is represented in the different collegiate governing bodies of the EuroHPC Joint Undertaking. BSC director, Mateo Valero, and BSC Operations Department director, Sergi Girona, were elected members of the Research and Innovation Advisory Group and the Infrastructure Advisory Group, respectively. And BSC’s associate director, Josep M. Martorell, was appointed a technical advisor of the Spanish representative in the Governing Board.

EPI Consortium

One of the pillars of EuroHPC is to promote research to develop European supercomputing technology. The European Processor Initiative (EPI) has been created with this aim in mind. EPI is a consortium that brings together 23 partners from research and form IT and automotive industry, coming from 10 different European countries with the aim of bringing low-power microprocessors and accelerators to market. BSC is the coordinator of the accelerator development, led by Mateo Valero.

The race to exascale

BSC also hopes to have a role as the host of one of the European pre-exascale supercomputers and enjoys the support of the Spanish and Portuguese governments, which signed a solemn agreement in November in which they committed to making it possible. The Catalan Government is also committed to this initiative.
Coordinator of the new European accelerator

BSC’s director, Mateo Valero, will coordinate the research for the construction of the new European accelerator within the framework of the European Processor Initiative (EPI). Valero proposes that this accelerator be Open Source and RISC-V, since these technologies are democratizing chip design.

EPI is the consortium selected by the European Commission to co-design, develop and market low-power hardware, one of the core elements needed for the development of the European Exascale machine.

Growth in Life Sciences with a new focus on personalized medicine

With the incorporation of Alfonso Valencia as its director, the Life Sciences department has been reorganized, aiming at becoming a leader in personalized medicine. Four new research groups have been created: Computational Biology (led by Alfonso Valencia), Integrative Computational Network Biology (Natasa Przulj), Computational Regulatory Genomics (Marta Melé), and Comparative Genomics (Toni Gabaldón). The restructuring has also entailed the creation of four new units: coordination of the Spanish Bioinformatics Institute (INB-ISCIII)-ELIXIR, Social Link Analytics, Genome Informatics and Text Mining. The restructuring will culminate in 2019, when the team will have grown from 45 to 120 people, included 3 ICREA researchers and 2 researchers with ERC Grants.

BSC involved in defining the government’s AI policies

BSC is taking part in defining the government’s artificial intelligence strategies. BSC’s associate director, Josep M. Martorell, and the head of High Performance Artificial Intelligence group, Ulises Cortés, are members of the artificial intelligence working groups promoted by the Spanish and Catalan Governments. The works are being carried out within the framework of the Declaration on Cooperation on artificial intelligence signed in April 2018 by 25 European states under the auspices of the European Commission.

Francisco J. Doblas-Reyes,
Earth Sciences director, selected to participate in drafting the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

Alfonso Valencia,
Life Sciences department director, appointed as a member of the Innovative Medicines Initiative (IMI) Scientific Committee.

Sara Basart,
Researcher in the Atmospheric Composition group, who has been selected as a member of the group of experts for the United Nations Coalition on Combating Sand and Dust Storms.

Markus Donat,
Climate Prediction group co-leader, appointed as a member of the Expert Team on Data Development and Stewardship of the World Meteorological Organization Commission for Climatology.
Featured publications

The multidisciplinary nature of BSC is evident in the wide range of disciplines in which its scientists publish articles. Below is a selection of the most outstanding publications in 2018.

**Cache side-channel attacks and time-predictability in high-performance critical real-time systems**

In this paper, the authors demonstrate why injecting randomization in cache memory timing behavior is the best way to achieve safety and security in embedded computers, beyond randomization solutions for time-predictability. Embedded computers are increasingly used to control systems directly interacting with humans and manage more and more personal or sensitive information, such as that related to the motor industry. David Trilla, Carles Hernandez, Jaume Abella and Francisco J. Cazorla. In Proceedings of the 55th Annual Design Automation Conference (DAC). San Francisco, US. Best Paper Award Nominee. Jun 2018.

**Architectural support for task dependence management with flexible software scheduling**

This paper presents Task Dependence Manager, a co-designed hardware/software mechanism to mitigate runtime system overheads in massive multi-core architectures. Results show that, on average, it achieves a 12.3% speed-up and a 20.4% energy-delay product reduction compared with a software runtime system; and a 4.2% speed-up and 7.3x fewer area requirements compared with a runtime system fully implemented in hardware. Emilio Castillo, Lluc Alvarez, Miquel Moretó, Marc Casas, Enrique Vallejo, José Luis Boscue, Ramón Beivide and Mateo Valero. Proceedings of the 24th IEEE International Symposium on HPC Architecture, Vienna, Austria. Feb 2018.

**Comprehensive evaluation of supply voltage underscaling in FPGA on-chip memories**

In this paper, authors characterize the undervolting of built-in FPGA memories. Results demonstrate 10x savings in power and energy. Authors also characterize the errors that occur due to undervolting, showing their deterministic behaviour at a given voltage, temperature and chip. Using this information it is possible to construct a ‘fault map’ for each chip; this map can then be used by an intelligent memory allocator which assigns the most reliable memory blocks to the most critical layers of a Neural Network application, thus minimizing the impact of undervolting faults while providing an order of magnitude energy savings. Behzad Salami, Osman Unsal, Adrian Cristal. The 51st Annual IEEE/ACM Int. Symposium on Microarchitecture (MICRO), Fukoka City, Japan. Oct 2018

**Mesh generation, sizing and convergence for onshore and offshore wind farm atmospheric boundary layer flow simulation with actuator discs**

The authors present a new mesh generation process for wind farm modeling together with a mesh convergence and sizing analysis for wind farm flow simulations. The generated meshes simulate atmospheric boundary layer flows on complex terrains modeling the wind turbines as actuator discs. The wind farm meshener generates a hybrid mesh conformal with the actuator discs and refined upwind and downstream. Abel Gargallo-Peris, Matias Ávila, Herbert Owen, Luis Prieto-Godino, Arnau Folch. Journal of Computational Physics. Dec 2018.
**PETGEM: a parallel code for 3D CSEM forward modeling using edge finite elements**


**Atmospheric processing of iron in mineral and combustion aerosols: development of an intermediate-complexity mechanism suitable for Earth system models**

The study estimates that the deposition of soluble iron to the ocean since the preindustrial era has roughly doubled due to higher emissions of iron-containing mineral dust and combustion aerosols, along with a more efficient atmospheric processing. It is also shown that given current uncertainties, an intermediate complexity and cheaper-to-run iron dissolution mechanism can do as well a complex one in comparison with observations. Rachel A. Scanza, Douglas Hamilton, Carlos Perez Garcia-Pando, Clifton Buck, Alex Baker and Natalie M. Mahowald. Atmospheric Chemistry and Physics. 5 Oct 2018.

**Skillful forecasting of global fire activity using seasonal climate predictions**

This article discusses an innovative strategy to improve seasonal prediction of climate-driven fires, a discipline which is still in its infancy. The strategy reveals an untapped and useful burned area predictive ability using seasonal climate forecasts that can play a crucial role in fire management strategies and minimizes the impact of adverse climate conditions. Marco Turco, Sonia Jerez, Francisco J. Doblas-Reyes, Amir AghaKouchak, Maria Carmen Llasat and Antonello Provenzale. Nature Communications. 13 Jul 2018.

**Re-analysis of public genetic data reveals an X-chromosomal variant associated with type 2 diabetes**

The study identifies new risk variants for T2 Diabetes through reanalysis of public data with innovative computational methods. It represents a new way of exploiting very large pre-existing genetic data to make relevant biomedical discoveries, highlighting the importance of data sharing initiatives and policies in science, as well as the power of HPC applied to big data analytics. Silvia Bonàs-Guarch et al. Nature Communications. 22 Jan 2018.

**Intronic CNVs cause gene expression variation in human populations**

The authors of this article have combined the most extensive maps of copy number variants (CNVs) common in human populations to explore the functional implications of introns. They have found that introns, which are an essential component of human genes, exert an important role in maintaining key functions related with the variability of gene expression and splicing. This large-scale exploration of genomic datasets in human populations can have important implications for the study of diseases and disease resistances in human populations. María Rigau, David Juan, Alfonso Valencia and Daniel Rico. Plos Genetics, in the press.
BSC coordinates an Europe-Canada flagship initiative for modern oncology and personalized medicine

The European Commission has given the green light to the European-Canadian Cancer Network (EUCAN-Can) project, coordinated by BSC, to create the standards and infrastructure that will support and enhance personalized medicine in modern genomic oncology. The project seeks to create a cultural, technological and legal framework for high-quality analysis and sharing of genomic and clinical data on cancer across countries. The standardization of procedures and formats will improve the discovery and application of new biomarkers in cancer by allowing the integration and combined analysis of larger amounts of data, and will serve as a model for globalizing and enriching personalized medicine initiatives, allowing the exchange of data, clinical experience and information across different healthcare systems. EUCANCan is a consortium of leading research centers in the field of genomic oncology, involving Spain, France, Germany, the Netherlands and Canada. BSC is also taking part in the EuCanSHARE flagship, coordinated by Pompeu Fabra University, which aims to create a platform for the exchange of cardiology data.

A young BSC researcher is co-first author of two PanCancer Atlas articles

BSC researcher Eduard Porta is the co-first author of two of the 26 PanCancer Atlas project articles that were released in a monographic edition of the prestigious scientific journal Cell in April 2018. The special Cell issue gathers together the work of nearly 1,000 scientists from around the world, studying 33 types of cancer using genomic data from 11,000 patients.

The PanCancer Atlas project was funded by the United States National Institutes of Health (NIH). In one of the papers, Porta publishes the most up-to-date list of the 299 genes involved in the development of cancer, including 59 genes that have been linked to cancer for the first time. In the second, he goes into further depth on the role of these genes in some of the body’s immune responses in fighting tumors and suggests routes towards the use of personalized immunology therapies.

BSC in charge of quality control for the Copernicus Climate Change Service’s Climate Data Store

BSC is the institution responsible for deploying the evaluation and quality control of the Copernicus Climate Change Service’s Data Store, the largest fully public global repository of climate data. The project puts BSC (leading a consortium of eight organizations) at the center of the rapidly-emerging fields of quality control and standard definition of data and software in climate services.

Artificial Intelligence to support healthy vision

Lenovo and BSC are working together to help ophthalmologists with early-stage detection of retinal diseases. Early diagnosis can reduce severe vision loss by up to 57%, but detecting retinal disease through in-person dilated eye examinations has a fairly low accuracy rate when performed by a human. Lenovo and BSC are exploring how a trained AI neural network can improve this accuracy and detect the disease sooner.
BSC awarded an ESA project to evaluate low-power GPUs for space applications

BSC has been awarded a European Space Agency project to evaluate the suitability of different processing devices for space applications. The project, named GPU4Space, will explore the suitability of embedded graphics processing units (GPUs) for space computing. In addition, it will compare specific low-power GPUs with other existing and future processing devices for use in spaces well as defining the future steps required for the adoption of low-power GPUs there.

BSC to participate in a NASA-funded space sensor to map the composition of the world’s dust sources

BSC researcher Carlos Pérez García-Pando is taking part in a NASA-funded space sensor to map the composition of the world’s dust sources. The project, called EMIT, will mount an advanced imaging spectrometer on the outside of the International Space Station to determine the mineral composition of dust sources that produce dust aerosols. The aim is to study whether mineral dust is contributing to warming or cooling the atmosphere.

First superconducting qubit in Spain

The BSC Quantic group has launched its first quantum bit or qubit. It is a superconducting qubit and it is the first with these characteristics to be demonstrated in Spain. The experiment was carried out in the laboratories of the Catalan Institute of Nanoscience and Nanotechnology (ICN2) in Bellaterra. It is expected that the Quantic group will soon have a laboratory at the Torre Girona building.

Repsol-BSC Research Center to receive the National Award for public-private partnership in R&D

The Catalan government and the Catalan Foundation for Research and Innovation have granted the joint Repsol-BSC Research Center the National Award for public-private partnership in R&D. This recognition highlights the longstanding partnership between both institutions in the field of research on seismic imaging technology. The Repsol-BSC Research Center focuses on the development of BSIT (Barcelona Surface Imaging Tools), a cutting-edge technology to reduce risk in the exploration of hydrocarbons and in its deployment in Repsol’s hardware infrastructure.

BSC and Fujitsu to build up an ecosystem for a future exascale supercomputer

BSC and Fujitsu have signed a 3-year collaboration agreement aimed at building up an ecosystem by preparing a necessary middleware stack and applications that could be used for a future world-class exascale supercomputer based on ARM processors. This collaboration has three main areas: script language platform, math libraries migration and optimization using BSC’s OpenSs programming model and migration of applications from x86 to ARM architecture.
Three new spin-offs based on BSC technologies

Three new spin-offs based on BSC technologies were created in 2018. The start-up of these three new companies is a leap forward in the history of BSC technology transfer and highlights the diversity of the research done at the center. They join Nostrum BioDiscovery, which was the first BSC spin-off.

**Nearby Computing** offers a differential and high-tech product for corporate deployments of Internet of Things and 5G networks, based on the research generated at BSC and UPC. These services allow companies and public authorities to automate complex cutting-edge computer processes, combining different commercial software products and the integration of hardware and software components.

**Mitiga Solutions** uses a technology that is able to evaluate the impact of the dispersion of ash from volcanic eruptions on the aviation sector. Through algorithms, information from different specialized sources and satellite images, Mitiga can know when a volcano has started erupting, forecast its impact on flight routes and airplane turbines and provide information to airlines for them to manage air traffic.

**ELEM Biotech** helps medical technology and pharmaceutical companies, CROs and doctors perform virtual simulations for the personalized treatment of some diseases. In a first step, this new biotech company is focused on modeling of the respiratory and cardiovascular systems of virtual patients. In the long-term, Elem’s vision is to progressively move to all organs and systems.

**BSC software makes Lenovo’s new set of cooling technologies more energy efficient**

BSC has contributed to the creation of the Neptune set of Lenovo cooling technologies that can allow data centers to run up to 50% more efficiently without hindering performance or density. BSC has participated with its Energy Aware Runtime software (EAR). EAR guarantees applications will run at the most energy-efficient frequency according to its dynamic characteristics, detected by the runtime library, and energy system configuration.

**BSC launches dataClay, the data store that provides programmers with a 30% saving in time and code**

BSC has made dataClay available to programmers. This is a data store that provides savings of up to 30% on time and code for application developers. dataClay is a distributed object store that avoids the need to have different data models in volatile memory and in persistent storage. It performs calculations directly on the object store without having to copy the data to the application space, thus avoiding both the time and energy costs associated with data transport.
Meet us in person

We are all aware that science and research contribute to the progress of our society. At BSC we see science and technology outreach as a fundamental part of our responsibilities as a public center. Making our research accessible to the public, promoting scientific culture, helping awaken scientific and technical vocations in young people and working to reduce the gender gap are objectives that are very close to our heart. See some of our outreach activities below:

Female-focused tours for primary schools.

During the 2018-2019 school year, six thousand elementary students will go on guided tours to find out about what supercomputers are and what they can be used for in a fun and female-focused way.

They are two-hour tours with eight games for kids to understand some of the basic concepts of supercomputing, such as programming, simulating, parallel calculation, the importance of data in understanding our environment, connectivity and energy efficiency.

Bridging the gender gap in science and technology is one of the objectives of this program, called "We are young women researchers", which we carrying out in collaboration with Barcelona City Council.

"MareNostrum" song by Macedonia

One of the key parts of the kids tour is the MareNostrum song by the pop group Macedònia in which the band members (all of them girls) are "scientists" who use the supercomputer to make discoveries.

BSC mascot to bring supercomputers closer to young people

BSC now enjoys the services of SuperGeek, a mascot whose mission is to bring supercomputers closer to young people and stimulate their interest in science and technology. This superheroine is a fan of computers, codes and hackathons and is responsible for BSC’s public relations in all kinds of activities.

Visit our supercomputer

MareNostrum is always ready to receive visitors. All you have to do is book through visits@bsc.es. In 2018, more than 14,000 people came to see Torre Girona chapel.