CSC

ICT Solutions for Brilliant Minds

CSC – IT Center for Science

Corporate responsibility report

2022

Image: Samuli Rosenberg

Content

Image: Samuli Rosenberg

Corporate social responsibility

Managing Director statement

The year 2022 was exceptional in many ways; the war in Ukraine, the economic sanctions imposed by the EU and the energy crisis have affected society as a whole and also CSC's operations. Despite all this, CSC excelled in managing the challenging year and, even under exceptional circumstances, we were able to increase our investments in responsible and high-quality service production.

In spring 2022, CSC launched its Sensitive Data (SD) services for verified data security suitable for processing sensitive research data. In the summer, they were supplemented with a limited version of the SD Desktop service, which is tailored to the needs of the secondary use of data authorised by the Social and Health Data Permit Authority Findata.

The single largest event in 2022 was the inauguration of the LUMI infrastructure for joint European scientific computing in June. After approximately 60 projects carried out in the pilot phase, the extensive computational resources of the third most powerful supercomputer in the world,

LUMI, were made available for application for all European researchers in January 2023.

Last year, great leaps were also taken in quantum computing when LUMI was connected to the Finnish VTT quantum computer Helmi. The EuroHPC Joint Undertaking also selected European quantum computer hosting sites in the autumn, and LUMI-Q was one of the selected projects. Its quantum computer will be located in Ostrava, at the Czech LUMI partner IT4Innovation's centre, and it will also be connected to LUMI in due course.

In autumn 2022, CSC was selected to lead an international project to develop the Climate Digital Twin to simulate the Earth's climate. This digital twin will serve as a key tool for assessing the impacts of climate change and supporting the decision-making on climate change adaptation in Europe. The project is part of the Destination Earth programme of the European Commission and commissioned by the ECMWF, the European Centre for Medium-Range Weather Forecasts.

The digital transformation of higher education institutions progressed rapidly as the Digivisio2030 project. CSC runs the project office for this project. In autumn 2022, CSC was also selected as Digivisio's service operator with a one-year agreement. We aim to renew our position at the end of 2023.

In addition to European cooperation, CSC has also concluded a number of significant cooperation agreements during the past year, for example with centres in the following countries: the United States, Japan, Australia and Singapore. This will also create new paths to international cooperation and computational resources for Finnish research communities.

As a special assignment company, we want to take responsibility of our customers, even in exceptional times. We have increased our personnel's information security and data protection training and developed our risk management process during autumn 2022.

In the future, we must invest even more in our personnel's competence. After many exceptional years, we also need to focus on our personnel's well-being and their coping at work. Growing business requires the ability to renew from the entire organisation, and CSC will invest both in more efficient recruitment and in the current personnel's prerequisites for work. Last year, CSC received once again the Most Inspiring Workplaces in Finland certificate. This is a good starting point for developing our operations.

Kimmo Koski
Managing Director

We create value*

OUR CAPITAL

Our strengths are extensive cooperation and sharing expertise

- CSC operates project office for Digivisio2030, joint project for Finland's 38 higher education institutions
- Wide international and national networks

Research data management
HUB OF EXCELLENCE

We enable research and education

- A national, digital operating environment for research, education and cultural heritage (e.g., FUNET, FIRI infrastructures)
- A part of joint European ecosystems

LUMI and DL2021
ENVIRONMENTS

We are an attractive workplace

- Over 500 experts from different fields
- A multicultural and inter-national work community
- Share of women is 35%

THE MOST INSPIRING WORKPLACES RECOGNITION: PEOPLEPOWER INDEX NUMBER
74.3

We are a non-profit enterprise

- Owners: State of Finland 70%, higher education institutions 30%

TURNOVER
EUR 64.4 million

We promote the digital green transition

- Destination Earth: a digital twin of the Earth

Low-carbon
DATA CENTERS

OUR PURPOSE

Together we build world-class research, learning and innovation environments

Solutions for creating a future

- Customer orientation and dialogue
- With expertise
- Openness and transparency
- Trustworthiness and security
- Increasing interoperability
- Responsibility
- Technology foresighting

THE VALUE WE CREATE

For our owners and customers:

A smooth daily life:
- Over 400,000 Funet network users
- 7,400 data management and computing services users
- Several interoperability solutions (e.g. Research.fi, Fairdata, PAS)
- Services that enable a smooth daily life at higher education institutions
- 1.4 M Funet Miitti video meetings

Trustworthiness and security:
- Regulatory compliance
- ISO 27001 certification
- Securing preservation of cultural heritage and research data, 25 long-term preservation contracts

Sharing expertise:
- 62 RDI projects (39 EU projects, 33 cooperation with Finnish higher education institutions and research institutes)
- 154 training events, feedback average 8,77/10
- We enable the sharing of 2,310 online learning materials via the Library of Open Educational Resources

Synergy benefits:
- Services for different administrative sectors
- Haka as a pathway to 451 services, 60 million logins and 330,000 end users
- Services produced by international networks (e.g. ELIXIR, EUDAT, EOSC)

To the society:

The digital transformation is advancing:
- Increasing resilience of our national digital competences
- Increasing number of international experts
- Developing new technologies and operating models (artificial intelligence, quantum computing)
- Solutions for data economy (e.g. data spaces, networks of trust)
- An extensive and efficient digital infrastructure (data connections of higher education institutions, supercomputing, data management solutions)

Better cyber security:
- Environments for sensitive data
- Information security certificates and testing
- Critical infrastructures
- A strong immunity to interference

Enhancing interoperability:
- Methods of transferability and interoperability: open and standard-compliant data, file formats, interfaces and source codes

Advancing green transition:
- Carbon neutral data centers
- Heat recovery
- A smaller footprint of procurements

Environmental impacts:

No direct greenhouse gas emissions through electricity consumption:
- Utilizing the waste heat generated by Kajaani Data Center in the district heating network

THE CARBON FOOTPRINT OF OUR ACTIONS
777 tCO_2ekv

OUR SUSTAINABLE DEVELOPMENT GOALS

*The value creation model is based on the numbers from 2022.

Financial responsibility

Finances

CSC's mission is to provide non-profit services to its shareholders. Rather than operating on market terms, CSC provides services in the business areas and to the organisations specified by our shareholders, as stated in our Articles of Association. At CSC, financial responsibility means transparency, open financial management, and the provision of high-quality yet cost-effective services.

Financial objectives and their attainment

The financial objective for 2022 was to respond to the challenges of a rapidly changing operating environment through good change management. As business expanded, good control and transparency of the cost structure also emerged as a significant theme. This represented an effort to respond to changes in the environment.

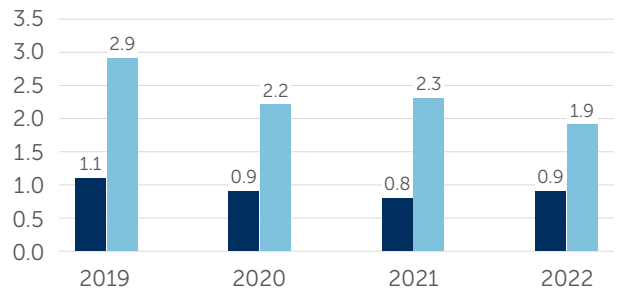
CSC's tax year 2022 was financially good. The company's business developed as predicted and the financial targets for the year were achieved. The impacts of the rapidly changing operating environment could be responded to through changes in the company's internal and external operating practices. The expansion of business was underpinned by new

customer relationships and new international projects. As in previous years, the company continued to operate in a cost-effective manner. Key indicators for CSC's financial performance and financial activities are presented in greater detail in the Report of the Board of Directors, Financial Statements and Auditor's Report.

Cashflows to stakeholders

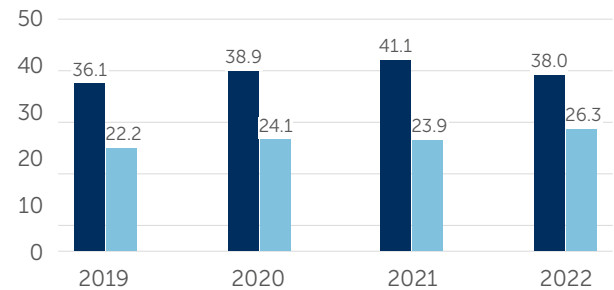
Cashflows to stakeholders	2022
Net sales	64.350 M€
EU, Business Finland, Finnish Academy fundings	12.765 M€
Suppliers	-32.743 M€
Personnel	-38.814 M€
Public sector (taxes)	-243,000
Non-profit organizations: grants and donations	0
Shareholders	0
Financial expenses	-29,000
Financial incomes	12,000
Financial profit	0.970 M€
Investments: depreciation	4.328 M€

Liquidity ratio



*Current Ratio: More than 2 = good, 1-2 = satisfactory, less than 1 = poor
**Quick Ratio: More than 1 = good, 0,5-1 = satisfactory, less than 0,5 = poor

Solvency ratio



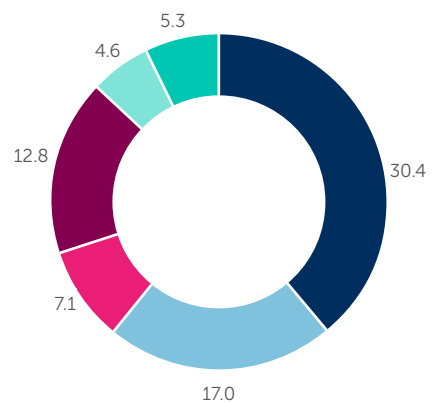
*Equity Ratio: More than 40% = good, 20–40% = satisfactory, less than 20% = poor
**Debt Ratio %: More than 80% = poor, 40–80% = satisfactory, less than 40% = good

Financial support from the state

Financial support from the state	€	€/000
Special state grant	5,155,624.21	5,156
Investment aid	465,366.29	465*

* Includes also money for the DL2021 investment.

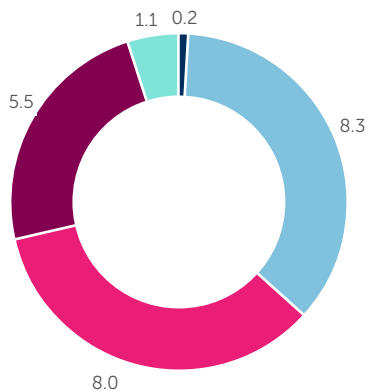
Incomes
EUR million



- Ministry of Education and Culture, 39%
- Higher and other education, 22%
- Public administration organisations, 9%
- Financers, 17%
- Research organisations, 6%
- Culture organisations and others, 7%

Year 2022 CSC's incomes were in total EUR 77.1 million

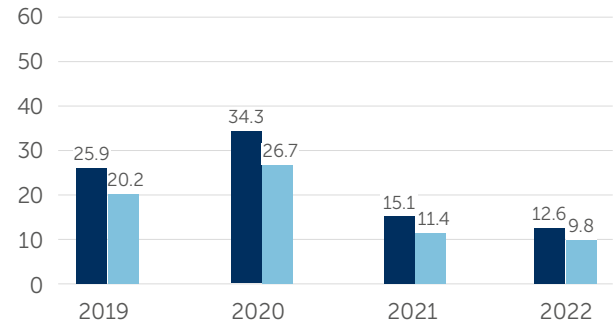
Tax footprint
EUR million



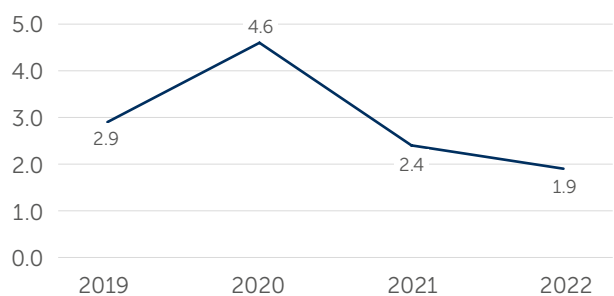
- Corporate tax, 1%
- Value added tax, 36%
- Withholding taxes on pay, 35%
- Employee pension payments, 24%
- Other statutory contributions related to personnel, 5%

Year 2022 CSC tax footprint was in total EUR 23.1 million.

Return on capital



Operating profit, %



Procurement

CSC adheres to both its own procurement guidelines and the Act on Public Procurement (1397/2016). Procurements are also governed by legal practices relating to the Act on Public Procurement. Additionally, we comply with other acts relating to each procurement and other legislative requirements applicable to the object of the procurement (such as the Act on the Openness of Government Activities and, on a case-by-case basis, also the General Data Protection Regulation and the Act on the Contractor's Obligations and Liability When Work is Contracted Out).

Even minor procurements that do not fall within the scope of the Act on Public Procurement are put out to tender following CSC's procurement guidelines. In strategically significant procurements, suppliers' subcontractors must also be approved in advance. CSC aims for fair treatment, long-term contracts and open cooperation in procurement. CSC organises centralised tendering processes, the results of which are used particularly by higher education institutions based on their position as in-house companies. CSC's goal is to develop partnerships and thus guarantee good business conditions for all parties and the best possible service for customers. All suppliers are expected to comply with CSC's operating principles.

CSC has entered into several framework agreements with goods and service providers subjected to a tendering process by Hansel Oy. Unless there is a particular reason not to, CSC always uses Hansel's framework agreements, which also take environmental perspectives into account. CSC's procurement guidelines instruct purchasers to consider environmental factors in accordance with the life cycle model: during the planning phase, during use, and at the end of the cycle.

CSC includes all information security requirements in its calls for tenders. Procurement contracts, and in particular those for IT services, software and hardware, contain a separate appendix on security. If necessary, the Head of Security or their designated representative is involved in the planning and implementation of the procurement. If, as part of a procurement, personal data processing is outsourced to the service provider or the service provider acts as the controller when providing the service the procurement contract concerns, the requirements laid down in the Data Protection Act are complied with.

The procurement strategy was reformed in 2022. The new strategy set three objectives for developing procurements for 2022–2025: 1) procurement data is used efficiently, 2) cost-effective and well-organised procurements, 3) ecological and social sustainability goals in procurement. The strategy identified knowledge-based management of procurements that allow efficient use of procurement data. Cost-effective and well-organised procurements contribute to achieving business objectives and ecological and social sustainability goals.

Information security and data protection

A secure partner

CSC is a secure partner for its customers and other stakeholders, both nationally and internationally. CSC's information security management system has been granted the international ISO 27001 certificate, which covers CSC's datacenter functions, ICT platforms, IaaS cPouta and ePouta, the LTP long-term data preservation service, the Eduuni, Tiimeri and Funet Miitti services and the maintenance of LUMI. CSC has been an international pioneer in ensuring information security compared to its peer groups, and the annually audited certificate has been granted to CSC for ten years already.

In 2022, CSC was also granted the Finnish Katakri certificate for security management and certain facilities.

CSC also participates actively in the development of security both in national security networks and in its international projects and research infrastructures. CSC has also issued statements on the regulation of cyber security at the Finnish and EU levels.

In 2022, the importance of cyber security has been emphasised especially due to the war in Ukraine. For its part, CSC has adhered to the imposed sanctions and actively monitored the situational picture of cyber security risks. CSC is classified as an organisation critical to the security of supply.

Data protection and the personnel's competence developed

CSC complies with the General Data Protection Regulation and is committed to processing personal data carefully, in accordance with applicable laws and regulations, and in a manner that respects and protects individuals' right to privacy. CSC acts as a processor for several public organisations. It develops services suitable for the processing of personal data requiring special protection for their use and in cooperation with them. This requires CSC personnel to be competent in data management and the implementation of data protection.

CSC offered its personnel an opportunity to demonstrate their data protection competence by acquiring a data protection expert's certification. More than 40 people participated in preparatory training for certification. Data protection management was developed, and the development work continues.

The whistleblower channel introduced at the end of 2021 allowed reporting suspected illegal activities to CSC anonymously. In 2022, no requests to investigate suspected data protection or data security breaches were sent to CSC. One personal data breach that warranted a notification to data protection authorities took place in the processing carried out with CSC as the controller. The controlling authority requested one report on the delay of reporting one personal data breach in 2021. There were no unwanted legal matters (complaints, compensations, appeals, statements or trials).

Responsibility for personnel

Personnel

Personnel policy, wellbeing at work and key figures

Mental working ability plays a key role in employees' motivation and coping at work, particularly among those working in an expert role. CSC took wellbeing at work into consideration in many different ways, for example by focusing on management and its development, especially on the management of hybrid work and leadership, by organising tailored work ability management training for line managers, by providing personnel with support in the form of various personnel benefits for hobbies and recreational activities and also with expert webinars to support the maintenance of their wellbeing at work. CSC also offers its personnel extensive and versatile occupational health care services and an extensive health insurance.

At the end of 2022, CSC had 567 employees, 93% of whom were in an employment relationship valid until further notice. Employee turnover was 8.9%, which is an excellent rate for the industry. The average duration of employment was approximately 7.3 years, and the gender ratio was 35% women and 65% men.

Code of Conduct and equality

The CSC Code of Conduct describes comprehensively the principles of personnel rights that are observed in all

our operations. CSC's entire personnel successfully completed the online Code of Conduct training in 2022. The Code of Conduct is complemented by an internal equality and non-discrimination plan, which is reviewed and updated regularly.

Performance management, competence development and rewarding

CSC conducts performance and target discussions during the first quarter of the year to assess the achievements of the previous period and to set targets for the next one. The employees' personal goals are set in proportion to the targets of the unit and the company. Competence development planning takes place with the help of the framework of the personal development plans in August and September, and the realisation of the plans is monitored actively in joint discussions between the employees and their line managers.

Incentive bonuses not exceeding approx. 4.7% of the annual salary were granted to the personnel in 2022. The Board of Directors makes an annual decision on the amount of the incentive bonuses and the criteria for awarding them as well as authorises the Managing Director to award the bonuses to the personnel.

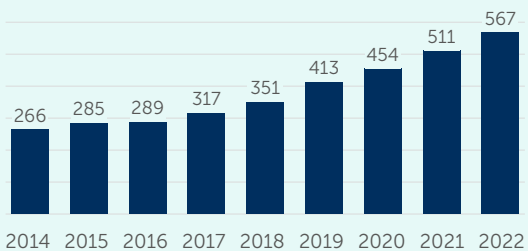
CSC aspires to be an attractive and responsible employer that motivates its personnel to achieve outstanding performances. CSC also encourages the personnel's lifelong learning and supports further studies by means of sabbaticals for competence development. The number of training sessions for line managers has been consciously increased to respond to competence development needs based on our strategy and to harmonise our management practices. The Leadership Development Program tailored for CSC started with a pilot group in autumn 2022, and everyone in line manager roles will partake in this training program. The personnel participated in various training packages aiming to develop their professional competence during the year, in addition to which their continuous on-the-job learning and knowledge sharing were encouraged.

"I am particularly pleased that our results concerning employer image, management and operating culture and supervisory activities are clearly above the reference level of 'Finnish experts'."

– Kimmo Koski, CSC's Managing Director

People 2022

Employees



Gender

♂ 65%

♀ 35%

Average employment length, years

7.3

Average age of retirement

64

Employee turnover 2014–2022, %

3.2–8.9

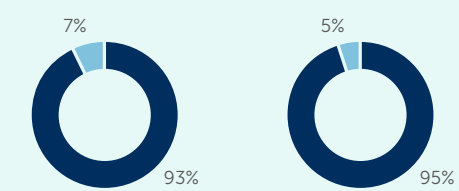
Absences due to illness average / person

8.5

Average age

43

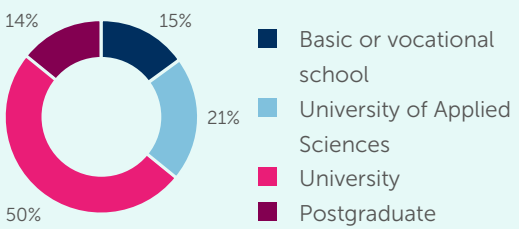
Employment



Training days 2014–2022 / person

0.7–2.1

Education background



Citizenships represented in staff

23

Environmental responsibility

Energy-efficient data centers

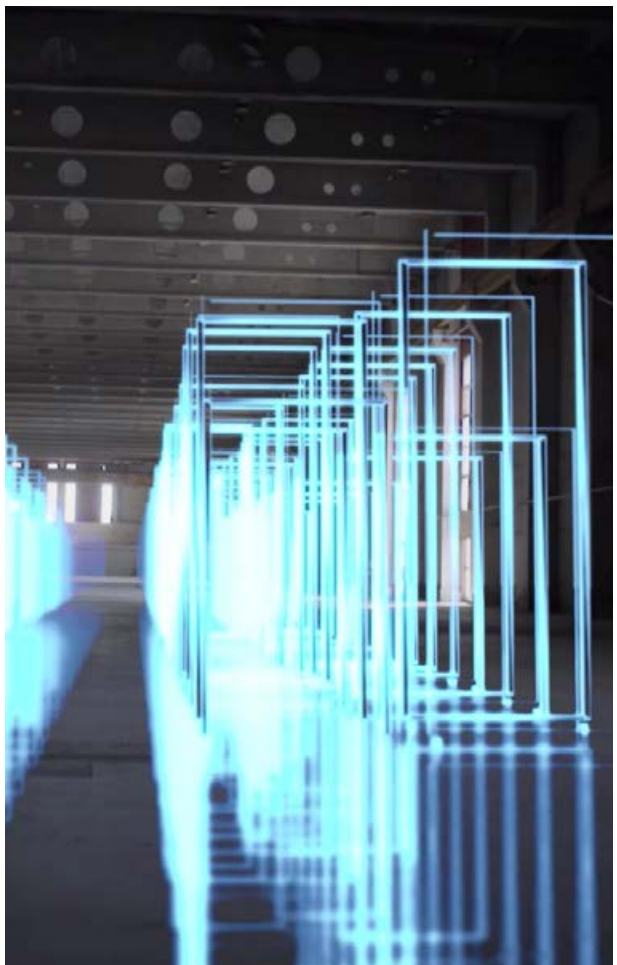
CSC's data centers in Kajaani offer world-class energy efficiency. By international comparison, the energy efficiency of the data centers in Kajaani is good or extremely good, and continued efforts are being made to improve it further. The key to energy efficiency is that all the energy consumed by the data centers is spent on meaningful activities and that the waste heat generated by them is used sustainably. The usage rate of the computing servers CSC offers to Finnish research is high, and our methods for ensuring efficient use of resources include scaling tests.

The LUMI data center has been in production in 2022. The second installation phase of the LUMI supercomputer was completed in 2022. In 2022, the PUE ratio measuring the energy efficiency of the LUMI data center was 1.19. The use of waste heat and district heating production by the LUMI supercomputer were enabled in 2022. Total district heating production capacity will probably be reached in early 2023, when waste heat will produce 20% of the annual demand for district heating in Kajaani, with no carbon dioxide emissions. All electricity used by LUMI is generated with renewable hydropower.

Thanks to an advanced cooling solution implemented for the supercomputer Mahti, the energy efficiency of Kajaani data center remained at a good level in 2022. In 2022, the PUE ratio measuring Mahti's energy efficiency was 1.07, which is very good. The PUE ratio measuring the energy efficiency of the modular data center (MDC1) commissioned in Kajaani in 2012 was 1.03 in 2022, which is one of the best in the world. The usage rate of the other modular data center (MDC2) commissioned in 2014 has increased steadily, but the exceptionally warm summer hindered the data center's energy efficiency, which stood at 1.20 in 2022. The energy efficiency of the Pohja data center in Espoo has improved slightly since last year. The PUE ratio of Pohja data center was 1.60 in 2022.

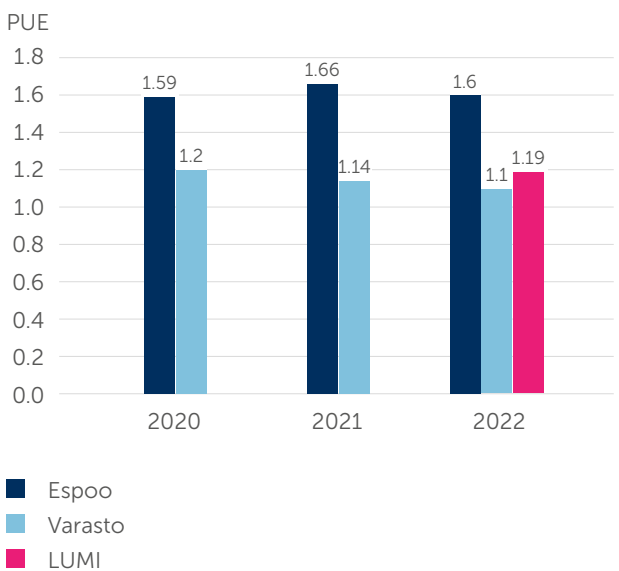
Energy and water

CSC's Espoo and Kajaani offices accounted for about 2% of CSC's total electricity consumption in 2022. The CSC data centers consumed the most electricity within the company. All electricity used by CSC's data centers and offices was generated with renewable hydropower.



CSC is not a major consumer of water. CSC's data centers mainly use a closed water-cooling cycle, which minimises their water consumption. In free-cooling data center modules, water is mainly used for humidity control and emergency cooling.

CSC's data centers energy efficiency in 2020–2022



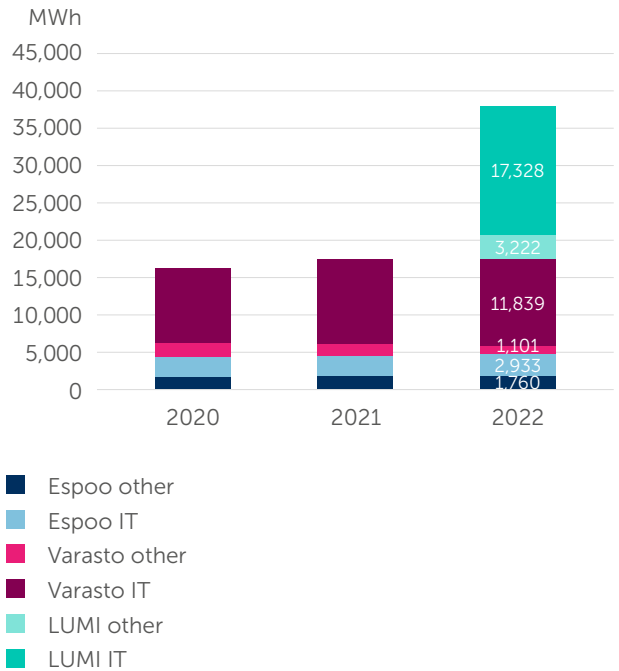
CSC leads the development of the Climate Digital Twin to simulate the Earth's climate

With the help of the LUMI supercomputer, CSC was selected to lead an international project to implement a climate digital twin to assess the impacts of climate change. The project is part of a broader Destination Earth initiative funded by the European Union, which will combine different thematic twins into a comprehensive digital twin of the planet by 2030. Three trusted entities implement the Destination Earth initiative: the European Centre for Medium-Range Weather Forecasts (ECMWF), the European Space Agency (ESA), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

The Climate Digital Twin project aims to develop a new type of climate modeling system that will produce climate simulations with an unprecedented resolution to assess the local impacts of climate change. These simulations will be combined with applications that support decision-making with information on climate change impacts.

Europe's leading supercomputers are used as computing platforms for the Climate Digital Twin. The LUMI supercomputer is one of the world's most powerful and sophisticated supercomputers and, therefore, a perfect platform for the Climate Digital Twin. LUMI enables climate models to be run at higher resolution and, as a result, find out local impacts on the climate. The project combines five different climate applications that provide information on how climate change impacts the weather, such as the spread of forest fires, heat waves, and other extreme weather phenomena. For example, it can be used to estimate what will happen to future wind power resources, i.e., where future wind power plants should be placed.

CSC's data centers energy consumption in 2020–2022



Responsibility to society

Stakeholders and stakeholder engagement

Open and active interaction with both customers and other stakeholders is particularly important for CSC's operations. Through dialogue, we can strengthen our stakeholder relationships, understand the expectations and wishes placed on CSC and strive to provide a better response to them. Cooperation and networking provide opportunities for sharing views and development that benefit society as a whole.

Customer orientation at the core of service development

CSC's customers are CSC's owners: the Finnish government, universities of applied sciences and universities. The Finnish government is the main owner of CSC and its largest customer. In particular, the Ministry of Education and Culture and its administrative branch, state research institutes, cultural and memory institutions and, to a more limited degree, public administration organisations are customers with a bilateral relation with CSC. Higher education institutions are also CSC's owners, customers and partners. They primarily organise their customer relationships as consortia, in some cases in a way that a state research institute or the Ministry of Education and Culture is a member of the consortium. As an in-house company of the government and higher education institutions, CSC only serves other customers to a limited extent, related to the objectives of the government and higher education institutions.

CSC delivers the services required by its customers within the framework of its strategy and its fundamental tasks specified in the ownership strategy. CSC's service and development activities rely on strong customer interaction and doing things together. The customers develop the services they need with CSC, and CSC supplies them at cost price. In other words, the guidance for developing CSC's services as well as the funding for development work and service provision come directly from the customers. Customers are also important partners of CSC, for example in external competitive funding projects. The customers play a key role in how CSC develops its services and capabilities.

CSC engages in active dialogue with its various stakeholders to understand the expectations and wishes concerning them and better respond to them. Customer satisfaction is surveyed not only through

Customers are satisfied with CSC's customer service

Responses to a survey including those who contacted CSC's customer service in 2022 (average for 438 respondents):

The answer I received was useful
3.7/4

My case was resolved quickly enough
3.7/4

Customer service was friendly
3.8/4

Net Promoter Score (NPS)
71

customer interaction but also through regular surveys and interview studies. In 2022, CSC commissioned a Reputation&Trust study from T-Media, interviewing rectors of higher education institutions. A similar study was commissioned in 2021 concerning directors-general of research institutes. Key cooperation networks, such as Universities Finland Unifi, the Rectors' Conference of Finnish Universities of Applied Sciences Arene and the Finnish Research Institute Partnership Tulanet, helped to clarify the messages of rectors and directors-general and to support CSC's strategy process. In 2022, feedback was also collected from contact persons for framework agreements with research institutes and higher education institutions at bilateral meetings. Based on the feedback, they are satisfied with CSC as an actor (the average of 19 higher education institutions and 4 research institutes is 4.1 on a scale from 1 to 5).

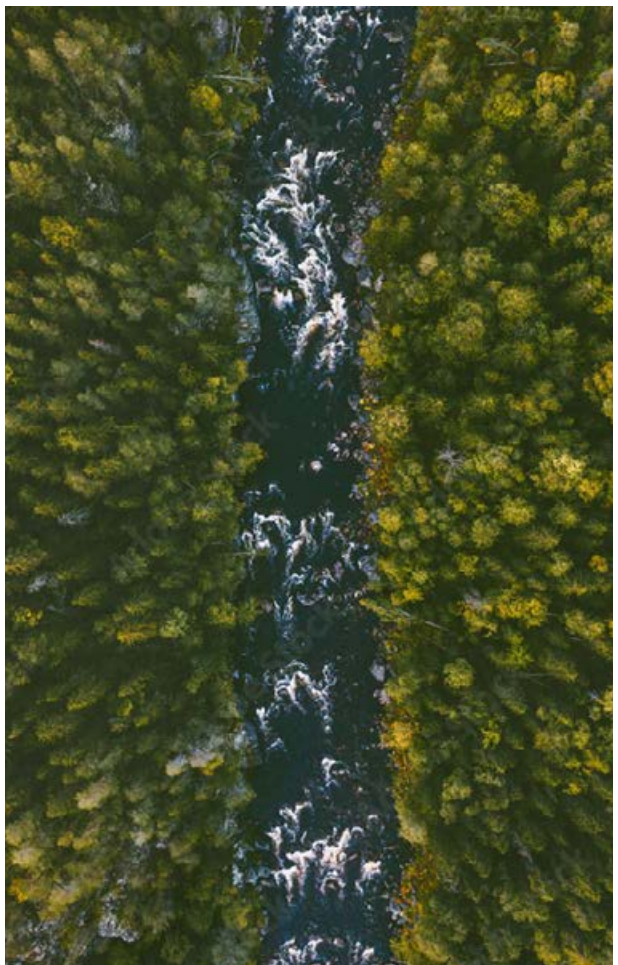
To ensure a customer-oriented approach, CSC follows a customer steering model which defines how customer orientation is realised in the company's strategy process, different stages of the service life-cycle model as well as decision-making and prioritisation concerning new initiatives.

Read more about customer steering ›

Influencing national and international operating conditions

CSC aims to influence the national and international operating conditions that are relevant for the company or its stakeholders. The basic principles of influencing are supporting the company's strategic goals, making it possible to use CSC's competence, capacity and expertise as widely as possible in society.

In 2022, CSC participated actively in EU consultations and comment rounds for legislative projects, some of which also involved committee consultations or meetings with Parliament, ministries, the European Commission or representatives of the European Parliament. Of particular importance regarding EU consultations was the preparation of the Ninth EU Framework Programme for Research and Innovation (Horizon Europe) and the Digital Europe Programme in cooperation with the national liaison officers of these programmes. CSC was involved in promoting aspects related to research infrastructures, data management



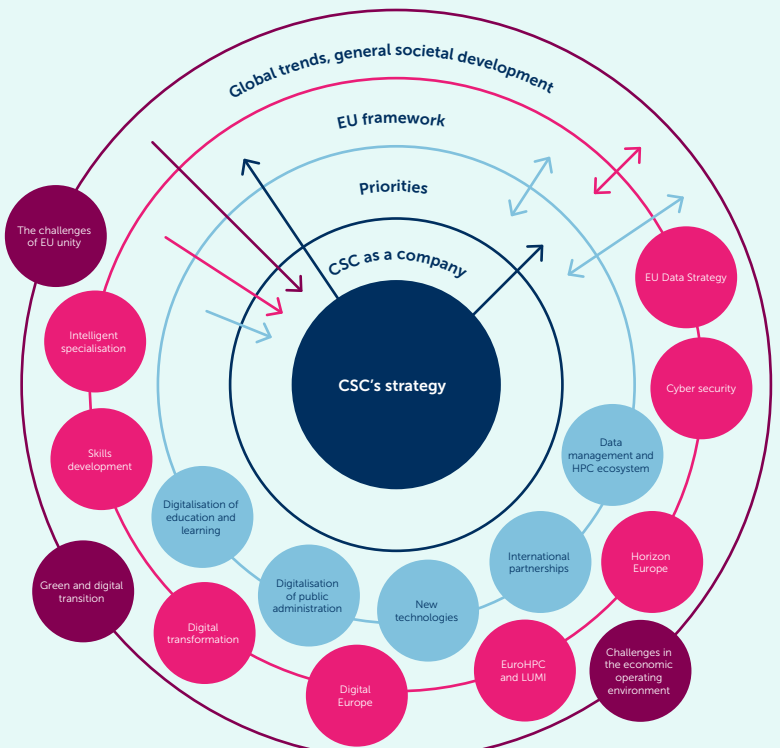
and computing, new technologies as well as interoperability, which are key to our customers, in the funding programmes and EU legislation initiatives.

CSC's Kajaani data center and the LUMI supercomputer attracted a great deal of interest, and ministers, parliament and EU parliament members visited the data center during the year. The placement of the LUMI supercomputer in Kajaani raises international awareness of CSC and Finland as pioneers of digitalization and research, development and innovation (RDI) activities and green and energy-efficient data centers.

Year 2022 was additionally marked by active social dialogue and stakeholder cooperation aiming to create international cooperation networks and a LUMI ecosystem that can be widely used by society. CSC also provided its expertise in the preparation of Finland's digital compass, the work of the parliamentary RDI working group and the work of the Artificial Intelligence 4.0 group.

CSC's public statements are available online on the Statements page of the company's website .

Framework of strategic influence

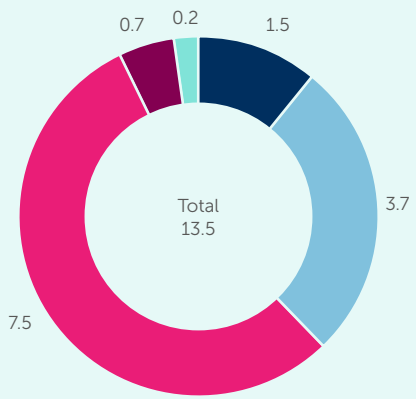


Benefits from RDI projects for customers

In 2022, CSC participated in 62 RDI projects with externally competitive funding, 33 of which involved a Finnish higher education institution or research institute. Most of the funding came from EU programmes (39 projects), but we also benefited from national funding programmes. In these projects, we developed services related to scientific computing and data management, artificial intelligence, software and management of user access rights, among other things. Many of our projects are part of broader international research infrastructures, including EuroHPC, PRACE, EOSC and ELIXIR.

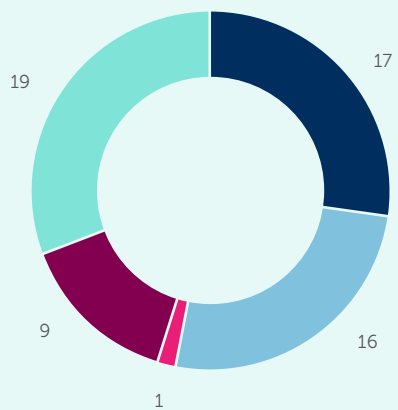
Distribution of project funding by financial instrument in 2022

EUR million



- Academy of Finland, 11%
- European Comission, 27%
- EUROHPC JU and LUMI consortium, 56%
- NeIC, 5%
- Other, 1%

Links between projects and international research infrastructures in 2022



- ELIXIR, 27%
- LUMI, 26%
- PRACE, 2%
- EOSC, 15%
- No linkage, 31%

Impact of research gets stronger

Internationally high-quality data management and computing infrastructures and the related services enable high-quality computational and data-intensive research. Enabling the use of services not only in research but also in higher education and innovation activities promotes the strengthening of the impact of research in society. Local, national and international cooperation is important to use the full potential of infrastructures.

LUMI benefits Finnish research, development and innovation activities

Getting the LUMI supercomputer ready for production and in benefit of Finnish research and education as well as company product development and innovation activities was one of the success stories of last year. LUMI offers international cooperation opportunities for both CSC and Finnish researchers.

LUMI was launched for production

The production use of the CPU partition based on traditional processors of the LUMI supercomputer began in January 2022. LUMI was the first of

Image: Fade Creative

EuroHPC's "pre-exascale" supercomputers to be launched for production in the midst of a global pandemic. LUMI's inauguration event was held in Kajaani on 13 June 2022. More than 150 invitees were present, and the event was also live broadcast online.

In May, LUMI was listed for the first time on the TOP500 list of the world's fastest computers and ranked third. LUMI is therefore Europe's most powerful supercomputer. LUMI also ranked third on the Green500 list, which compares the TOP500 list of supercomputers based on their energy efficiency. The HPCG (High-Performance Conjugate Gradient) list, which is an alternative way of measuring the performance of a supercomputer, also ranked LUMI third.

The installation of LUMI's GPU partition began in the spring, and almost 30 pilot projects were launched in November 2022. The projects represented several disciplines from astrophysics to climate and cancer research. There were also fields of science that have only recently begun to use computational methods, such as natural language processing. During the year there was a total of 55 LUMI projects from Finland, including the pilot projects.

In November 2022, LUMI was again ranked third on the TOP500 and HPCG lists, and seventh on the Green500 list. On the HPL-AI list, LUMI ranked second. The HPL-AI benchmark measures the convergence of high-performance computing (HPC) and artificial intelligence (AI) workloads.

During the year, LUMI received several international prizes.

Using LUMI for business was promoted in several ways

LUMI offers companies the opportunity to utilise high-performance computing as part of product development and innovation activities, and 20% of the capacity of the LUMI supercomputer is reserved for companies. The best ways to serve companies have been developed together with the Ministry of Education and Culture, the Ministry of Economic Affairs and Employment, VTT Technical Research Centre of Finland and Business Finland. In 2022, CSC and VTT concluded an agreement that enables VTT and their business partners to purchase some of LUMI's capacity and expert support for their cooperation projects. The opportunity to utilise LUMI's capacity has also been included in Business Finland's funding applications. A total of six pilots have been funded based on these applications, three of which began in 2022.

Image: Juha Torvinen, CSC

The industry and companies became familiar with CSC and high-performance computing, and several new projects that utilise the national data management and computing infrastructure and the EuroHPC/LUMI environment began in 2022. Cooperation between companies and higher education institutions and research institutes has also increased in CSC's projects using data management and computing infrastructure. Active work in the EuroCC programme has also provided companies with expert support, and the EuroCC2 programme to be launched in 2023 will further strengthen this.

LUMI increases the impact of Finnish quantum computing

In recent years, the perception that quantum computers and supercomputers must coexist, intensifying each other's strengths, has become established. This way, LUMI has increased the international impact of Finnish quantum computing and interest in cooperation with Finnish institutions. Finland has become a pioneer in interconnecting supercomputers and quantum machines. In March 2022, the first cross-border quantum calculation on LUMI was done in a supercomputer environment with the Chalmers quantum calculator in Sweden.

In November 2022, the integrated platform combining LUMI and VTT's Helmi quantum computer was made available to Finnish researchers. This was the first time in the world that an entity consisting of a supercomputer and a general-purpose quantum computer was offered for open research use, which was widely noted internationally.

Together, artificial intelligence, high-performance computing and quantum computing form the basis for Finnish innovations on a broad front.

LUMI creates new international opportunities

Thanks to LUMI, CSC was selected in October 2022 to lead an international project to create a digital twin of the Earth's climate in the European Commission's Destination Earth programme. The consortium brings together centres of expertise in climate modelling and supercomputing across Europe. The aim is to create an efficient, advanced climate modelling system with LUMI. This will be essential in supporting the EU's adaptation to climate change and the assessment of its impacts as well as relevant decision-making. In addition to CSC, Finnish participants include the Finnish Meteorological Institute and the University of Helsinki.

In October 2022, the EuroHPC JU selected the host projects of the newest European quantum computers. The LUMI-Q consortium of 14 members and 10 countries was one of these, and its quantum computer will be located at IT4Innovations centre in the Czech Republic. In the LUMI-Q consortium, several quantum computers will be connected with European supercomputers, including LUMI. This gives Finnish users access to a broad network of quantum computers.

With LUMI, interest in CSC has grown globally. In 2022, CSC concluded Memoranda of Understanding (MoU/MoC) with the Australian Pawsey Supercomputer Research Centre, Singapore Quantum Office, Singapore National Supercomputing Centre, Singapore Advanced Research and Education Network and National University of Singapore, Japan's Riken Center for Computational Science, Canada's Digital Research Alliance and Texas Advanced Computing Center. CSC has also intensified research cooperation with the State of Colorado and Japan. Basing on state level and EU-level and multilateral and bilateral cooperation arrangements, CSC strives to support the international cooperation of the Finnish research community, develop capabilities and expertise, influence global technological and policy-level development, provide the best possible services for Finnish researchers and promote strategically important themes, such as green data center activities.

Building European Open Science Cloud

The ambition of the European Open Science Cloud (EOSC) Co-Programmed Partnership is to build a Web of FAIR data and related services for Europe. Added values of EOSC include enhanced data and service connections, a better ability to address interdisciplinary and societal challenges, and improved e-infrastructure services and tools for research infrastructures and their data consumers. The EOSC Association together with the European Commission (EC) steer the development of the EOSC Strategic Research and Innovation Agenda (SRIA) that identifies priorities and gaps for achieving a full operational EOSC by 2030.

CSC is a member of the EOSC Association with representation in the Board of Directors and in the Task Forces and it is contributing to more than ten EC funded EOSC-related projects. CSC is also operating the office of the EOSC Finnish Forum, the structure established in 2021 to coordinate the EOSC activities at country level. All these activities give CSC the opportunity to influence the future developments of EOSC, to promote the CSC services and expertise at European level, to increase the CSC competences in key areas on open science and FAIR data management, and to pilot services and proof of concepts that then can implemented at national level.

New services for managing sensitive data

Customer's needs for managing sensitive data are met with services offered to both organisations and end users (researcher, learner, teacher). International cooperation plays an important role in the development of services.

Researchers, learners and teachers can now use Sensitive Data services

The Sensitive Data (SD) services offered to higher education institutions and research institutes provide tools for cooperation between organisations to manage sensitive research data during the project and to enable the secondary use of research in accordance with the FAIR principles. Out of this service series, the SD Connect and SD Desktop services were in production in 2022. The use of services grew, supporting several disciplines, ranging from life sciences to humanities. User feedback on the service and its customer support has been mainly positive. In 2022, development work on the integration of high-performance computing as part of SD Desktop began. In addition, SD Submit and SD Apply services to be launched later were piloted with the University of Helsinki.

CSC audited the SD Desktop service in accordance with the Social and Health Data Permit Authority Findata's regulation 1/2022. Service production

together with Findata began in summer 2022, enabling normal service production of the research on register data governed by the Secondary Use Act and authorised by Findata.

Sensitive data management services were also developed for organisation customers

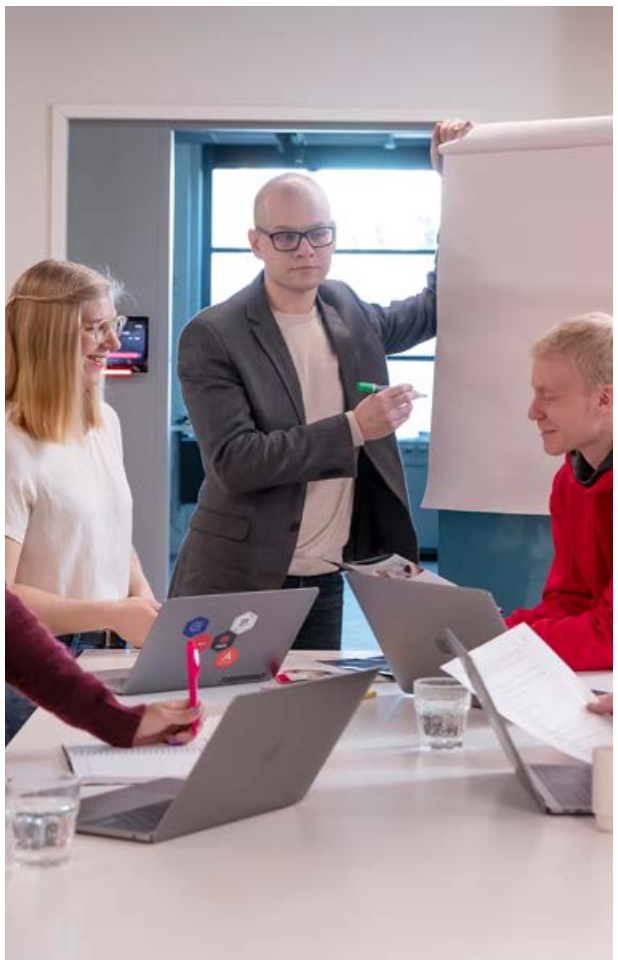
In addition to SD services, CSC also maintains and develops secure information systems and remote access environments, for instance, for the Social and Health Data Permit Authority Findata and Statistics Finland. The most significant reform of 2022 in the Kapseli solution produced by CSC for Findata was enabling the use of Linux operating systems as an alternative to Windows operating systems. In 2022, the information security of Findata's remote access environment for researchers and its extensions was reassessed, and the environment received a passing grade. Many developments that began in 2022 will reach their conclusions in 2023, such as Findata's research data storage solution, which will be launched for production at the beginning of 2023.

Statistics Finland's remote use system, Fiona, is a secure environment for processing unit-level data sets needed in research, including Statistics Finland's micro data. CSC is responsible for Fiona's technical maintenance. Analysis of the Covid-19 situation room of Helsinki Graduate School of Economics (GSE) was carried out using Fiona. The development of the Fiona environment was continued in 2022, responding to researchers' need to use open-source tools. The need for Linux has also been identified for Fiona, and this will become possible in 2023.

International cooperation supports the development of national services and capabilities

ELIXIR Finland, the host organisation of which CSC is, is the national node of the ELIXIR research infrastructure in the field of life science. The project portfolio coordinated by ELIXIR Finland included 24 projects funded through European financial instruments. These projects have developed the capabilities of both CSC and the Finnish research community to manage and use sensitive biomedical research data. Project funding channelled through ELIXIR cooperation has played an important role in the development of SD services and the Finnish Federated European Genome-phenome Archive (FEGA) service. Read more in the news article.

In 2022, ELIXIR Finland participated in leading ELIXIR Compute platform and in establishing a new ELIXIR single-cell omics community. Through ELIXIR Finland, CSC participated in the development of a pilot implementation in the field of cancer research for



the 1+Million Genomes initiative that promotes the research use of genome data in Europe.

Through ELIXIR, Finland is closely linked to the Global Alliance for Genomics and Health (GA4GH). The open-source solutions developed by CSC for the management of sensitive data through ELIXIR cooperation also find new application opportunities outside Europe. For example, the Australian Biocommons is interested in CSC's entitlement technology REMS.

Services broadly into use by improving usability and ease of use

In recent years, special attention has been paid to developing the usability and ease of use of the data management and computing services offered by CSC and to the relevant customer support and training. The services benefit research, higher education and cooperation extensively.

Development of services and customer support as an answer to expanding use

CSC regularly collects user feedback, for example, through an annual user feedback survey. In 2022, the total number of users (customer IDs) was 7,400 (28% growth compared to 2021). Based on the feedback, a number of measures were taken in 2022

Funding of national data management and computing infrastructure to be more predictable in the future

For decades, the funding of hardware investments needed by CSC to provide national data management and computing services has been burst-like and difficult to predict. In 2022, funding was finally granted in the state budget on a continuous basis. When the predictability and the amount of funding are known, it is possible to implement investments in a timely manner. Additionally, the cost-effectiveness of procurements will be further improved as the development of technology cycles and user needs can be better taken into consideration in their implementation instead of the previous investment cycle of five to seven years. The continuous funding model ensures that Finnish research and innovation actors will receive resources for internationally competitive scientific computing and data-intensive research far into the future. High-quality and sufficiently high-performing national scientific computing services create a significant advantage for Finnish researchers in utilising the computing resources provided by LUMI and other exascale supercomputers in solving even the most challenging research problems and forming international cooperation relationships.

"CSC's services have developed much during the nine years I have used them. For example, the quality of customer service has improved dramatically as well as the ease of use of service interfaces. In the past, it felt like the services were intended only for IT professionals. Now I feel that they are for all of us. Thank you for your great work!"

– User feedback

to enhance the usability of services and the ease of getting started.

The Puhti supercomputer's web interface was introduced at the end of 2021, and at the end of 2022 it was regularly used by 25% of the around 2,500 users of Puhti. The web interface makes many tasks easier, such as opening the Jupyter notebook and interacting with computing nodes while displaying information about the status of computing tasks and the machine's operations. The web interface is one of the key factors in spreading computational methods and the utilisation of computational capacity to new fields of science and to companies.

In order to lower the threshold for users to approach our experts in the application of services and computational methods in their field of research and to hear about the latest developments in services, piloting weekly support coffee sessions was started in 2022. At these events, people can meet CSC experts remotely and discuss without a predefined script.

Services benefit research and cooperation
In addition to hardware investments in the data management and computing infrastructure development programme, which operated in 2017–2021, measures were targeted at developing competence and capabilities in new user groups. As these services have traditionally been used especially in the fields of physics, chemistry and life sciences, the range of disciplines that use the services has broadened over the past three years.

Data management and computing services are also used more and more in cross-organisational and cross-sectoral cooperation. Approximately one in six user projects in 2022 was a joint project of several organisations. For research institutes' projects, this number was up to 40 per cent. Based on a user survey conducted in 2022, users feel that CSC's data management and computing services benefit their cooperation.

NPS in 2022:
67
Survey for users of data management and computing services (486 respondents)

2022 total

154
training sessions or events

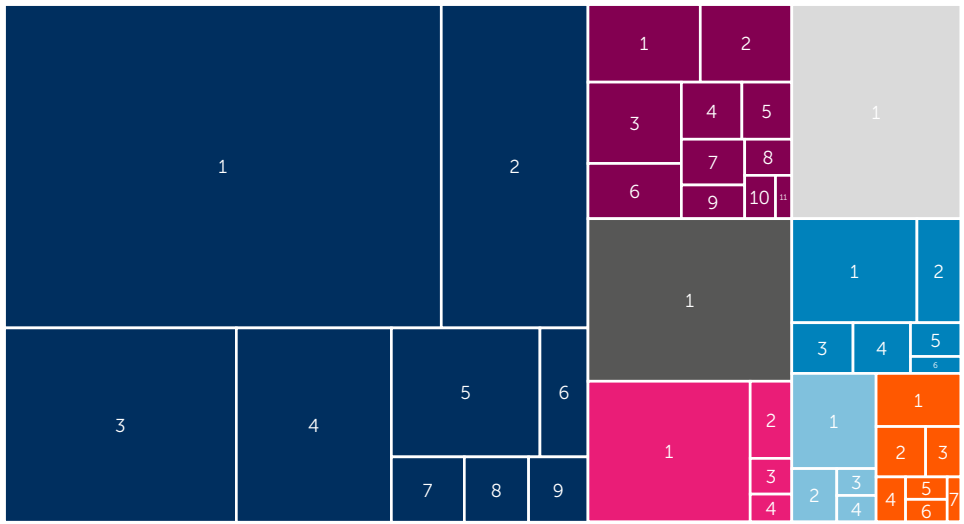
308
training/event days

6,897
participants

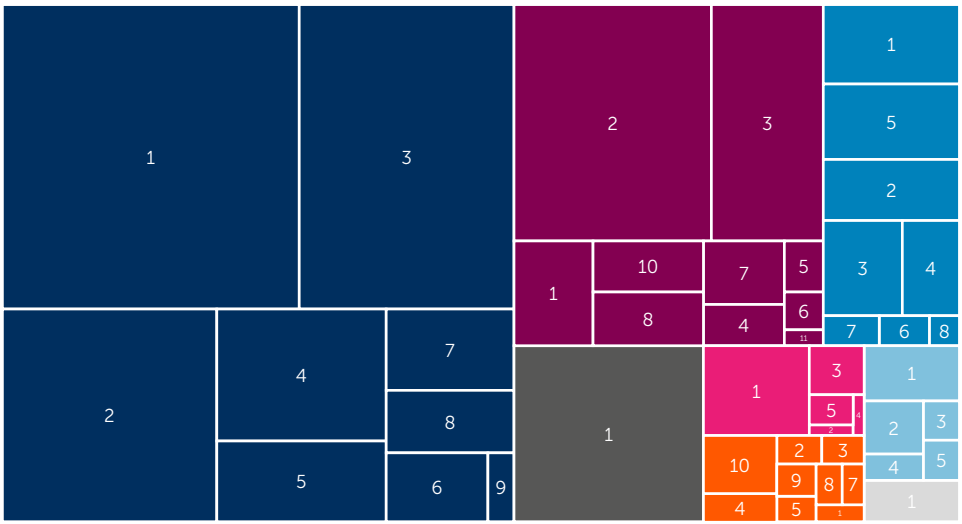
Feedback average of
8.77/10

The range of disciplines using the services has broadened

2019



2022



Natural sciences
1. Biological sciences, 611 (578)
2. Computer and information sciences, 434 (179)
3. Physical sciences, 296 (194)
4. Geography and environmental sciences, 147 (119)
5. Chemical sciences, 85 (77)
6. Astronomy and space science, 43 (26)
7. Statistics and probability, 69 (18)
8. Other natural sciences, 51 (16)
9. Mathematics, 11 (15)

Engineering and technology
1. Mechanical engineering, 53 (36)
2. Electronic, automation and communications engineering, electronics, 316 (30)
3. Other engineering and technologies, 179 (30)
4. Materials engineering, 20 (14)
5. Civil and construction engineering, 14 (12)
6. Nanotechnology, 10 (20)
7. Medical engineering, 35 (11)
8. Environmental engineering, 36 (7)
9. Engineering and technology, (8)
10. Chemical engineering, 36 (6)
11. Environmental biotechnology, 3 (2)
12. Architecture, - (1)
13. Industrial biotechnology, 1 (-)

Medical and health sceinces
1. Basic medicine, 73 (54)
2. Health sciences, 53 (17)
3. Pharmacy, 50 (13)
4. Clinical medicine, 35 (12)
5. Medical biotechnology, 66 (7)
6. Sport and fitness sciences, 9 (3)
7. Internal medicine, 9 (-)
8. Forensic science and other medical sciences, 5 (-)
9. Dentistry, 1 (-)
10. Nursing, 1 (-)

Humanities
1. Languages and literature, 65 (88)
2. Arts, 2 (13)
3. History and archaeology, 18 (6)
4. Philosophy, 2 (4)
5. Other humanities, 10 (1)

Social sciences
1. Social studies, 5 (3)
2. Economics, 9 (10)
3. Business and management, 8 (7)
4. Media and communications, 12 (5)
5. Political science, 7 (4)
6. Social sciences, - (9)
7. Psychology, 5 (2)
8. Social and economic geography, 6 (-)
9. Educational sciences, 8 (1)
10. Other social sciences, 26 (1)
11. Law, 1 (-)

Agricultural sciences
1. Agriculture and forestry, 37 (33)
2. Animal science, dairy science, 20 (9)
3. Agricultural biotechnology, 9 (4)
4. Veterinary science, 10 (4)
5. Other agricultural sciences, 9 (1)

Others, 219 (134)

Unknown, 24 (145)

In these figures, the area of each discipline portrays the relative share of the discipline of end-user projects using resources (billing units) in that year.
The absolute number of projects is presented in the figure. The total number of projects was 2,001 in 2019 and 3,264 in 2022.
Data for year 2022 reported first, 2019 in parenthesis.

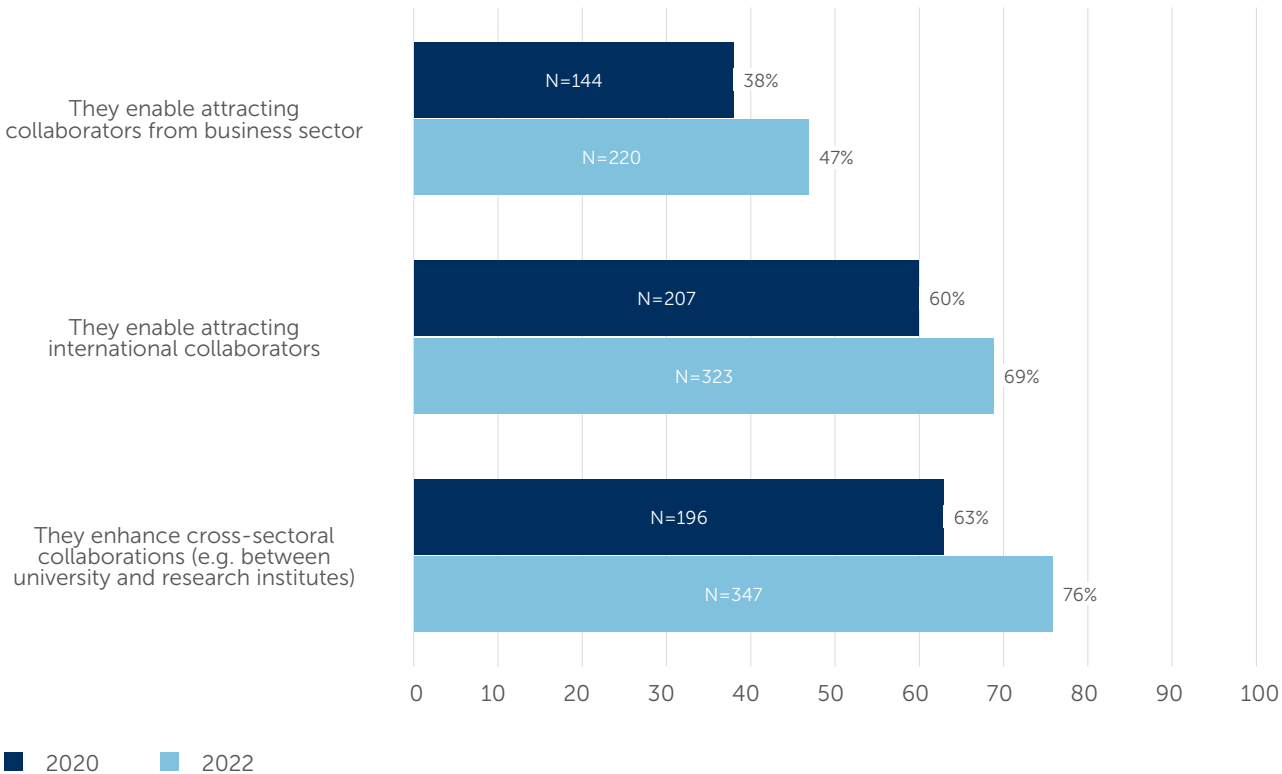
Getting to know supercomputers already during studies

With LUMI, we wanted to inform general upper secondary school students, business representatives, students of universities of applied sciences and other interested parties about high-performance computing and supercomputers. For this purpose, we created an open online course in cooperation with Kajaani University of Applied Sciences, Elements of supercomputing, which presents the basic concepts and principles of high-performance computing and supercomputing. The course offers exercises and a final exam, which awards one credit. In 2022, 448 registrations took place, and the course was completed 212 times. In 2023, Oulu University of Applied Sciences will use the online course as part of its teaching.

"CSC services are currently invaluable, foreign colleagues are constantly surprised of the quality of services."

– User feedback

Data management and computing services benefit cooperation



The figure shows the percentage of respondents in the data management and computing services user survey who agreed with the statements concerning cooperation. The percentages have been calculated from those who answered to the statement (Ns in the figure).

In 2022, the Finnish Revontuli team assembled by CSC participated for the first time in the annual Student Cluster Competition (SCC) on supercomputing organised in connection with the Supercomputing conference. The team won the HPL Hero Run Challenge section by a landslide and finished third overall. SCC activities are an excellent way to familiarise students with high-performance computing and present it as a challenging and interesting study path and career option.

The use of services in teaching has been streamlined by automatisation and by instructing to create one's own environments for the Puhti web interface. The CSC Notebooks service has also been developed, and more ready-made templates have been produced in the Rahti cloud service, making it easier to establish tailored services and servers to support teaching. The Puhti web interface has been used in CSC training, but our customers have also found it and used it as a platform.

"CSC services are vital to my teaching. Additionally, the service I have received has been first-class and customer-oriented throughout the company. Keep it up!"

– User feedback

"The services provide students with sufficient resources for testing and developing virtual machines and services. An essential part of the teaching workflow and research."

– User feedback

Digital transformation cracks on

CSC promotes digital transformation in the fields of research, higher education and public administration. The digital service environment makes it easier for researchers, learners, teachers and education providers alike to use services independently of time and place. With its competences and services CSC facilitates broad use and availability of information hubs, analytics and digital data.

Digital transformation of higher education and research

CSC provides higher education and research with a comprehensive digital infrastructure and services for a smooth everyday life. In addition to running the programme office for Digivisio 2030 programme shared by all higher education institutions, CSC also supports the success of the programme outside the programme office and the actual programme.

Objectives of the digital transformation of higher education and research became clearer

The digital transformation of higher education institutions develops cooperation to serve users more comprehensively in data management and computing

services, internationally, nationally and locally. With the help of European and national world-class infrastructures, higher education institutions develop competence and innovation capacity locally to reach the international level. Supporting research and research-based teaching, the digital service environment is at the centre as a meeting place, as excellence and education are introduced to workplaces through the implementations of continuous learning based on research, development and innovation work in the continuous learning strategy of higher education institutions. CSC's social responsibility from the point of view of data management and computing services is discussed in more detail in the chapter Impact of research gets stronger.

Digivisio 2030 of higher education institutions progressed to the implementation phase

All Finnish higher education institutions are building a future for learning together in the higher education institutions' Digivisio 2030 programme. The goal is a new era of learning, the core of which is the continuous development of digital pedagogy, in which each of us can learn and accumulate their competence in an ever-changing world. The programme helps higher education institutions implement shared platforms, common operating models and other operating conditions that enable flexible and learner-centered learning paths.

The implementation of Digivisio 2030 services up to software development was launched on the basis of jointly approved plans, a shared enterprise architecture and conceptual model. The institution-specific change plans and the change coordinators, who have already started working at almost every institution, have started to promote local transformation. It has been estimated assessed that the Digivisio programme office has succeeded especially in ensuring that the programme progresses according to the objectives, supporting the launch of the change in higher education institutions, creating dialogue and discussion, and keeping all higher education institutions involved in this complex programme.

Rectors expect CSC to be a strong interlocutor, bringing in vision, proposals and solutions

CSC also plays an important role in the success of the Digivisio 2030 programme outside the programme office and the actual programme. ICT infrastructures and different digital services for learning and research in higher education insitutions must be able to develop and reform at the pace of the Digivisio 2030 programme.

For example, through the expert service offered to the Peppi consortium of 31 higher education institutions, CSC provides a significant amount of specialised expertise and versatile competences for the use of higher education institutions. The expert service supports the cooperation and competence of higher education institutions and strengthens their preconditions for using the services produced by Digivisio in an agile and smooth manner in the future.

As the digital transformation progresses, the digitalisation of critical processes and implementations increases the need to ensure the continuity of services. The construction of a cyber security operations centre (CSOC) was initiated with higher education institutions to respond to cyber threats.

A smooth everyday life for learners and teachers

Digital services facilitate the everyday life of researchers, learners and teachers when, for example, remote and hybrid arrangements in teaching work correctly and enable natural and reliable ways of interacting, the availability of learning materials is better and there is no need to travel to another location for an exam. CSC's Funet Miitti service will continue to be an active solution that enables remote and hybrid teaching in higher education institutions.

CSC plays various roles in supporting the development of digital services for higher education institutions. The number of learning materials found in the Library of

Open Educational Resources implemented by CSC for the Ministry of Education and Culture continued to increase in 2022, and the library will reach an increasing number of learners and teachers in higher education institutions. Open sharing of learning materials facilitates the planning and implementation of teaching as well as teaching cooperation and enables continuous learning for learners. The distribution service for medical teaching materials produced by CSC, MEDigi, offers medical faculties a way to share materials with teachers.

Digital entrance examinations make it easier for applicants to take the examination and, above all, facilitate the work of the auditors and administration reviewing the answers. CSC supports the planning and organisation of student admission processes in higher education institutions. During 2022, approximately 30,000 applicants participated in entrance examinations using solutions that CSC has provided to higher education institutions. The electronic exam system EXAM provides students with flexible opportunities to choose the time and place of their exam, also in the premises of an institution other than their own. Thanks to exam visits, a student living in Rovaniemi but studying in Helsinki can take an exam in the University of Lapland's exam class and avoid having to travel to their exam.

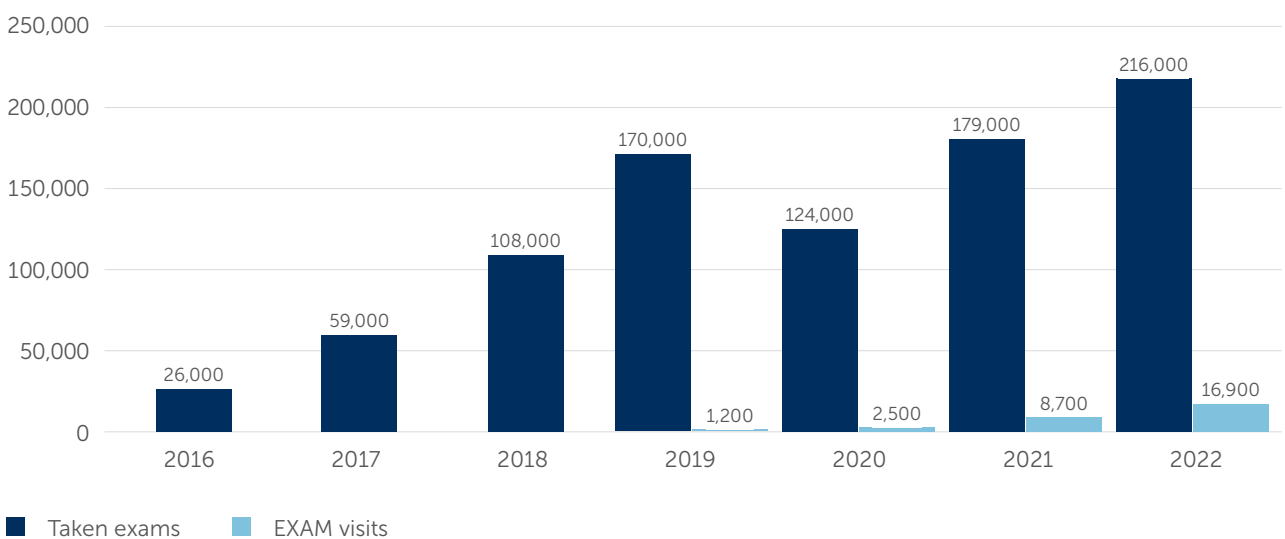
The Library of Open Educational Resources is widely used; in 2022

91%
of higher education institutions utilised the library

65%
instructed their teachers in the use of the library

41%
of higher education libraries offered open learning materials as part of their collection

Taking exams in the EXAM service



Digital transformation of public administration

In addition to research and higher education, CSC's expertise extensively benefits public administration. Information hubs promote digital transformation in areas of both education and public administration, as there is no need to ask and transfer the same information several times. Digital preservation services can be used to ensure that valuable research and cultural heritage data are available in digital format for future generations.

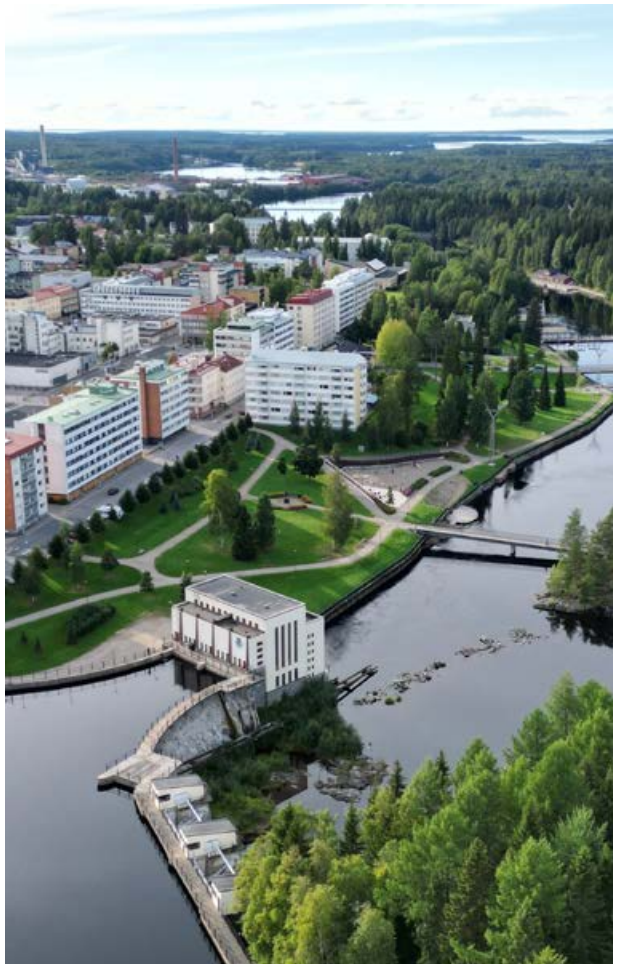
Contents of data resources for education and research expanded

CSC develops and maintains several national information hubs for different levels of education, research data and public administration. Data on education and research, development and innovation activities are processed into statistics and reports in the Education Statistics Finland service Vipunen. The service provides a comprehensive and high-quality knowledge base to support the knowledge-based management and the monitoring of the activities of sectors both nationally and for individual education providers. In 2022, Vipunen contained approximately 4,200 reports, and the service had 270,000 visitors. Vipunen's data content was expanded in 2022 to include early childhood education and care data. The annual report on early childhood education and care contains information on early childhood education actors and places of work as well as children participating in early childhood education and care. The contents benefit, for example, the possibilities of experts in education administration and early childhood education and care providers to monitor the implementation of early childhood education and care. In addition, the reporting on extended compulsory education, which entered into force in 2021, was imported to Vipunen, enabling the education administration and the media to monitor the achievement of the objectives of extended compulsory education.

In recent years, the use of data resources has expanded significantly from the original purpose of reporting and statistics. High-quality, comprehensive and commensurate data is widely utilised through interfaces in different services and applications. For example, a researcher search published as a pilot version in 2022 in the national Research.fi service makes it easier to find experts in different fields of research in Finland for the use of the media, companies, decision-makers and other parties interested in science.

CSC's expertise for the use of public administration

Since 2016, CSC has been the developer and maintainer of the State Treasury's financial information system. The aim was to automate financial reporting by municipalities and joint municipal authorities, and to obtain information more quickly for decision-



making. From the beginning, the financial information system was built in a commercial cloud, striving for extensive integration directly from the municipalities' financial information systems. The system began to collect financial data in 2021, and in 2022, the financial data collection of wellbeing services counties was also built on it. This meant a significant extension and a more frequent reporting schedule, involving technical challenges. The collected financial data can be viewed in the exploreadministration.fi service, and under certain conditions, parties requiring financial data can also search for it via the interface. CSC's own expertise, which used to mainly benefit higher education institutions and the Ministry of Education and Culture, was thus also introduced to public administration.

CSC was involved in the digitalisation of government grants led by the Ministry of Finance. CSC was involved in the development of the Glossary of Discretionary Government Grant Terms and has served as a consultant in the development of the new operating model and as a trainer and coach in the implementation of the operating model in different ministries.

Analytics for a wide range of uses

In the area of digitalisation, 2022 will be remembered for the rise of AI methods to public awareness and widespread use. ChatGPT, DALL-E and Lensa AI are examples of AI applications that became very popular in little time. CSC's role in the midst of the latest hype has been to interpret the possibilities and restrictions of new methods to its customers and to help them plan for a deeper adoption of artificial intelligence and data analytics in a rapidly changing operating environment.

Analytics were produced extensively for different customers and uses. For example, CSC carried out an analysis of the national Move! monitoring results and mapped the possibilities for using analytics, machine learning and artificial intelligence in the national digital service package for continuous learning. The identification of research topics produced in the Research.fi service using machine learning methods provides, for example, higher education institutions and research institutes with useful information on ongoing research projects related to different research topics.

CSC is involved in the OpenWebSearch.eu project launched in 2022, which aims to diversify the search engine market. The project develops openly available technology and data resources related to search engines. CSC is involved in the development of the technical platform, especially in the processing of Finnish and in the use cases of scientific search.

Processing natural language is a key feature of new AI tools. CSC develops competence in natural language processing for AI methods and for training them, especially with the LUMI environment. The focus is on Finnish and, more generally, small European languages. CSC is involved in the GreenNLP project, in the development of energy efficiency of training massive natural language models. CSC's expertise and environments help customers to automate the processing of large text archives with artificial intelligence, for instance.

Services to support the evaluation of teaching and education

Cooperation with the Finnish Education Evaluation Centre (FINEEC), which implements statutory evaluation of education and early childhood education and care, expanded in 2022 when the project to develop the evaluation system for learning outcomes (DigiOTA) was launched. The project set by the Ministry of Education and Culture will develop an evaluation system for FINEEC to manage and carry out national assessments of learning outcomes in basic education. At the national level, the key objective of learning outcome assessments is to produce data on how well pupils have achieved the objectives set in the curriculum.

Valssi, the quality assessment system for early childhood education and care to be developed for FINEEC, was also ready for production in 2022. The purpose of the system is to support early childhood education and care actors in the evaluation and development of activities. Valssi can be used to carry out data collections, report on the data collected, compile the data produced by discussing and publish the actor's statutory evaluation results. The use of Valssi will begin gradually in 2023.

The Education Management Information Service Arvo implemented 11 national data collections to assess the effectiveness of teaching and education from basic to higher education. Examples of these include the collection of student feedback data for vocational education and training and higher education institutions. In 2022, a total of 322,000 respondents and nearly 9.5 million individual responses were collected using the service

The use of digital preservation services to increase
Digital preservation or availability ensure the preservation and availability of digital data for the needs of researchers and other users for decades or even centuries. To achieve this, CSC has successfully developed and maintained capabilities for preservation that are significant by national standards and that ensure the management of data integrity, authenticity and file formats, quality assurance and continuity of the activities. The digital preservation services are provided under an agreement between CSC and the Ministry of Education and Culture.

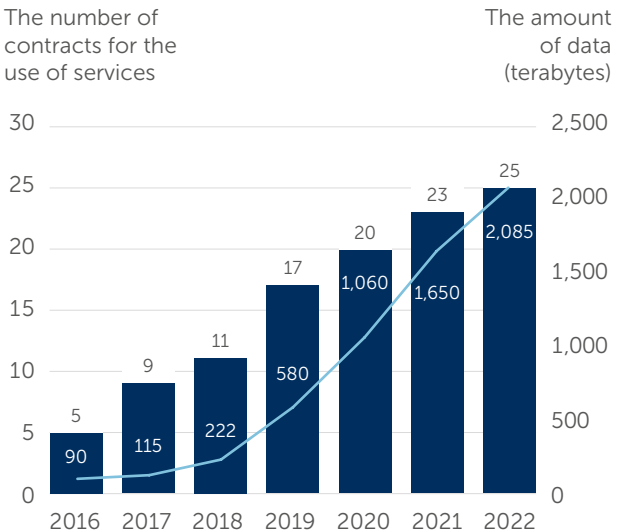
As part of the provision of Digital Preservation Services, CSC supports organisations that utilise the services by sharing competence related to capabilities. Understanding of and competence in managing and storing data will be promoted together with organisations.

In 2022, the amount of material stored in Digital Preservation Services exceeded two petabytes, with an annual accumulation of approximately 420 terabytes. Thus, organisations managed to transfer high-quality data to storage well over a terabyte per day every day of the year.

Together with the National Archives of Finland and their needs, CSC has developed a SAPA platform, which enables central government authorities to receive documentary material and transfer it for preservation. The SAPA service has succeeded in significantly promoting the digital transition in central government archiving.

A template for the data protection impact assessment (DPIA) for preservation of research data was prepared together with higher education institutions using Digital Preservation Services. Organisations can use this template to assess the realisation of data protection in the preservation of data in the Digital Preservation Service. The aim is to help higher education institutions as data controllers to assess the capacities of processing sensitive personal data in the Digital Preservation Service.

Development of the use of Digital Preservation Services



Synergy benefits are gained

CSC offers the sectors it serves synergy benefits arising from the use of shared expertise, functions and technologies. CSC utilises shared technical platform solutions in service production. These solutions can be scaled in accordance with changes in needs.

CSC also creates qualitative, operational and financial benefits by effective integration of several different technologies. Even in international comparisons, CSC's operations combine exceptionally comprehensive expertise in different areas of technology. In 2022, these benefits were reflected, for example, in the successful introduction of the European LUMI supercomputer, which was an extensive combination of CSC's expertise in scientific computing, data center operations and telecommunications as well as good international cooperation networks.

CSC's services and solutions also directly support the interoperability of different sectors, architectural work and information and service management. Here are some examples of these.

Service integrator and service management respond to higher education institutions' wishes
Developing centralised IT service management integrated with higher education institutions is one of the higher education institutions' wishes for CSC, part of the fundamental tasks stated in CSC's ownership strategy, and a goal set by CSC's Board of Directors. A centralised service integrator develops a shared environment for higher education institutions in which the IT services used by higher education institutions are as flexible and cost-effective as possible. The aim is to manage and create a situational picture of the interdependencies between different information systems so that individual services can form interoperable and large-scale service entities with resilience to deviations.

The service integrator creates an overall picture that covers the entire higher education field, the coverage of which is based on increasing mutual understanding, cooperation and mutual trust. The added value of service integration in a multi-vendor multi-customer environment typically also arises from the harmonisation of different processes and operating methods. Successful service integration must be able to have a concrete impact on the uniform user experience of end-users in their home institutions, which is made possible by systems that exchange information.

In 2022, CSC established a Service Management Office (SMO), which is responsible for service management in the Digivisio 2030 programme at its first stage. The SMO will gradually expand to cover other higher education services during 2023

Interoperability through coordination, architecture and uniform interfaces
CSC produces an up-to-date overall picture of information flows and a comprehensive knowledge base for knowledge-based management in the sectors of research, education and public administration. CSC coordinates, for instance, information flow and vocabulary work at the Ministry of Education and Culture and produces architectures for the sector in cooperation with various stakeholders. CSC plays a nationally important role in bringing together experts from different stakeholders, mapping needs and requirements, producing an overall picture of data flows and supporting common operating methods and data specifications. Architectures are used, for example, in the planning of digital service packages, the development of operating methods for knowledge-based management and the transformation of operating models both nationally

The VIRTA National Data Warehouse For Higher Education compiling the data of degree students in higher education is used extensively, including by:

- Direct data collection by the Ministry of Education and Culture
- Data collection by Statistics Finland
- International mobility periods of the Finnish National Agency for Education
- Finnish Student Health Service
- Kela, Valvira, Employment Fund, Finnish Education Evaluation Centre (FINEEC)
- Surveys and follow-up studies (Eurostudent, Career Monitoring, THL/KOT)
- Research use (e.g., UAS student selection consortium)
- Personal details can also be used by higher education students in the Tuudo and Pivo mobile applications

A total of approx. 56 million interface queries in 2022

and in higher education institutions, for example. In 2022, CSC produced an enterprise architecture for the Jatkuvan oppimisen digitalisaatio (In English: Digitalisation of continuous learning) project. We also promoted reference architecture work in early childhood education and care and pre-primary and basic education, commissioned by the Ministry of Education and Culture.

Common architectures and uniform data specifications for data compiled from a number of different sources ensure the national and international interoperability of different services and systems. This enables comparable data, which can be widely used via shared data resources in various services through machine-readable interfaces.

The interoperability of data management services improves the visibility and findability of data

Since 2020, the Finnish Meteorological Institute has published its METIS research data in the EUDAT B2SHARE service. Since December 2022, the descriptive metadata of the datasets have also been available in the Fairdata service, and thus also in the Research.fi portal. This significantly improves the visibility and findability of data. With these integrations, data is automatically transferred between different services in a reliable and timely manner.

The project succeeded in creating an up-to-date and automatic way to import metadata of METIS materials into the Fairdata service and the Research.fi portal. This significantly improves the visibility and findability of data in addition to the current EUDAT B2FIND harvesting. Implementing such integrations in several services improves the reliable findability of information with little effort after the original project, which creates impact with less effort in the long term.

Creating links between research entities and research materials and finding them is important for creating an overall picture of Finnish research and its impact at the national and international level. Funders and decision-makers need reliable information and transparency in order to make steering decisions. Finding links between research results, funding, infrastructures and organisations is also vital for developing research information management.

A smooth daily life and synergies with the Funet services

Funet, an information network for Finnish higher education institutions, research and teaching, covers all Finnish higher education institutions and serves over 400,000 end users throughout Finland. The Funet network has been operating in Finland for 40 years. 1 December 2023 marks the 35th anniversary

of the day on which Funet connected Finland to the internet.

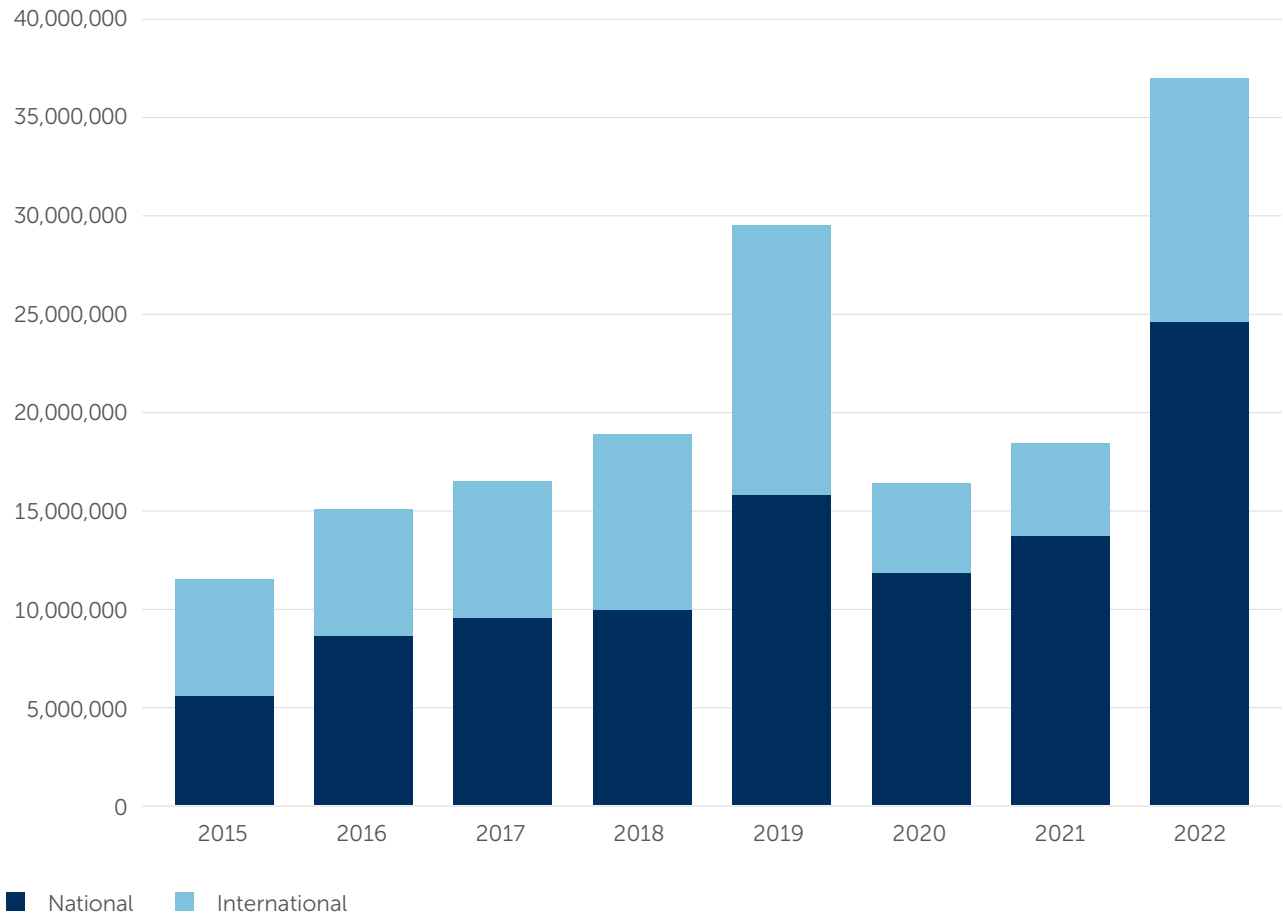
During 2022, the final development measures of the Funet life cycle update were completed and the use of an even more reliable, uncongested, secure and cost-effective Funet network continued at full speed.

The wireless campus network eduroam supports and promotes the mobility of its users worldwide, enabling easy and secure connection to the wireless network. At the end of 2022, the coronavirus restrictions had largely been dismantled, and a record number of almost 5 million monthly roaming visits with Finnish eduroam IDs was accumulated.

Through the Funet certificate service, a record number of approximately 8,000 server and personal certificates were transmitted to Finnish higher education institutions and other Funet member organisations in 2022, in a very cost-effective manner.

The Funet video services increasingly support cooperation, teaching and research. For example, the online meeting service provided by Funet was used to organise video conferences, meetings and online teaching for up to 230,000 hours, or 27 years a day, on peak days.

Development of the use of the eduroam roaming service in Finland



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