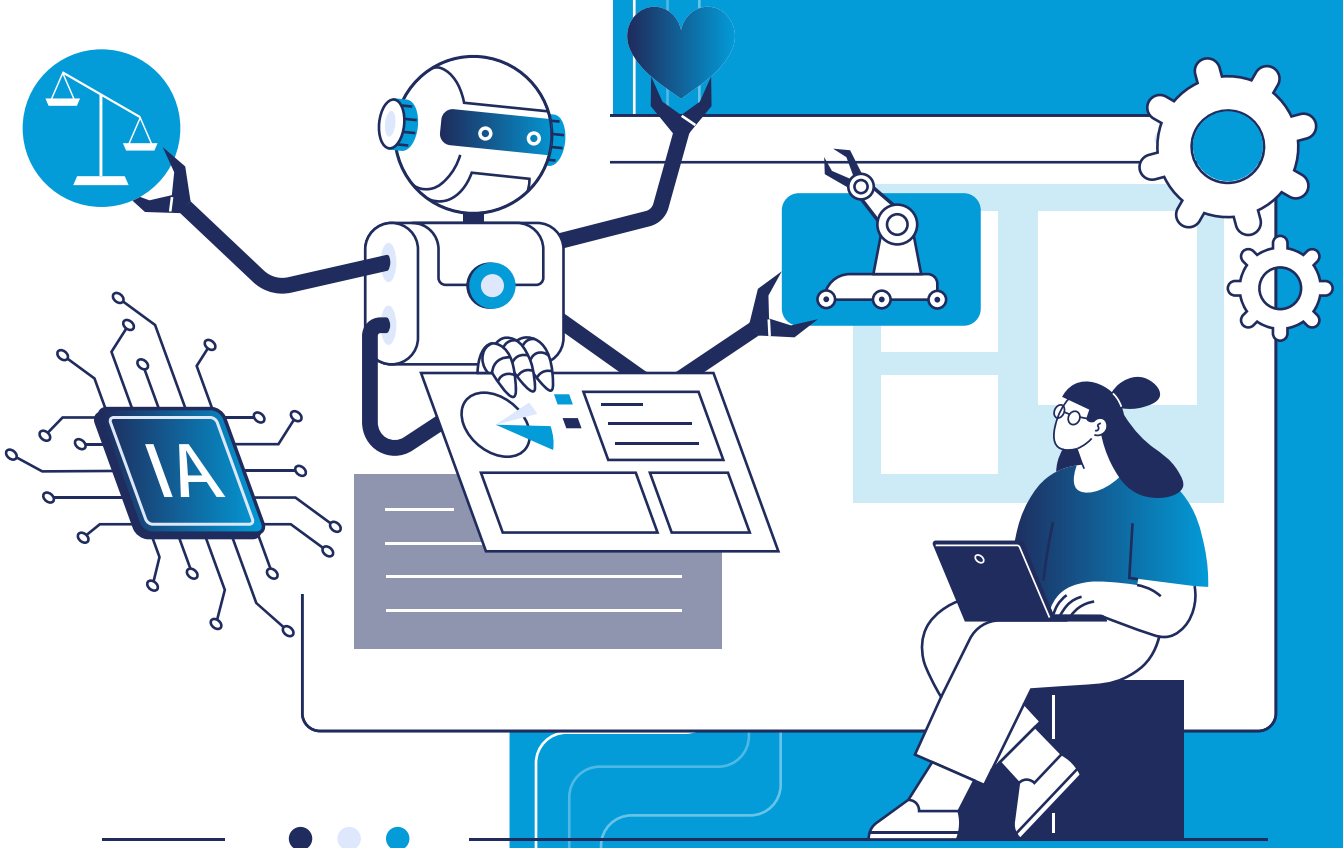
INSTITUT CARNOT
Télécom & Société numérique

RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

Supporting the digital transformation

FOR THE INDUSTRY OF THE FUTURE



ACTIVITY REPORT 2023-2024

About Carnot TSN

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editorial

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WORKING FOR THE FUTURE OF TELECOMMUNICATIONS

In our 2023 Annual Report, we presented a mixed assessment of our country's economic and geostrategic situation.

Since then, despite all the talk of reindustrializing France and revitalizing its business fabric, economic growth has been in short supply, to say the least. Admittedly, GDP grew by 0.2% in Q1 2024.[1] However, this figure needs to be put into perspective, given that the French government's public debt rose by 0.73% over the same period to 110.7% of gross domestic product.[2] Indeed, since July 2024, France has been subject to a formal **procedure launched by the European Union in response to its repeated excessive deficits** (>3% of GDP/year). If we add the three-month political crisis following the dissolution of June 9 to this unflattering picture, **France seems to be deeply in the doldrums.**

Objectively speaking, in such a situation, lacking control over our future energy supplies and with limited access to raw materials, opportunities to restart the national economic machine are few and far between. One approach seems to stand out: **creating value and competitiveness through innovation.**

Over a period spanning more than 20 years, the desire to innovate has clearly failed to permeate the heart of our society, since France has never managed to exceed the target of investing 3% of GDP in R&D, enshrined in the Lisbon Strategy in 2000. The culture of our national companies must change, and their leaders must realize that innovation is not the icing on the cake for well-managed companies, but their **main driver of medium- and long-term growth,** in a context that has become extremely constrained.

This is not the time to focus yet again on our nation's SMEs and mid-caps, which are fighting for survival on a day-to-day basis, but to focus, for once, on our major groups. These powerhouses of French industry bring their full weight to bear on our country's institutions. Whether they like it or not, our major groups represent **France's economic future**, and they must now set an example. Their managers need to make a cultural shift by no longer seeing R&D as a cost item, but rather by treating the innovation process as **THE main source of future turnover.** To this end, we need to move away from an "accounting-based mindset", which aims to adjust R&D levels to the research tax credit ceiling, and to systematically attract subsidies from the various funding agencies in calls for projects, while making research the adjustment variable in the event of a drop in turnover or net profit. It is now up to our captains of industry to use the findings of hundreds of in-house technological foresight exercises as grounds for switching to structured, multi-year R&D programs, financed from their own funds. They also need to learn how to sell this to shareholders for what it really is: **an investment.** By going on the offensive, our industrial groups will be able to **build lasting competitive advantages,** while simultaneously structuring an ecosystem of subcontractors of all sizes, which will then be able to benefit from the major groups' innovations. This will also slow down the brain drain of researchers to other countries and gradually recreate a feeling of optimism among young graduates.

Carnot Télécom & Société Numérique, which was first accredited in 2006, has historically acted in this way, prioritizing long-term collaborations with its industrial partners. We have succeeded in modifying our internal processes to adapt to the industrial context, while gradually becoming increasingly involved in the strategic aspects of implementing the innovation cycle on our clients' sites. Despite all these efforts, the volume of the Carnot institutes' direct business with major groups has stagnated since the COVID crisis, in favor of projects financed under the "France Relance" and "France 2030" programs. The point here is not to criticize manufacturers' use of these types of schemes. However, their use should not lead to a redistribution phenomenon, but rather to an increase in the overall research activity of CAC40-listed companies, which is clearly not the case.

It has become essential for our major groups to be part of a collective project to turn France around, and to accept this responsibility by implementing **long-term innovation policies.** The ecosystem of the 39 Carnot Institutes, which accounts for 60% of the €1 billion in public R&D funding by companies, is sufficiently mature and structured to help them achieve this.

[1] Source: Banque de France
[2] Source: INSEE

CARNOT TÉLÉCOM & SOCIÉTÉ NUMÉRIQUE

FRANCE'S LEADING PUBLIC R&D PARTNER SPECIALIZING IN DIGITAL TECHNOLOGY

The Carnot Institutes are groups of research teams from several public institutions working on the same topic.

The Carnot label was created in 2006 as a label of excellence awarded by the French Ministry of Higher Education, Research and Innovation to foster partnership-based research, i.e. the performance of research activities conducted by public laboratories in partnership with socioeconomic stakeholders such as businesses.

Find out more

As a key player in R&D and digital innovation, Carnot TSN makes it easier for businesses to access the expertise of public research laboratories with a structured, targeted research offering that is easy to implement and adapted to the needs of each company.

Thanks to its research teams and technological platforms, the Télécom & Société Numérique Carnot Institute works with companies of all sizes on the technical, economic and social implications of digital transition.

An accelerator of the digital transformation

Carnot Télécom & Société Numérique brings together laboratories and research teams at 11 establishments of research excellence: a network of components with strong links to the local community and easy access to business.

Carnot TSN, a guarantee of excellence in partnership-based research

Carnot Télécom & Société Numérique, a Carnot-accredited institute since 2006, is France's leading Carnot Institute for "Information and Communication Sciences and Technology".
With over 1,900 researchers – over 200 more than the previous year – Carnot TSN focuses on the technical, economic and social implications of the digital transition. In 2020, the label was renewed for the fourth consecutive time, demonstrating the quality of the research and innovations achieved through collaborations between researchers and companies.

Carnot Télécom & Société Numérique brings together 11 research establishments of excellence. It is the first Carnot Institute specializing in digital science and technology at the national level.

Discover Carnot TSN on video

Our fields of scientific and technical expertise to help companies of all sizes meet the challenges of the digital transition

- Networks & the Internet of Things
- Big Data & IA
- Cybersecurity
- Industry of the future
- Smart Cities
- Smart mobility
- Environment
- Energy systems
- Digital health

key figures 2023

OUR STAFF

146 post-docs

419 researchers and faculty members

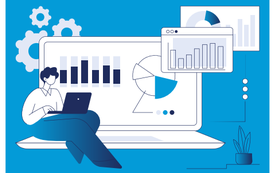
201 research engineers and technicians

1,164 PhD students (230 on CIFRE contracts)

ECONOMIC DATA

Consolidated research budget

€115 M



REVENUE RESEARCH PARTNERSHIPS

€41 M from contracts financed for agencies

€47 M from direct contracts with businesses

€3 M from technology transfers

COMPONENT LABORATORIES

11 component entities

30 joint laboratories with businesses

38 industrial chairs

77 technology platforms

SCIENTIFIC PRODUCTION

INNOVATION AND TRANSFER

69 new priority and software patents filed in 2021

88 inventions declared

41 companies created during the year

PROJECTS AND PARTNERSHIPS

More than 1,046 companies supported in their research and innovation projects. Carnot Telecom & Société Numérique is committed to intensive bilateral contract research with industry, signing a growing number of R&D contracts every year.

84% of partnership-based R&D focused on the development of French regions

16% of R&D serving international companies

96% of companies satisfied

1,085 contracts were signed

764 direct contracts with a socio-economic partner

178 collaborative projects with agencies in France

143 European collaborative projects

key events

SEPTEMBER 2023

5G event at Sophia Antipolis

The "5G Advanced for the Industry of the Future" event, supported by Carnot TSN, was held at EURECOM. Discussions and workshops bringing together European specialists in the field focused on the industrial and societal challenges associated with 5G and the latest innovations in mobile networks and standardization, paying particular attention to sustainability issues and new use cases.

A look back at "5G - Advanced for the Industry of the Future", at EURECOM

Find out more

DECEMBER 2023

Bercy-IMT Innovation Prize

This prestigious award, supported by Carnot TSN, recognizes excellence and innovation within the community of startups supported by the Institut Mines-Télécom incubator network. The winners of this 2023 edition were DeepHawk, and in partnership with the Caisse des Dépôts Group, uMotion (ecological and inclusive transition category) and Carbon Blue (territorial impact category).

2023

OCTOBER 2023

Rendez-Vous Carnot 2023

The 16th edition of the Rendez-vous Carnot event provided an opportunity for Carnot TSN to honor one of its components – Strate Design School – whose students designed the trophy for the Partnership-Based Research Prize for SMEs and Mid-Caps, awarded during this event. The first "Rencontres Carnot - France Biotech" event also enabled Carnot TSN to highlight the TAMIS Health Data Hub Project during a round table discussion on the challenges of data management in e-health.

NOVEMBER 2023

IP Prize

The Intellectual Property Seminar Prize for 2023 in the "Deep Tech" category was awarded to Ghaya Rekaya, a researcher and professor at Télécom Paris, a Carnot TSN component institution, for the creation of MIMOPT Technology. This startup is developing an innovative digital signal-processing solution to improve the data rates and performance of optical communication systems.

Carnot TSN congratulates Ghaya Rekaya (Télécom Paris), researcher and founder of MIMOPT Technology, on winning the IP Seminar Prize for 2023!

Find out more

Web Summit

Carnot TSN participated in this world-class event, at which startups, established companies and digital influencers come together to contemplate the future of digital technology. On the Institute's stand, the founders of Runblind, a startup drawing on research carried out at École Polytechnique, a TSN Carnot component institution, presented their sound spatialization guidance system.

A look back at Carnot TSN's participation in the Web Summit in Lisbon, the world's leading technology conference!

Find out more

MAY 2024

"Digital Sovereignty" Day

Convinced that collaboration between public, private and academic players is essential to Europe's digital autonomy, IMT played an active role in this event organized in Brussels by Business France, the French-Belgian Chamber of Commerce and Industry and French Tech Brussels.

A look back at "Digital Sovereignty" day in Brussels

Find out more

Viva Technology

Carnot TSN attended this major innovation event on the Carnot Network stand, with two partner startups: Runblind and Shift89. Runblind, a startup created at École Polytechnique, a Carnot TSN component institution, is developing a guidance technology based on three-dimensional sound perception. Shift89, a startup specializing in augmented reality and digital solutions for the industry of the future, signed a framework agreement for research, innovation and training with Carnot TSN in 2021.

A look back at the participation of startups from Carnot TSN at Viva Technology 2024

Find out more

2024

JUNE 26, 2024

XG Innovation Day morning session

Institut Mines-Télécom (IMT), lead institute for Carnot Télécom & Société numérique (TSN), and Ouest Valorisation, organized a morning session dedicated to the FRAMExG program, a pillar of the "5G and Networks of the Future" National Acceleration Strategy (SNA). This event, hosted by the Cap Digital competitiveness cluster, aims to unite the scientific community and strengthen France's position in the communication networks of the future.

Revisit the morning session of "XG Innovation Day: Towards Digital Sovereignty", with IMT and Ouest Valorisation

Find out more

MARCH 2024

Gaia-X Hub France

IMT took charge of the Gaia-X Hub France community and launched the DataSpaceLab, an initiative designed to structure the different data ecosystems. This laboratory will provide a secure space for experimentation to companies of all sizes, thanks to TeraLab, its Carnot TSN-accredited data and AI platform.

Sixth plenary session of the Gaia-X Hub France: a sovereign, interoperable European cloud network

Find out more

World Mobile Congress

EURECOM took part in WMC – the World Mobile Congress – with the support of Carnot TSN, its parent institute. It presented the OpenAirInterface Software Alliance community and startup BubbleRAN on its stand.

EURECOM – Innovation and technology transfer for future generation networks

Find out more

Global Industrie trade fair

The presence of Institut Mines-Télécom (IMT) on the Bpifrance stand was an opportunity to highlight the Corenstock Chair (lifecycle-oriented design and systems approach to the energy efficiency of heating system storage). This Industrial Chair, supported by Bosch Thermotechnology, aims to develop the hot water tanks of the future, which will be more energy-efficient and less costly in terms of raw materials.

A look back at the Global Industrie 2024 trade fair

Find out more

Visions symposium

Carnot TSN supported and participated in the Visions symposium, a two-day event featuring discussions on the contributions of design to industry and the transformation of human organizations, as well as to communities and territories.

JUNE 2024

Eurosatory

Joint participation of IMT and ESARIS INDUSTRIES at Eurosatory 2024, the world's leading defense and security trade fair, where they presented their joint research projects for the sector.

IMT and Esaris Industries together at Eurosatory, the world's leading defense and security trade fair

Find out more

5G/6G AND COMMUNICATION NETWORKS OF THE FUTURE

PREPARING FOR THE DIGITAL SOCIETY OF THE FUTURE

Carnot Télécom & Société Numérique (TSN) is playing a key role in meeting the sovereignty and competition-related challenges related to 5G and networks of the future. As a key player in higher education, research and innovation, and in close collaboration with industrial, institutional, academic and socioeconomic stakeholders, the Institute is conducting numerous partnership-based research projects to develop innovative use cases for these technologies. It is also bringing its expertise to bear in supporting public policy.

Carnot TSN, its IMT and non-IMT schools (IMT is a Carnot TSN-accredited institute) have achieved a high level of visibility and are now positioned as the "academic orchestrator" of this national ecosystem, at the heart of the National Acceleration Strategy for 5G & telecoms networks of the future.

focus on 5G/6G

Beyond5G

This Carnot TSN-supported project, funded by the government as part of the France Relance recovery plan and the Investments for the Future Program, brings together IMT, EURECOM, Thales and Ericsson. It aims to make specific advances in terms of performance, resilience, quality of communication services (bandwidth, latency, network management) and solutions to guarantee reliability, network security and access for users and connected systems. The goal is to provide France with genuine, sovereign, capacity-building prospects through a fruitful dialog between research and platform testing. This project has already led to the publication of 15 scientific papers and the filing of several patents.

5GMetaverse

To meet the new needs created by the metaverse, this project, led by Airbus Group and with partners including IMT, Orange, Shift 89, Immersive Factory Kalray and Boa Concept, aims to evaluate and develop 5G technologies and standards, particularly for object and data identity management. One of the aims is to bring the possibilities of the metaverse to Factory 4.0 tools such as digital twins and mixed reality. This pragmatic approach will rely on generic use cases derived from consumer and industrial applications.

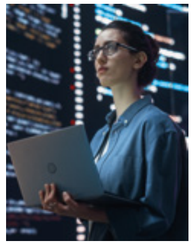
5G NTN mmWave

This project, funded under the Innovative Solutions for the 5G & 6G Networks of the Future (France 2030) call for projects, brings together a consortium led by Constellation Technologies, including GreenerWave, ONERA and IMT via Télécom Paris.
Constellation Technologies is developing an innovative satellite infrastructure to provide high-speed, low-latency Internet service where terrestrial networks are unavailable.

To meet market expectations, particularly in terms of pricing, this solution stands out for its use of the 5G mmWave spectrum and a multi-orbit VLEO and MEO architecture. One of the challenges is to implement millimetric bands in a satellite context. An in-orbit demonstration is planned with terrestrial 5G mmWave infrastructure operators to validate the solution's various subsystems in a representative environment.

Orange 5G PIEEC-MECT

IMT, EURECOM, Ekinops, CEA List and b<>com are working with Orange SA on this project which seeks to develop concrete solutions for the next decade by creating and rolling out secure, sustainable digital infrastructures through “5G everywhere”. The proposed solutions contribute to companies' digital transformation through vehicle-to-X infrastructures and private 5G/6G networks. Special efforts are being devoted to the development of Open RAN, with all its implications for antennas, network processors, quality of service and access network management. Collaboration with the microelectronics sector will help align research throughout the digital value chain.



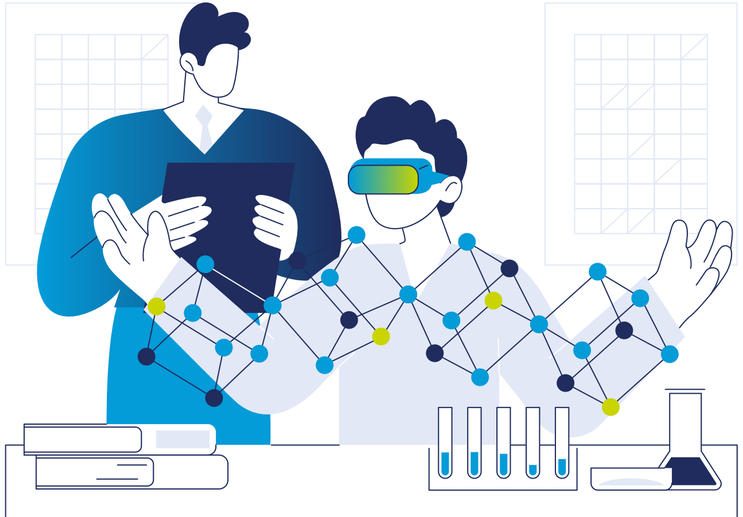
FRAMExG

Led by Carnot TSN and Ouest Valorisation, this project brings together IMT, EURECOM, French technology transfer companies, b<>com and INRIA to create an academic “Team France” for 5xG. The aim is to bring breakthrough 5G/6G technologies to maturity and accelerate their transfer to the socioeconomic and industrial world. Involving the majority of the country's research laboratories, technology transfer offices and technological research institutes, the project is supported by major French and European manufacturers.

FRAMExG is based on a breakthrough approach to research commercialization and technology transfer: a patent factory system developed over many years by Carnot TSN efficiently generates a critical mass of patents, which can then be transferred directly to industry and/or brought before international standardization committees, where international competition and telecoms sovereignty – both crucial issues today – are at stake.

ACCELERATING THE INDUSTRY OF THE FUTURE THROUGH RESEARCH AND INNOVATION

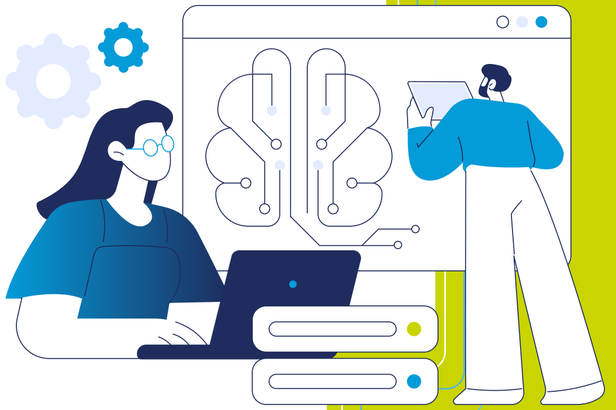
The Carnot Institutes' mission is to develop partnership-based research and reach out to companies. Carnot Télécom et Société Numérique leverages its scientific expertise and know-how to develop breakthrough digital solutions in a collaborative approach to transfer technology to industry. Its innovations contribute to the development and competitiveness of its industrial partners while formulating responses to the major scientific, economic and social challenges of the future, including the industry of the future, smart devices and networks, cybersecurity, big data and artificial intelligence, smart cities, and digital health.



research & innovation

A PROACTIVE SCIENTIFIC POLICY

Maintaining the institution's scientific excellence, as recognized by its Carnot label, requires upstream research on topics, with a possible scientific or technological breakthrough made over a potentially distant horizon, but always with an economically viable application potential. This goes hand in hand with anticipating industrial and market demands and changing standards. Patents, the creation of startups and research partnerships are a winning recipe at Carnot TSN.



ANR BOOM project: “deflating” online political opinion bubbles

The ANR BOOM (“Modeling and Opening Opinion Bubbles”) project, led by the Mines-Télécom Business School (IMT-BS), a Carnot TSN component entity, in collaboration with the Lorraine Laboratory of Research in Computer Science and its Applications (LORIA), CEA-LIST, the Goods, Standards and Contracts Laboratory (LBNC) and the Syllabs company, aims to counter the effect of social network recommendation algorithms, which lock users into similar opinion bubbles.

Platforms capture their users' attention by offering them content that targets their interests and points of view. These mechanisms do not encourage diversity of opinion – quite the contrary. They increase political polarization and exacerbate social tensions, such as the opposition between pro-vaccination and anti-vax advocates seen during the COVID-19 health crisis. They can also be used to influence citizens' decisions, particularly during elections.

To address these problems, the BOOM project is developing a recommendation system that exposes users to a variety of opinions without directly exposing them to points of view opposed to their own, but by gradually leading them to consider different perspectives.

It draws on expertise in data collection and analysis, IT development, user experience, digital economics and political science, notably to analyze the mechanisms underlying the polarization of opinion. Metrics have been developed to assess each individual's level of polarization and adapt recommendations accordingly, in order to encourage open-mindedness. This project has been subject to the ethical requirements of the University of Lorraine's Ethics Committee.

ANR BOOM project: “deflating” online political opinion bubbles

Find out more

OSA-O-RAN agreement: towards more open radio access networks

Find out more

OSA/ O-RAN agreement: towards more open radio access networks

Radio Access Networks (RANs) are essential for telecoms operators. They ensure data and voice transmission between users and the core network, enabling the rollout of the full range of mobile network applications.

To break free from the constraints imposed by a small number of equipment manufacturers and provide more open and interoperable RAN networks, the O-RAN ALLIANCE was created in 2018 by AT&T, China Mobile, Deutsche Telekom, NTT DOCOMO and Orange, in order to establish common standards. The aim is also to develop more adaptable and energy-efficient networks thanks to the RIC (RAN Intelligent Controller), a software component capable of automatically adjusting the network according to its status and users' needs.

In this spirit of openness and innovation, the O-RAN ALLIANCE and OpenAirInterface Software Alliance (OSA) recently signed a cooperation agreement. OpenAirInterface (OAI), a Carnot TSN-accredited open-source software platform, enables the reproduction of a complete mobile network environment, in 4G or 5G/6G. Managed by EURECOM and enhanced by an entire community, it enables researchers and manufacturers to test services combining open-source software and proprietary systems in real time, as Orange and Airbus have done for various projects.

The O-RAN ALLIANCE and OSA are planning to pool their efforts to further integrate O-RAN specifications into OAI solutions, and to experiment with future generations of networks, potentially including 6G.

The “3D Acquisition and AI” Innovation Chair

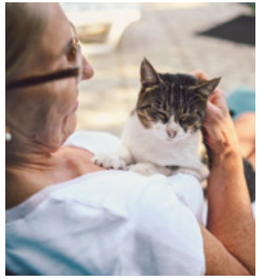
The “3D Acquisition and AI” Innovation Chair, the fruit of a partnership between Télécom Saint-Étienne and SICK, aims to train engineering students to meet the challenges of Industry 4.0. Focusing on data science and artificial intelligence (AI), it complements their curricula in computer science, telecoms, electronics, imaging, networks and photonics programs.

Supported by Carnot TSN, this collaboration is a response to current changes in the industrial sector. Industry 4.0, or the Industry of the Future, involves the use of automated solutions using AI and data science to improve various aspects of industrial processes such as production, logistics and maintenance. In particular, AI-assisted machine vision systems enable the development of quality controls with unrivaled performance. Data acquisition and AI are complementary fields, with sensors supplying data to algorithms, which in turn optimize the collection devices.

Students from Télécom Saint-Étienne will benefit from a theoretical and practical approach, with industrial immersion periods at the SICK Academy in Germany and innovation projects carried out in collaboration with the company. For SICK, the Chair offers recruitment prospects for qualified engineers. In addition, this initiative could evolve into partnership-based research collaborations, further strengthening synergies between the academic and industrial sectors.

A chair to train engineering students to meet the challenges of Industry 4.0

Find out more



Technology to enhance relationships between seniors and their pets

The aging of the population presents society with many challenges, including loneliness and loss of autonomy among the elderly. While the daily presence of a pet can have beneficial effects, the rate of pet ownership unfortunately declines after the age of 65, due to financial or health constraints. A CIFRE thesis examines the use of technology to reverse this trend. Led by Hazar Zilelioglu and jointly supervised by Yacine Amirat, Abdelghani Chibani and Ghazaleh Khobadandelou from LISSI (Images, Signals and Intelligent Systems Laboratory), and Ioana Ocnarescu from the Strate Design School, it is being carried out in partnership with frog, a Capgemini Invent startup, alongside BNP Paribas Cardif and the Robotics by Design Lab (Strate).

The thesis began with a study of the needs of the elderly, which revealed that, although familiar with smartphones and computers, this population is reluctant to use robotics to manage their relationships with their pets. A less intrusive solution has been adopted to monitor the animals' activities: a collar fitted with accelerometers and gyrometers to track their movements. This information is supplemented by data collected via a dedicated mobile application, developed with the support of Carnot TSN, as well as by videos, with each participant having been filmed for an hour at the start of the experiment. This data informs artificial intelligence models designed to predict the animals' behavior.

The experiments have shown a decline in animals' activity with age. In addition, they suggest a correlation between pet activity and individual well-being, although these results, obtained on what remains a limited sample, need to be confirmed. The researchers therefore plan to continue the study but with more participants to further investigate these results, focusing not only on activity but also on behavior and interactions between animals and their owners. This research illustrates that simple technologies may be sufficient to monitor and improve the relationships between elderly people and their pets.

Find out more

INNOVATION AND TRANSFORMATION PROJECTS

Since 2006, Carnot Télécom & Société Numérique has been committed to promoting business innovation and supporting the economy. Our research teams are highly attentive to the needs of the industrial world, responding with agility and creativity to the scientific and technological challenges facing our society, and contributing to the emergence of the operational solutions of the future.

Here are some of the standout innovation and transformation projects of 2023.

MiMédi: democratizing advanced therapy drugs

The MiMédi project, supported by the Femto Engineering school and the Carnot TSN institute, aims to improve the accessibility of innovative therapies by rationalizing their production, which is subject to stringent health constraints. Used to treat diseases such as cancer and autoimmune disorders, these therapies are based on the modification of cells to improve their ability to fight disease. However, their high cost limits access to them.

To remedy this problem, MiMédi has brought together the French Blood Service (EFS), two laboratories at the University of Franche-Comté (UMR RIGHT and FEMTO-ST), Besançon Regional University Hospital (CHRU) and FEMTO Engineering, a component of Carnot TSN, along with six industrial partners: iLsa, Smaltis, AUREA Technology, Diaclone, MED'INN'Pharma and Bioexigence.

The team's biologists and engineers have devised an alternative to centrifugation for cell selection, based on the cells' response to electrostatic fields, using microfluidic chips manufactured by nanometrically precise robots. To reduce contamination risks, the researchers have opted for sterile connections between the various components. They have also developed control methods based on spectroscopy or AI-assisted computer vision.

Completed in December 2022, the MiMédi project led to the creation of CellQuest, a startup which aims to reduce the production costs of the CAR-T cells used in immunotherapy. Pending clinical trials, the team is working on new initiatives to improve donor compatibility and target patients to maximize the chances of success of these innovative therapies.

MiMédi: democratizing advanced therapy drugs

Find out more

A Digital Intelligence Observatory for Michelin Group

For several years now, Michelin has been encouraging its teams to adopt new digital tools via the "Collaborative Move" program launched in September 2019. This transition, accelerated by the COVID crisis, has revealed a number of technology integration challenges linked to the diversity of the Group's businesses.

A CIFRE thesis, supported by the Carnot TSN institute, was launched in response to these findings, following discussions with Aurélie Dudezert, a faculty member at IMT-Business School. Initially focusing on the implementation of a method to encourage the adoption of emerging technologies in working practices, the aim of this thesis, carried out by Harry Ramadasse, has evolved to include the creation of a "Digital Intelligence Observatory". To characterize this appetite, new indicators will be co-constructed with Michelin teams to evaluate the use of collaborative work tools, as well as their effectiveness, while ensuring that data collection remains acceptable to employees. Overburdening employees could slow down the digital transition that Michelin is seeking to facilitate for all its teams.

The initial diagnosis also revealed differences in attitudes to digital technology, for example, between employees working in offices and those working in factories, with the latter being less likely to benefit from teleworking. To avoid frustration and ensure the success of its digital transformation, Michelin needs to take account of the specific expectations of its 100,000 employees worldwide, with their diverse occupations and cultures. Another challenge is to reconcile business processes that play a key structural role for the manufacturer, but which can sometimes complicate the adoption of a more flexible digital culture, which is essential for the service activities that the group wishes to develop.

A Digital Intelligence Observatory for Michelin Group

Find out more

Can ikigai robotics enhance occupational well-being?

A CIFRE thesis on ikigai robotics, conducted by the SNCF, Strate Design School, a Carnot TSN component institution, and CESI, examines how robots can contribute to well-being at work. Beyond encouraging the acceptance of robotic tools and simply improving performance, SNCF also wants robots to improve well-being in the workplace, particularly for railway maintenance workers.

Researchers, including Ioana Ocnarescu from Strate and Stéphanie Buisine from CESI, have developed a scientific model for assessing ikigai in a professional context. Ikigai is a Japanese concept meaning "reason for being", which is often represented by four overlapping circles: what I love, what I'm good at, what I'm paid for and what the world needs. Mégane Sartore, the PhD student carrying out this thesis, has created a questionnaire based on validated psychometric scales used to measure ikigai. The questionnaire was completed by 321 French workers and around 50 rail maintenance operators, validating the initial model and revealing differences between populations.

The study highlighted the preponderance of a sense of collective belonging as a predictor of ikigai for railway maintenance workers. Other key drivers included "mindfulness", being passionate about one's work, and a feeling of autonomy, with varying impacts according to the populations studied.

The first case study concerns PICAUTO, the train roof inspection tool. An initial prototype has been improved in collaboration with operators to take greater account of their ease of use. A pole capable of speaking and introducing itself has been devised, along with a dozen other new ikigai-enhancing features that will soon be implemented and evaluated. If this approach proves successful, ikigai robotics could be rolled out to other SNCF teams, enhancing the employees' occupational well-being.

Find out more

TECHNOLOGY PLATFORMS HELPING COMPANIES TO INNOVATE

Carnot TSN brings together nearly 80 R&D technology platforms throughout France, which play a central role in our components and work as closely as possible with researchers and regional scientific fields of excellence such as nanotechnologies, healthcare and environmental imaging.

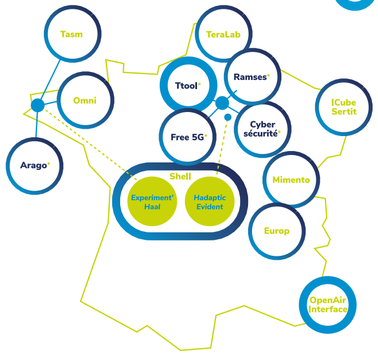
Platforms, the point of entry for companies

Carnot TSN offers a wide range of experimental and digital platforms combining a high level of expertise with state-of-the-art equipment in the target fields of application. They are available to help public and private partners develop their activities in research, development, transfer of results (proofs of concept, prototyping, trials, etc.), and training.

Platforms of excellence

Thirteen platforms have been singled out by the "Carnot TSN Platform" label of excellence, guaranteeing a formalized service offering open to businesses.

Five of these platforms(*) have also been awarded the "2023 IMT Platform" certification and received the support of Institut Mines-Télécom's eponymous strategic program to boost their service offering across the entire technology readiness scale (TRL).



13 certified platforms

NETWORKS AND SMART DEVICES

OpenAirInterface, EURECOM
Open source hardware/software for wireless communications

EUROP, Télécom Saint-Étienne
Fixed network and industrial transfer for very-high-speed communication technologies

RAMSES,* Télécom Paris
Analysis and production code for embedded real-time systems

TTool,* Télécom Paris
Network configuration simulation and experimentation

Free5G,* Télécom Paris
Design, development and evaluation of new network features in a software radio environment

DATA AND SERVICES

TeraLab, IMT
Big data and cloud computing

OMNI, IMT Atlantique
Transferring social sciences and humanities to the digital society

HEALTHCARE AND AUTONOMY

SHELL
Network of healthcare living labs, autonomy and quality of life

SECURITY

Cybersecurity,* Telecom SudParis
Design, assessment and demonstration of security and defense mechanisms

SMART MATERIALS

Arago,* IMT Atlantique
Optical technologies and smart materials for the industry of the future,

MIMENTO, FEMTO Engineering
Micro and nanotechnologies for mechanical, acoustic and optical microsystems

ENVIRONMENT

ICube-SERTIT, Télécom Physique Strasbourg
Regional Remote Detection and Image Processing Service

TASM, IMT Atlantique
Digital communication via an underwater acoustic link

IMT SDR-Lab

The IMT SDR-Lab platform, located at Télécom Paris in Palaiseau (Essonne), a component of Carnot TSN, aims to evaluate various types of emerging applications with 5G/6G. With high data rates and low latency, 5G/6G meets the needs of connected agriculture, autonomous driving systems and renewable energy management, for example.

Supported by Carnot TSN, the IMT SDR-Lab enables tests to be carried out on the entire chain (radio access, core network), providing access to all the equipment and functions of a 5G/6G network. This specificity makes all the difference when carrying out "proofs of concept" linked to the implementation of millimetric bands for 5G/6G, and even 6G.

Serving telecoms players, from operators to equipment manufacturers, and companies using 5G/6G, such as energy network managers and IoT manufacturers, the platform includes a Faraday-cage-type experimental room, isolating all communications. The next step will be the roll-out of outdoor antennas.

Network and radio security for cellular systems

Find out more

TASM (Underwater Acoustic Transmission)

The Carnot TSN-accredited TASM Platform in the IMT Atlantique Mathematical and Electrical Engineering (MEE) Department sets out to study and evaluate underwater acoustic communication systems. These systems enable ships, submarines and underwater drones to communicate wirelessly over distances of up to several tens of kilometers.

Created in 2010, the TASM platform aims to make these systems as robust as possible thanks to signal processing adapted to the oceanic context.

Experimentation plays a key role in validating technical solutions in real-life conditions, as underwater propagation and the resulting distortions are very difficult to model accurately. In turn, the data collected improves our understanding of this propagation environment and the realism of simulation tools.

Open to manufacturers and institutions, the TASM platform is equipped to perform trials at sea and has a tank equipped with transducers, hydrophones and signal-processing software.

TASM platform: underwater acoustic communication

Find out more

OMNI, the MARSOUIN Digital and Innovation Observatory

The MARSOUIN Digital and Innovation Observatory (OMNI) is located on the IMT Atlantique campus in Brest. Supported by Carnot TSN, this platform is attached to the Marsouin Scientific Interest Group (GIS), which brings together Brittany's universities and grandes écoles, focusing on digital transformations and their social, economic and professional implications.

OMNI helps manufacturers and local authorities to identify and meet the challenges they face. To this end, it carries out quantitative (questionnaires) and qualitative (interviews, observations) surveys, whose results are analyzed statistically to produce scientifically valid findings.

The raw data collected is published in compliance with open data standards to promote its use in research and training.

To keep pace with the rapid changes in digital usage, OMNI maintains an ongoing dialog with its partners to define relevant issues and improve its data collection and analysis methods.

Measurement and analysis of the impact of digital uses and innovation.

Find out more

the Carnot Network

THE MOST POWERFUL RESEARCH OFFERING FOR CORPORATE INNOVATION

Carnot institutes are accredited by the French Ministry of Research for their proven ability to develop research partnerships and promote technology transfer with socioeconomic players, notably companies ranging from SMEs to major corporations. Drawing on their high level of scientific expertise and professionalism, Carnot Institutes form a unique network of 39 French public research organizations committed to partnership-based research. Their work meets the R&D needs of different business sectors, helping to boost France's economic recovery and sovereignty through innovation.

La recherche CARNOT pour l'innovation des entreprises

The Carnot label

The Carnot label was created in 2006, and aims to develop partnership-based research by managing research activities carried out by public laboratories in partnership with socioeconomic players, mainly companies (from SMEs to major groups), in response to their needs.

A strong response to the challenges of industry

With 20% of France's public research staff, the Carnot Institutes carry out 55% of the R&D outsourced by companies to public research laboratories. Each year, more than 10,000 direct R&D contracts are signed by the institutes and companies in all industrial sectors. In addition, the Carnot Institutes are involved in numerous collaborative R&D projects with their partners in the socioeconomic sector, as part of undertakings such as European programs, ANR thematic programs, and competitiveness clusters.

The Carnot Institutes have become key players in collaboration between public and private players, and in scientific and technological transfers for corporate innovation. Their remarkable results and their unfailing commitment to our industrial companies place them on the front lines of the industrial revival.

Jean-Denis Muller
Director General, AiCarnot

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