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Orange research has a responsibility which goes beyond technological innovation: taking part in building a fully digital and human future. To do so, Orange Research reaches out beyond its own ecosystem to enter into a conversation with the whole of society. This is how we will be able to understand new uses and anticipate the ethical and societal challenges they raise.

Orange intends to use this research to improve the daily lives of all users by creating innovative and responsible uses for new digital technologies and providing easy and seamless access to services. Other crucial interests include controlling the efficiency of our networks, while increasing their speed and their energy efficiency. Orange researchers also explore technological breakthroughs, new uses and innovative economic models. They invent the technologies required to deploy the networks and services of the future.

In the wide-ranging field of digital technology that is now global and increasingly open where cooperation has become key, the Group’s Research Division is working in a state of permanent interaction with all the innovative, academic, institutional and industrial ecosystems. Against this backdrop, Orange has implemented increasingly integrative research, which is open throughout the Group, and also interacts with any external figure interested in this joint creation.

Building new skills, getting Orange involved in dynamic ecosystems and promoting high-quality intellectual property and inventing or testing new technological developments remains an asset for the Group’s future, now more than ever.

Some key figures:
- **640 researchers** and **140 PhD students** and post-doctoral researchers working full time on our areas of research, with a wide range of skills (radio, fibre optics, software, cloud, Big Data and artificial intelligence, security, but also sociology, economics or design…).
- **Top European operator for patent filing with 222 patents** filed in 2018, significant contributions to the development of international standards (5G, video encoding, etc.) and very significant participation in the creation of Open Source solutions for infrastructures of the future.
- **A Scientific Board**, a consulting body composed of eight world-renowned high-level scientists whose mission is to give the Group recommendations on its research policy.
- **Over 150 academic and industrial partnerships.**
Communications resources, prizes and publications

Through its publications and speaking engagements, the Research Division of Orange has been instrumental in deciphering the issues surrounding technologies, uses and the digital economy for a growing audience. Some of the key events and publications include:

- **140 scientific publications** per year, recognised by researchers from around the world.
- **Over 4,000 visitors to the Salon de la Recherche**, providing an opportunity for exchanging and discussing ideas, where Orange researchers share their work in around forty presentations.
- **The Digital Society Forum**, an open collaborative platform initiated by Orange to give everyone the keys to understanding our digital life. The Digital Society Forum brings together sociologists, academics and civil society players around the major themes of daily life. [http://digital-society-forum.orange.com/](http://digital-society-forum.orange.com/)
- **Orange’s participation in the ImpactAI group**, a think-and-do tank which brings together various French companies to lay the foundation for responsible and ethical use of Artificial Intelligence. [https://impact-ai.fr/](https://impact-ai.fr/)

**Iconic prizes were awarded to Orange in 2018:**

- Laval Virtual Jury’s Grand Prize for the tree of life, the result of open research with the National History Museum, background work on viewing large graphs (Thing in).
- Our excellent researchers recognised by prestigious awards including the “Général Ferrié” Electronics Grand Prize awarded this year to one of our researchers for her work on “Focusing radio waves for an energy-efficient internet of things”.
- Two Intellectual Property and Licensing awards.
- Two Celtic Awards granted to the cooperative projects Convince (Consumption Optimization in Video Networks) and Gold (Gigabits Over the Drop).

**You can find researcher publications via their blog posts on the site:**

[https://hellofuture.orange.com/en/research-blog/](https://hellofuture.orange.com/en/research-blog/)

1. [https://hellofuture.orange.com/en/smart-5g-antennas-are-on-their-way-here-at-orange-weve-been-ready-for-a-long-time-the-next-step-has-already-been-planned/](https://hellofuture.orange.com/en/smart-5g-antennas-are-on-their-way-here-at-orange-weve-been-ready-for-a-long-time-the-next-step-has-already-been-planned/): A project recognised with the National Research Agency’s “Economic Impact” Prize / Dinh-Thuy Phan-Huy


3. [https://hellofuture.orange.com/en/homomorphic-encryption-the-key-to-security](https://hellofuture.orange.com/en/homomorphic-encryption-the-key-to-security): “Fully homomorphic encryption, or how to perform operations over encrypted data” / Sébastien Canard, Marie Paimdavoine


Follow the @Orange_Future Twitter account to discover the latest Orange research and innovation news. You can also follow @ndemassieux, the Twitter account of Nicolas Demassieux, Director of Orange Research.
Orange research priorities

To adapt to current and future technological transformations and to invent tomorrow’s uses, nine areas of research have been identified, each with its own specific ambition.

1. Digital personal life
The information, knowledge and resources which we use in our everyday lives will continue to become digital. They will become our digital heritage. That is why we are imagining the personal and inter-personal services of tomorrow - to produce, manage, store and exchange rich digital content within a more interactive and immersive communication experience, while continuing to explore the ways in which artificial intelligence and user experience design can support our everyday digital activities.

2. Digital society
With the large-scale roll-out of digital technologies, many aspects of our society are being transformed: health, roaming, smart transport, industry, civic life, etc. Bringing together disciplines to assess and examine the effects of technology on society, including in ‘real-life’ situations; that is the ambition of this area of research.

3. Digital emerging countries
The adoption of digital and mobile technologies is expanding exponentially in emerging markets. That is why we prefer to support the emergence of digital ecosystems in partnership with stakeholders on the ground to offer accessible connectivity to as many people as possible and develop new services and infrastructures adapted to local contexts.

4. Digital business
So that Businesses are able to fully take advantage of the digital transformation, we are carrying out in-depth studies of new digital tools and ways of working, to lay the foundations of the digital and human employer of tomorrow model.

5. Ambient connectivity
We are developing new connectivity technologies for people and devices. With our ecosystems, we design the networks and the economic models of the future to provide ambient connectivity, saving on costs and energy consumption and creating value. In particular, we are working on 5G and its application at all levels of society - for individuals, communities or manufacturing.

6. Software infrastructure
Because network equipment and functions will be software-based and the cloud will become increasingly distributed, we are focussing on how to manage the convergence of IT and telecoms and the impact of this on networks, clouds and IT systems. We are designing network functions and are building a unified execution and operating environment for 5G.
7. Internet of Things

Currently, the Internet of Things is very fragmented. We are contributing to the emergence of the Internet of Things: a distributed platform to support interactions between humans, physical objects and digital services (cyber-physical systems), on a massive scale and for a range of applications (homes, cities, companies, industry, cars, transport, agriculture, etc.).

8. Data and knowledge

Astonishing advances in artificial intelligence related, in particular, to the availability of ever-growing volumes of data are driving innovation and operational efficiency. To develop this potential, this area of research aims to design trustworthy technological building blocks and platforms which respect users’ privacy, rooted in artificial intelligence and Big Data.

9. Trust and security

Because innovation is only desirable if it lives up to our values and delivers trust and respect for privacy, our experts are developing the systems which will guarantee future users’ peace of mind: a fluid user experience, security and trust in our services and our infrastructure (virtual of physical), cyber-security, protection of data, for example.

Integrative research for three profound revolutions

Orange’s research has three research platforms reflecting the three revolutions which will significantly affect the interaction between the physical world and the digital world:

**The internet of things**

**Sensitive homes**

**Ambient connectivity**

The way in which we design and develop the technology is, more than ever, inseparable from its uses. That is why we are convinced that, to ensure these three revolutions help to drive progress, research should be integrative, open to its clients and ecosystem:

- We like to look at the big picture when it comes to research, thinking about the links and interactions of various technological building blocks with one another and with users.
- We believe that understanding these relationships and interactions requires an ongoing conversation with society. It also means making innovations and their societal or ethical implications accessible for everyone to understand.

Integrative research involves co-creating a shared vision, to invent the next technological revolutions and uses. Making this understanding of innovation a standard is a project which we will carry out hand in hand with those who share it.

The path ahead has not been mapped out. We are entering a territory where everything has yet to be explored, to build a future that benefits everyone: users, public research institutes, start-ups, manufacturers...

Our platforms are drivers of collaboration between us, the rest of the group and external ecosystems.
Through billions of connected objects, the IoT brings new meanings and a physical presence to the digital world. Services are able to respond to what is going on in the physical world, and are able to respond to it, in the city, in manufacturing, or in homes. While connected objects are currently limited to their own specific applications, in future, when they are able to connect to other objects and a number of users, they will set the scene for innovations in services, new modes of collaboration and a new economy.

In the same way that the web, by networking digital content, exposed the power of the internet, the IoT will only reveal its potential if objects are networked for the benefit of users. Our shared challenge is to create a web of things: a web through which billions of objects will be referenced, defined and connected, so as to become accessible, even remotely, to users. The cornerstone of this web of things is indexing the world’s connected objects and getting them to ‘talk to each other’.

We will build the web of objects around an open, online digital index of objects and links between them. A bridge between the digital and physical worlds, this index will not only reference the properties of objects and links between them but, crucially, connect owners and users. Everyone will be able to request access to connected objects, or the data which they generate, to put them to different uses, opening the way to new business models and major new innovations in services.

To create this index, we must:

- Develop the tools required to define and categorise the connected objects.
- Design the search engine which will analyse the web of things and deliver up to date search results.
- Define management of rights and authorisations for access.

To achieve this, our integrative research programme provides a shared research environment where manufacturers, owners, object operators, and developers of services and technologies can work together. The aim of this platform is to uncover, experiment and observe new uses in vivo and potentially new business models through its ability to contextualise and open up the internet of things market, which is currently highly fragmented.

Over the next few years, artificial intelligence will have the power to simplify our daily lives and improve our quality of life. Our homes will become smart and empathetic, saving us time and increasing wellbeing, offering greater autonomy for people with special needs and monitoring the health of those close to us.

We believe that for the sensitive home to become a reality, technologies must not only be completely secure and respectful of our privacy, but also facilitate openness and connections with others.

How to imagine this smart and sensitive home so that it protects our privacy, without trapping us in a bubble? That raises technical and user design questions, but also fundamental sociological and anthropological questions about our relationships with others, our communities and our homes.

Supported by our researchers’ expertise, both in artificial intelligence and uses, and our expertise in security, we want to allow all contributors (builders, developers, entrepreneurs, sociologists, anthropologists, designers) to help create a home, whether it is:

- **Intelligent**: making interactions with the digital world second nature and automating a whole set of tasks, simplifying the lives of occupants.
- **Sensitive**: taking context into account and making the right suggestion at the right moment to improve the way the household works.
- **Trustworthy**: always under the control of its residents and keeping information about the home within the home.

Our integrative research platform is both:

- A sensitive and experimental home embodied by a “digital butler”, a sort of personal assistant serving the home, to deploy technologies and uses in situ and in vivo.
- A common architecture to facilitate the integration of new technological components, allowing each contributor to work in an open, stable and interoperable environment.
« Plug in the future » platform: Ambient connectivity

Soon, ambient connectivity will become almost as necessary to human activity as the air we breathe. From 2020, 5G will offer ultra-high-speed broadband, more reliable, more powerful, and more efficient (particular in terms of energy efficiency). It will bring about major shifts in uses and economic models. For companies, 5G will provide access on demand to the network. Users will be able to make the most of very high-speed mobile broadband, the IoT, and their applications, from fun, futuristic uses such as virtual or augmented reality and holographic communication, to vital ones such as connected cars or remote medical treatment.

To make these promises a reality, the 5G network must be ambient and flexible, but also secure and reliable. Because networks will essentially become software functions, using technologies developed based on the cloud and artificial intelligence, we must re-imagine the way we design and manage them. We therefore have (at least) four major challenges to take up:

- Responding to exponentially growing needs for connectivity.
- Developing the infrastructure which will integrate virtual network functions.
- Designing the user experience for managing the network.
- Improving energy efficiency.

Orange is preparing for the arrival of 5G in Europe, and putting out a call to anyone who wants to contribute to designing applications connected to the 5G network of tomorrow: a high-performance, reliable and efficient network.

To develop and experiment with changes in 5G technology as well as inventing uses in conditions close to real life, we are opening an integrative research platform. This is both:

- A software development environment: a “sandbox” to create, test and integrate 5G technologies.
- An in vivo experimental space, a network management centre prototype: the cockpit.

In 2018, the Plug in platform built the first fully open-source experimental mobile network from end to end, in order to demonstrate it at the Mobile World Congress.

We are putting our network expertise, our 5G expertise and our international clout at the service of this open platform, because we know that this kind of revolution is only achieved together: operators, end users and B2B, researchers, developers, designers, etc.

In 2018, Integrative Research accelerated significantly. We have integrated many bricks to research platforms and conducted the first experiments with the opening to partners.

In 2019, the Research show identifies the first lessons from this integrative research model. This show is also an opportunity for Orange to unite its teams and partner ecosystems around its various research projects. A strong exchange that allows researchers to share their progress, perspectives and key issues of research through forty demonstrations.
A deep involvement in ecosystems

Each of the Group’s research and innovation centres is integrated into a geographic ecosystem of its own, and works as part of a network with all local actors (startups, businesses, universities, research laboratories, etc.) as well as within international bodies and collaborative projects.

- Orange is a major figure in research programmes developed with partners. The Group contributes to more than 50 collaborative projects, both in France (Single Interministerial Fund, the National Research Agency, Investing for the Future Programme) and at the European level (European Commission Seventh Framework Programme, EUREKA-CELTIC, Horizon 2020). In particular, the Group is part of public-private partnerships such as:
  - the «Advanced 5G Network Infrastructure for the Future Internet» public-private partnership
    The founding members of the 5G Infrastructure Partnership Association have signed the «Advanced 5G Network Infrastructure for the Future Internet» public-private partnership agreement with the European Commission. This European research programme, which is part of the Horizon 2020 programme, is intended to define the infrastructure of the fixed and mobile communications networks for the next generation - 5G networks. Orange took part or is taking part in 22 5G PPP projects.
  - The Big Data public-private partnership. A memorandum of understanding was signed in October 2014 between the European Commission and Big Data Value, an association acting on behalf of digital companies including ATOS, Siemens and Orange, to push forward research on controlling the proliferation of data.

- As part of the French government’s Investing for the Future Programme, the Group is closely involved with a Technological Research Institute (IRTs). It chairs the IRT b<>com which works on 5G networks, the IoT, security, Artificial Intelligence and immersive multimedia (RV, RA, Holography, etc.).

We are now one of the leading private figures in digital research in France:
- Orange supports seven centres of excellence (and chairs the Images & Networks centre) as well as two shared laboratories (the CREMANT, the laboratory researching antennae with the CNRS and the Nice-Sophie-Antipolis University, and the I<>OLab with the INRIA which works on networks and the cloud).

- Orange has implemented over 30 Research contracts with leading research centres in France and worldwide (Institut Mines Telecom, INRIA, CNRS, Polytechnique, Centrale Supélec, Fraunhofer Munich, University of Bern, York University, Ben Gurion University in Israel, etc.) and is involved in academic chairs, including one on the values and policies of personal information with Institut Mines-Télécom, whose Foundation we also support.

Our key achievements in 2018 were as follows:
- Orange identified as a “key innovator” for 15 innovations (14 Orange Group and one Orange Poland) in European projects considered high potential by the European Commission’s “innovation radar”: https://www.innoradar.eu/innovator/999908981.
- Launch of the Prometheus H2020 project, which aims to offer encryption systems which can resist quantum computers to protect individual privacy in local services (electronic voting, payment, ticketing, transport, etc.). It positions Orange as a trusted operator in terms of protecting Orange customers’ privacy, securing services, discussions and anticipation of a post-quantum world.
- Launch of the AI4EU H2020 project based around artificial intelligence, aiming to build a complete European AI platform on demand to reduce obstacles to innovation, encourage the transfer of technology and act as a catalyst for the growth of new businesses and SMEs in all sectors through open calls and other initiatives. The platform uses the entire European AI ecosystem, bringing together 80 partners in 21 countries.
- Orange is an active partner of ten PPP 5G Phase 2 projects, which aim to develop the different technological blocks that will be a key part of 5G and will help to develop the Plug’In platform.
- The FIWARE project continues to deploy the innovation platform allowing rapid development of innovative applications in the fields of Smart Cities, Smart Agriculture and Industry 4.0. This platform offers standardised APIs shared by the entire European ecosystem, allowing the creation of a catalogue of usable applications, specifically in the countries where Orange operates.
We are inventing the networks of tomorrow, contributing to making it possible for them to work together, and we are a major player in Open Source, both as a contributor and a user. Thus, with the ecosystem, we are creating the conditions required for the development of technologies and uses.

Orange Labs and Orange Silicon Valley also actively watch or “scout”, to catch the latest trends and best initiatives coming out of Asia and the United States or Israel. A possible practice thanks to their immersion in local ecosystems and constant interaction with local digital players like startups, companies, manufacturers and academics.

To accelerate the adoption of new technologies and guarantee interoperability between all digital players, Orange has always been highly involved in standardisation bodies, and is a strong contributor to Open Source initiatives. In terms of the Internet of Things, we are taking part in Eclipse IoT, OM2M, and FIWARE... For the Cloud and virtualisation, we are contributing to Cloud Foundry, Openstack and, alongside other operators and manufacturers, we are co-developing ONAP, a telecoms-oriented Open Source cloud OS.

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Intellectual property and licensing

Within the Orange Technology and Global Innovation and Orange Labs Research division, Intellectual Property and Licensing (IPL) Directorate creates, manages and promotes the Orange patent portfolio, which is one of the Group’s immaterial assets. It also promotes software.

Intellectual property allows Orange to stand out with its academic and industrial partners. It also aims to defend the Group’s interests in the event of disputes.

Orange is fully committed to innovation, and intellectual property is a key aspect for the Group as part of its innovative business approach.

Protection of inventions, patents and software has progressed significantly worldwide in the past three years. IPL supports Group strategy by building and promoting its assets and defending its interests. In the digital world, intellectual property has recently been transformed to go beyond just protection and promotion of innovation and legal discipline. It is now at the crossroads between Orange innovation, business, competitiveness and interest to support the company’s everyday challenges.

Orange has protected 222 new inventions in 2018, and has nearly 7,000 patents and patent requests in its portfolio, mainly from the Orange Labs network in France and overseas; these include major technical contributions to standardisation (5G, voice, audio and video encoding, etc.). Orange is a respected figure in intellectual property and standards.

Beyond the main patent portfolio creation and management activities, promoting assets and defence in the event of disputes, Orange’s intellectual property is part of several Patent Pools (patent holder groups, by technology) to promote its patents in accordance with the FRAND (Fair, Reasonable and Non-Discriminatory) rules, thus making innovation accessible to as many people as possible.

Rankings and recognition:

- Orange is the leading patent filing operator in Europe, and amongst the top 12 across all industries in France (source: INPI, 2018 ranking of the leading patent filers).
- In October 2018, the fourth edition of the Trophées du Droit - Business Edition awarded two gold trophies to the Orange Intellectual Property and Licensing department, including “Best Patent Intellectual Property Department” and “Best Licensing Department”.

Key figures:

- Nearly 7,000 patents and patent applications in France and overseas.
- Including over 220 patents filed in 2018.
- Over 2,500 software registered since 2005.
A brief history

A long-time force for technological research in France and throughout the work, Orange has been at the forefront of many technologies which users enjoy today, thanks to the international standardisation in which we actively take part. Our inventions are core components of Wi-Fi and 4G, as well as audio, video and voice compression (MP3, MPEG and HEVC, Audio DRM, etc.) wireless technologies (RFID, NFC), SIM cards and its e-SIM version, and PON optical technologies, amongst others.

Orange Research began in 1944 when the National Telecommunications Research Centre (CNET) was founded. When Orange Labs opened, CNET was tasked with research and development in telecommunications.

A few major milestones:

- **1961** – Antinex, the most powerful calculator in Europe, is developed using the then brand-new technology, transistors.
- **1962** – First satellite television broadcast between the United States and France via the Telstar satellite and the Pleumeur-Bodou PB1 station.
- **1964** – Ramsès II is developed, a computer shared by 64 users.
- **1970** – Electronic time switching system called Platon that simplifies telephone exchanges.
- **1976** – Development of Transpac, the first data network and «packets» that contains some of technology used in the 1990s to develop the Internet.
- **1980** – Testing of the Minital developed by CNET, that in 1982 led to the launch in France of the world’s first set of consumer digital services.
- **1981** – First optical link between two of the operator’s exchanges following research on fibre optics.
- **1981** – CNET starts the digital mobile network called Marathon that from 1982 to 1991 was a major contributor to standardizing 2G (GSM) and led to the commercial release in 1992 of Itineris in France.
- **1988** – Invention of OFDM (Orthogonal Frequency Division Multiplexing) radio technology for coding digital signals. It was adopted in 1995 for Digital Terrestrial Television, in 1999 for Wi-Fi and in 2008 for 4G.
- **1989** – RNIS (Digital Network of Services Integration) is launched in Saint-Brieuc, the first commercial network in the world that established exchange links in 64 or nx64 kb/s circuit mode on the telephone network.
- **1990** – First election with a computer.
- **1992** – Antine, the most powerful calculator in Europe, is developed using the then brand-new technology, transistors.
- **1993** – Telecom-Bretagne, then part of France Telecom, starts turbo-codes, a coding technology that maximizes speed over many types of networks (mobile, satellite, etc.
- **1995** – Prototypes for fixed telephony services in Orange’s Voice over IP that was operationally deployed in 2004.
- **2000** – Contributions to the international standardization of ADSL that led to the high-speed Internet.
- **2000-2009** – Standardization and development of high-definition voice (WB AMR) that was commercially released in 2009.
- **2004-2015** – Contributions to a series of versions of Livebox and Livebox Play
- **2014** – Orange and the partners of the PERCOL collaborative project win the ANR and DGA challenge using Artificial Intelligence technologies to detect people in a video.
- **2015** – Demonstration of advances in optical transmission based on research done for the SASER project by a world record optical link between two operational hubs.
- **2016** – Development of and participation in the standardisation of 5G technology which will be introduced after 2020.
- **2017** – Standardisation of 5G (Phase 1 standardized in 2017 and Phase 2 to come): 3GPP.
- **2017** – In the area of Artificial Intelligence, Orange wins an international challenge for semantic similarity of texts and demonstrates its technologies for transcribing speech, identifying speakers and thematic structuring within the framework of an experimental platform for exploring audio-visual scientific content at the Fondation Maison des sciences de l’homme.
- **2018** – Joining the Mobile World Congress and demonstrating the first fully open source experimental mobile network from end to end.