Towards Inria 2020
Strategic plan
Since 1994, Inria has regularly conducted a foresight and strategy exercise that results in the creation of a multi-year strategic plan for the institute. The process of reflection regarding this new strategic plan, which covers the 2013–2017 period, was characterised by an even more fundamentally different set of circumstances than with previous plans, given that society as a whole and all of its citizens are today faced with a major digital revolution. Informatics, computer and mathematical sciences, all central components of our activities, are playing a key role in this revolution, which as a result is having a significant impact on our institute. This strategic plan aims to position our research and the resulting innovations so that they contribute to this revolution, as well as helping our citizens to understand and fully participate in it.

To assist us and help us consider our future, we drew on the skills and vision of individuals from highly diverse backgrounds. These included our staff of course, but also futurists, manufacturers, entrepreneurs, researchers from all disciplines, thinkers and philosophers. These testimonials and sometimes radical opinions were crucial elements in our process of reflection. During our contact with these great thinkers, we had the opportunity to meet with Michel Serres on several occasions. His vision of the evolution of human and social sciences, included below, which was prompted by reading our strategic plan perfectly illustrates the difficult and sometimes inherently contradictory questions that collectively we cannot and must not ignore. His personal, visionary and incisive words illustrate the far-reaching deliberations and developments that are under way and on which our sciences are duty bound to shed light.

Given the extremely competitive scientific climate and in order to make an outstanding contribution at a global level, we need to make choices that are the result of concerted development efforts within the institute and be capable of explaining them to our national and international partners. This strategic plan enables us to clarify our choices and organise ourselves to help resolve the numerous and difficult challenges facing our sciences and the digital society. The dynamic of this revolution is such that, while making progress on resolving the challenges that we set ourselves, we will of course have to regularly adapt this plan to very rapid developments and constraints.

These challenges will require us to gather all of the skills and collaborative efforts needed to resolve them, both internally and externally, nationally and internationally. As has long been our policy with researchers in the natural sciences and the life and health sciences, we aim to work in partnership with researchers and experts in human and social sciences. We need to collaborate with them to gain a better understanding of the developments within society, analyse them together and contribute to them, the goal being to take up the exciting challenges facing digital sciences.
Language sculpted man. With writing came the beginning of history. Printing revived this process, to the extent that we call its introduction the Renaissance. These three major transformations in the medium-message pairing – body-word, paper-text, printed books – brought about all-encompassing changes in humanity, communities, law, politics, cities, sciences and religions that have been more decisive than the often-mentioned but very much less impactful changes caused by hardship, the Palaeolithic or Stone Age, the Bronze Age and the Industrial Revolution. Computer science is now forging a fourth revolution that, once again, is opening up a new world, one that Inria’s programme is assessing and preparing for the resulting changes, which are sometimes difficult to predict.

Scientific, this new world is mobilising several disciplines, as it deploys the range that separates and unifies the computational methods to the life and earth sciences, as well as physics and chemistry. This technical new world is also populated by networks and machines. Lastly, it is completely transforming our social, economic, political, environmental, educational, medical, personal and ethical behaviours and preoccupations. What we are now witnessing is the transition between an old and a new world.

Computer science creates the world in which we work, live and think. It follows, therefore, that it should concern itself with the consequences and monitoring of its own inventions. The continuation of the scientific and technical exploits of computer science is the goal of the programme and its projects. The realisation that it should also give consideration to the human behaviours brought about by these technologies is an unexpected obligation, but one made necessary by the fact that any research, project or development concerning digital technology now affects, as I said, the whole of society: education, health, politics – in short, our relationships and our institutions. However, thus far and, given the collective inertia, undoubtedly for some time to come, these human behaviours are moulded in and by the world forged by previous revolutions, those to do with spoken language, writing and printing. Even computers are opened like a book and their screens are still read line by line like a page! Consequently, the transitional period is accompanied by a change for which society is not always ready and which it sometimes resists. This changeover in phases causes crises.

This gives rise to the second issue concerning interdisciplinarity. While the only obstacle facing the first goal – to unite the hard sciences – may be the willingness of those participating in it, the goal of bringing together the hard and soft sciences is no easy task. And here’s why.

Once again, previous revolutions – those pertaining to writing and printing – have for so long and so profoundly sculpted, modelled and moulded our politics, our laws, our manners, ideas and relations – in short, our personal and social lives – that we are no longer aware of the profound effect imparted on us by the old models formed from speaking, writing
and printing. This effect is so profound that some among us believe that the state preceding our current state constitutes our ‘true nature’. Mentioned several times in the report, the multidisciplined combination of computational sciences with social and human knowledge is therefore facing a hurdle that is something other than a question of good will. Indeed, the latter describe the communities and individuals that currently make up our Western societies, or those of historical or even prehistoric communities. However, yet again, over the course of centuries and even millennia, these have all been extensively modelled and powerfully moulded either by the exclusively oral state or by the successive revolutions of writing and printing. The various networks of human relationships, the institutions of power, health, education and research, collective organisations and, even more so, the cognitive backdrop expressed by literature, the arts and the philosophies are closely dependent on these centuries-old and even millennia-old practices. Therefore, as precise and rigorous as they may be, the descriptions of these practices created by the human and social sciences depend on these same practices. The same applies to the methods that they use. Suddenly brought face to face with this new situation and using the tools provided by the previous state, their acceptance and understanding of it may not be optimal. How can these knowledges, being conditioned by these moulds, aid in creating an understanding of this new world and predicting the developments resulting from digital technology? Reflecting, therefore, the changeover in phases to which I referred beforehand, the interface between the hard and human disciplines is immediately in a crisis situation.

In other words, computer science is producing totally new networks of relationships and institutions in a nascent state, as well as atypical individuals and unusual communities. Like most scientific and technical research today, it also raises ethical questions concerning the privacy of individuals and the public life of communities. Only an accompanying overhaul of the human sciences would make them capable of understanding and describing these new phenomena, which throw up a combination of undeniable advantages and unanticipated risks. To benefit not only the future of the research that concerns Inria but also the future of our societies, perhaps it would be better if the architects of computer science trained their own researchers in social sciences and ethical issues, even if that meant remodelling them, rather than seeking out researchers from a different mould within these disciplines as they exist today.

So what would remodelling entail? For example, if the vast volume of global data concerning demography, transport, economics, agriculture, industry, finance and commerce, education and research, the health of populations and the state of the planet were to become accessible to as many people as possible – whereas in the past even the most powerful of tyrants or the most resourceful of legislators did not have access to this data –, such an event would be liable to put political institutions and the sciences that study them on a new path, perhaps more quickly than we expect. Expertise would suddenly shift from the top of a power pyramid or the analyses of a handful of experts to the near-entirety of individuals who were once subjects. This would overturn the fundamental, sequential form of society. What we would then have is a game in which computer science, taking the initiative and landing the first blows, would reshape the rules and the very form of the game board itself. Suddenly relieved by these mobilising innovations, the widespread socio-political inertia may vanish or fade away.

Nevertheless, I would couple this too dynamic and perhaps forced wager with one doubt: this collective inertia, this obstacle brought about by suspicion, the rejection of the new – in short, these conservative attitudes – are not always a negative factor, as they can serve as a reflexive buffer and a sapiential restraint device for decision-makers and even inventors.

However, I remain firm in my belief that the political future of our societies is too serious a matter to be left in the hands and up to the deliberations of politicians and the political sciences; and that their human and social fate is too serious a matter to be left to depend on today’s social and human sciences.
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Towards Inria 2020

One of our era’s leading observers gives his vision
Are we on the threshold of new human sciences?

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MISSION AND IDENTITY

Under its founding decree as a public science and technology institution jointly supervised by the French ministries for research and industry, Inria's missions are to produce outstanding research in the computing and mathematical fields of digital sciences (see "Digital sciences and computational sciences" inset) and to ensure the impact of this research on the economy and society in particular. Inria covers the entire spectrum of research at the heart of these fields of activity and works on digitally-related issues raised by other sciences and by actors in the economy and society at large.

The ways in which all human endeavours will be affected by society's "digital transformation" are still a long way from being understood and fully grasped. This transformation also concerns numerous actors outside the sphere of research. The fundamental role of digital research and Inria is to build knowledge and devise solutions and technologies for the digital society. As a result, Inria's added value lies in its ability to accentuate and accelerate the scientific, technological, economic and societal impacts of French academic research in the digital field by taking advantage of the unique collection of skills employed, its know-how and its international reputation to serve economic and social growth in France and Europe.
Inria’s strategy is based on:

- a scientific policy defined at a national level, based on strategic programming and the implementation of operational mechanisms to support research;
- a technology transfer policy serving the entire French research and innovation system;
- a policy of attractiveness, originality and cultivating talent, also based on the admission of staff on mobility assignments;
- a regional foothold at the heart of university centres and innovative economic and social ecosystems;
- european and international deployment that is capable of giving leverage to French actors;
- engagement in educational, scientific mediation and training structures.

A European and international actor, Inria is a national operator in research into digital sciences and is a primary point of contact for the French state on digital matters. It is a founding member of Allistene, the Digital Sciences and Technologies Alliance. The institute deploys its national policy through its research centres, positioning itself as an actor in and partner of the regional policies conducted by academic, economic and societal entities.

Beyond its structures, Inria’s identity and strength are forged by its ability to develop a culture of scientific innovation, to stimulate creativity in digital research by empowering itself to understand the environment in which we live, to predict the key trends that concern its fields of activity through extensive intelligence gathering and a decisively open attitude to the outside world, and to support research in which it believes, while proving capable of taking on the associated scientific risks.
SCIENTIFIC FORESIGHT
Algorithmic geometry: intersection of quadrics.
VEGAS team.
The world is now digital.

All human, economic, scientific and industrial activities now face challenges that are, to a greater or lesser extent, linked to scientific and technological progress in the computing and mathematical fields of digital sciences.

Of course, digital sciences have strong interactions with other disciplines, something that also contributes to their expansive and beneficial nature. It is common for advances in another scientific field to provide input for digital sciences, or for an application issue to give rise to a new fundamental problem that needs resolving.

Major challenges that the computing and mathematical fields of digital sciences will have to face are presented below through four key concepts: systems, data, uses and models. The advances resulting from work on these challenges will in turn influence numerous fields of application.

A few challenges seen as vital are then briefly examined. These stem from issues raised by society or other scientific disciplines. Digital sciences help us to grasp these issues, usually within the framework of multi-disciplinary approaches.
THE CHALLENGES FACING DIGITAL SCIENCES

Systems
Today, digital systems are comprised of hardware, software and networks containing billions of transistors, millions of lines of code and millions of connections, making them more complex than any other system designed by human. Constantly evolving, these systems will break major new ground in the coming years: firstly, through the emergence of computers «everywhere» around us, often imperceptibly and almost always connected via a network; and secondly, through the design of machines containing a huge number of processors. These ground-breaking developments will bring with them vast scientific and technological challenges.

We will continue to be surrounded by a growing number of computers in everyday situations (at home, in our cars, in cities, etc.). Before long, tens of billions of very different devices will be communicating. The management (in the broad sense, i.e. managing access to data, safety, performances, etc.) of billions of simultaneous communications poses considerable problems that extend far beyond what current management mechanisms can handle. One challenge is the ability to program these networks. This is linked to their shift into a virtual environment, enabling the deployment of virtual networks managed in an impenetrable and configurable way on a single physical infrastructure. The evolution of the Internet will also allow information to be taken into account in a more fundamental manner (Information Centric Networking) and will lead to the evolution (or overhaul) of its architecture. This will then be able to make the leap from the paradigm of searching for a machine to searching for information in the context of the semantic web, taking into consideration the very meaning of the information stored or transmitted.

In this context, networks of sensors embedded within objects or even people will be even more widely deployed. The most significant change lies in the uncertain nature of their organisation. Initially perfectly structured as part of networks, sensors are more and more disseminated in an unsupervised way. This means it is necessary to develop systems that dynamically adapt to these unstructured organisations and that, over time, will have to contend with extensions, as well as operational failures such as outages and faults.

What’s more, hardware will continue to evolve by incorporating an ever-larger number of both generic and specialised processors, and will result in exaflop \(^1\) machines, most likely around 2018. Consequently, support needs to be provided for three consecutive ground-breaking developments: the switch to multi-core systems, the diversification of specialised accelerators and, owing to integration density and the limitations imposed by energy constraints, the ability to adapt to processor errors.

The development of hardware that affords an ever-larger processing potential does not automatically lead to increase the performances. It is essential that questions be asked about the use of this hardware and therefore its programming. These technological developments are leading to the creation of new paradigms that enable adaptation to a comprehensive
tens of billions of devices will be communicating
range of available hardware: embedded systems, multi-core architectures and massively parallel or distributed machines. Factoring in the dynamic nature of new hardware is one of the key issues. Whether in a parallel machine, a cloud or a sensor network, the rise in the number of processing or acquisition units increases the likelihood of a set of components becoming unavailable during execution. As a result, it is vital that the management of this uncertainty be integrated into the software. This is leading to the creation of adapted languages and the development of compilation techniques that, in addition to uncertainties regarding component unavailability, take into account their distribution and potential responsIVENESS.

The ecological footprint is one major challenge shared by all of this hardware (Green IT). For example, it is essential to reach a compromise between performance and energy expenditure while at the same time controlling heat dissipation by diversifying the energies used and recovered.

The omnipresence of these digital systems in most human, professional and personal activities turns the central issues of the safety and security of these systems into critical factors. It is important to continue the efforts already undertaken in order to verify the correct functioning of a digital system by design. Programme proof and verification methods need to make the shift to certifications guaranteeing that software provides the services expected and defined by users, taking into account if necessary the ‘real time’ aspect of systems, particularly embedded systems. However, regardless of the progress achieved, it is not reasonable to assume that an end to errors, particularly human errors, is in sight. As such, it is imperative to continue working on improving the reliability of digital systems so as to ensure increased resilience against malfunctions. The notion of ‘adaptation’, both of software and hardware, to these failures is clearly emerging as an important direction in research.

Security by design must become a feature of systems in order to plan ahead for malicious acts, which are increasingly numerous, sophisticated and often carried out automatically. Special attention must be paid to digital risks, both in terms of their scientific analysis and within the framework of technology transfer and innovation initiatives.

Digital systems are often comprised of separate components assembled dynamically, and therefore form systems of systems. Because there is usually no overall design, achieving a comprehensive command of the interrelations between all of these structures remains a difficult problem. No firm plans are made for the consequences of cascading failures, and responses in the event of crises have trouble adapting.

Work must therefore be carried out on modelling and simulating these complex systems so that they can be better designed and understood. Risk prediction and management methods also need to be developed in order to contend with the inevitable residual errors.
Data

In systems comprised of hardware, the networks and systems mentioned in the previous section transmit huge volumes of data (big data) from many different sources: data resulting from calculations, captured by sensors or produced by human input. Storing, exchanging, organising, utilising and handling these data are all major challenges. Depending on its origin, data comes in a wide variety of structures, types and formats: it can be text, images, words, music, audio content or videos, as well as data with a specific structure (spreadsheets, lists, etc.). Finding the right balance between genericity and efficiency in order to handle large volumes of data remains a key challenge. Retrieving data from storage spaces or transfer flows often means reaching a compromise between processing speed and data relevance. A process of reflection regarding the criteria for measuring the quality of data, some of which may be uncertain or erroneous, is essential. Analysing this data is also a fundamental challenge.

The raw data that exists in the digital world needs to be distinguished from the information we extract from it and the knowledge that we can build from it. As such, the creation of a Data – Information – Knowledge processing chain is a central component of this issue, while the growing use of meta-data, if possible in connection with ontologies adapted to its semantics, is one of the factors in achieving success. Furthermore, approaches based on visual, audio, olfactory and tactile representations are major sources of improvement that allow us to better understand this information.

This body of data includes confidential information (about individuals, companies, organisations, etc.). The simultaneous growth in volumes of information and the interest that industries and governments are taking in utilising this information calls for greater vigilance and the introduction of principles and tools that guarantee respect for privacy, the right to oblivion and the protection of confidentiality. To establish this essential trust, it is important to combine various complementary approaches, ranging from the encryption of elementary data to the introduction of a genuine right to inventory and erase our personal information, and the design and adoption of safe protocols.

Most data, particularly personal data, is now stored in large data centres, most of which are run by a handful of major actors (central buying offices, search engines, social networks, etc.). As an alternative, parallel and distributed solutions are being developed, both for the storage and processing of this data. These solutions call for new paradigms and algorithms, both for search engines and social networks, while also raising new questions about heterogeneity and interoperability, as well as legislation and law.

The geopolitical nature of data

- Web 2.0 services are continually being developed. Search engines and community encyclopaedias have completely changed how we access knowledge. Social networks and blogs are revolutionising our interactions with the world and new systems are continually emerging, calling into question how we teach, for example, and ultimately our educational system.
- Most of these services are free to access. Their business model is based on the commercial value of the data provided by users, often without their knowledge. Concerns are arising regarding respect for individuals and their privacy. Today, this data is primarily being used to profile users in order to effectively target advertising. Tomorrow, the added value will come from a far more extensive and subtle spectrum of applications.
- Social data is now a resource for the digital society in the same way as raw materials are for traditional industry. Capturing social data is therefore a strategic issue for society, for the economy and also for security. The US is home to over two thirds of the web’s largest companies. Asia, particularly China, is very active, while Europe is still lagging behind. Nevertheless, succeeding in the information society is one of the major challenges for our continent’s economic growth.
Additionally, open data (and linked open data) initiatives that provide free access to data, particularly community data, are in turn set to become more commonplace and affect numerous facets of the digital world, notably by opening up new prospects for producing high value-added information through the integration of various sources of open data.

**Interaction and uses**

Originally restricted to computer science experts, digital systems have gradually become available to non-computing professionals, followed by the general public. Having been originally designed for computation only involving the entry of numerical values via a keyboard or a magnetic medium, these digital systems have become more diverse in nature and now offer a huge range of applications. This expansion has been accompanied by the emergence of new peripheral input devices such as the mouse and the joystick, and more recently by touchscreens popularised by Apple’s iPhone and accessories from the world of gaming, such as Sony’s Eye Toy and Microsoft’s Kinect.

Almost all of these applications require an explicit motor action by the user, for example to enter text onto a keyboard, interact vocally or to slide your finger on a screen. While maintaining and improving the robustness of this type of interaction, the coming years will see an increase in uses governed by implicit behaviour on the part of users: from applications involving the automatic recognition of individuals to systems that require the capture of user behaviour that is both external (physical movements) and internal (mental states).

Another key area of the development in uses involves the interconnection between digital systems, which enables data produced in one application to be reused in other software. Resulting from the professional world based on the concept of interoperability, this trend has gradually spread to the web and social networks, primarily for commercial ends. Indeed, people are now used to receiving offers that match their interests in a location-based application on their smartphone. This development will undoubtedly become further accentuated and will of course require deliberations and processes to ensure that these exchanges of information abide by the principles of privacy and confidentiality.

A third key component in the development of uses is a direct result of the emergence of distributed systems and mobile devices. Today, we are all used to reading our email on a variety of platforms and therefore in any environment: at home, at the office or on public transport. More and more software will be developed with usability on different devices in mind. From smartphones to tablets, desktop computers and the cloud, these multi-platform capabilities will need to be made ever-more transparent to the user.

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**Google TV provides a varied offering made up of programmes, games, applications for download, and access to social networks and YouTube videos. In 2012, an hour of video was uploaded to YouTube every second; in other words, one year of YouTube production corresponds in duration to 36 production cycles for a standard TV channel. Another finding is that in the space of five years, more videos have been uploaded to YouTube than the three leading US TV networks have produced in 60 years. As a result, the site has attracted over 1,000 billion views, an average of 140 per person.**

**These figures illustrate the change of scale in the current creation of digital content versus the production of ‘conventional’ content. This boom does not merely boil down to an increase; it also raises implementation problems that are entirely new (storage, online broadcasting for millions of users, searches for desired information, etc.) and of such complexity that only scientific advances can resolve them.**

**The television market is experiencing profound changes, with traditional players (TV channels) now being joined by digital giants via the Internet. While Apple (with the iTunes Store) is already the leader in the video-on-demand market and Amazon (with Netflix) is the leader in subscription TV, Google could revolutionise free TV with YouTube.**

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**A tidal wave of video data**

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This considerable increase in user number has resulted in a proliferation of various uses and requires the design of far more open Human-Computer Interaction (HCI). Particular attention needs to be paid to users' degree of specialisation, age, language, digital culture, and physical and mental capabilities (particularly disabilities). More generally, it is now important to consider users with unknown 'characteristics', which relates to the notion of uncertainty already addressed regarding systems and data. Acceptance by users, which is linked in particular to enjoyment of use, is now becoming an additional criterion that HCI needs to take into account, as well as the more traditional concepts of accuracy, ease of learning and ease of use. Studying this acceptance also involves multi-disciplinary research conducted together with experts in human and social sciences (ergonomics specialists, psychologists, sociologists, etc.).

From a more technical viewpoint, the coming years will see progress in interfaces, including mechanisms for capturing human activity that is both external (a movement or a position) and internal (a physiological state and in particular brain activity), and the creation of new metaphors that utilise these mechanisms. The goal will be, for example, to move beyond the current use of touchscreens, which is restricted to simple 2D tasks such as scrolling through contact lists or zooming in and out on a photo, and turn them into an interface for interacting with 3D spaces such as those in a game or an computer aided design application.

At the same time, new devices that produce a 'real' phenomenon such as a force or sensation will continue to gain ground in numerous fields of application. One global challenge will be to combine diverse modes of interaction (tactile, motion sensor, voice recognition) and presentation (relief image, spatialised sound, forces, vibrations) with the constraint of controlled cost. Video games and their expansion in the form of serious games will continue to act as a driving force in the development of these platforms, which will in all likelihood bring about changes in the very notion of human relationships, as social networks have already begun to do.

In this context, robotic systems are a key challenge in research and technologies. From advanced industrial robots to the automation of modes of transport (cars, trains, planes) and humanoid companions for games and support, developments in robotics are prompting research that combines advanced techniques in command perception and learning, reliability and the modelling of human behaviour, including for example the notion of curiosity. Robots are complex platforms that integrate research and technologies from a lot of areas of the digital world. They are also particularly valuable fields of investigation in terms of modeling and managing social behaviours with other robots or interacting with humans in individual or group situations.
Acroban humanoid robot, an experimental robot learning platform.

FLOWERS team.

3D mesh adapted to the airflow behind a supersonic aircraft.

GAMMA 3 team.
Models

The approach that researchers take to gain a greater understanding and move towards an effective digital resolution of major scientific and societal challenges draws on the virtuous triangle of ‘modelling – simulation – experimentation’. One central constraint is upscaling at every level, something that has become considerably more pronounced due to the dramatic increase in current computing resources and the quantity of experimental data available.

Models are mathematical or computer representations resulting from the abstraction, to a greater or lesser extent, of a given real or virtual situation. The models that are at the heart of the digital world can be continuous or discrete, deterministic, probabilistic or non-deterministic. Their digital simulation draws on other types of models, the most fundamental research objects in computer science: models of computation, from classic models based on the Von Neumann architecture to quantum computation and communication models, and biological, membrane and chemical models. Their study, extension and use within physical structures for the effective processing of information are at the heart of multiple and multi-disciplinary fields of research.

The increase in the physical complexity of the systems to be observed and understood, the combinatorial explosion in the computation costs linked with their full-scale simulation and the management of the data required for these simulations now requires a suitable hierarchical approach starting from the modelling stage. The naturally multi-physical and multi-scale nature of the phenomena studied makes this need even greater. As such, models will be designed to capture the right information at the right scale by breaking down the overall complex system studied into a judicious combination of simpler and/or smaller sub-systems for which appropriate and finely analysed modelling can be used. This model pairing approach will create a hybrid approach that enables varied combinations between discrete and continuous, deterministic and probabilistic, or stochastic and naturally multi-scale modelling. Aspects involving the optimisation and control of the dynamics of the phenomena being observed, as well as the sensitivity analysis and inverse problem resolution requirements, will of course be integrated into this approach. Another key factor will be the essential and complicated process of taking into account, from the modelling stage, the uncertain nature of very large volumes of data produced by experimental mechanisms.

This hierarchical approach to modelling will lead in a calculatory manner to the design and high-performance implementation – itself also hierarchical and even multi-resolution – of algorithms and digital simulation codes using an approach that judiciously combines code libraries. As such, the computer processing of large volumes of data constitutes a core research avenue. The physical structure, itself also hierarchical, of large computing platforms, peta/exaflop computers with different levels of parallelism and grids or clouds within a more distributed approach, will of course be beneficial for this global hierarchical approach.
The progress achieved in connection with the challenges presented in the previous section will usually have direct applications outside of our own sciences. To take just two examples, exaflop machines that are ‘easy’ to use will also be able to be employed both to make more accurate and longer-term weather forecasts and to handle new models from computational neurosciences. In addition, progress in the processing of large volumes of data, for example using statistical learning methods, will have consequences for the processing of information both from social networks and the fields of digital telescopes.

We are therefore now addressing key questions raised by other sciences and major fields of application, to which computer and mathematical sciences must contribute. The ever-more extensive use of models and the greater simulation opportunities have led most sciences to develop a digital dimension (see the ‘Digital sciences and computational sciences’ inset above), as well as greater interactions with computer and mathematical sciences, in order to serve the multi-disciplinary research now required for all scientific and technological fields.

### Health and well-being

Digital models have become crucial for life sciences: following a period of proliferation in very large volumes of raw data (genome, proteome, metabolome, etc.), this data now poses numerous challenges connected with its heterogeneity. This is because data that is multi-scale, both temporally and in its spatial representation (1D-3D, atom-cell-organism), needs to be integrated in order to study and model complex biological systems. Modelling the interactions between this data is also essential in order to be able to utilise it and better manage its future production. For example, we are now seeing a boom in data produced by so-called ‘next-generation’ sequencers (NGS). This raises difficult questions, both in terms of processing the volumes of data produced and developing relevant and customisable digital models.

In the field of health, the digital approach is complementing experimentation and shedding new light on the biological and biophysical mechanisms at play. The most important factor to mention is the contribution to the treatment of illnesses (cancer, cardiovascular disease, diabetes, etc.). This ranges from improvements in diagnosis, which is earlier and more accurate in particular due to advances in imaging, to the optimisation of surgical procedures (planning in virtual reality, assistance in the theatre in augmented reality, surgical robotics) and an improved understanding of how treatments work so as to minimise their side effects and personalise them in order to take individual variables into account.

Neurosciences and cognitive sciences have also forged closer ties with the digital world by developing models that show how areas of the human brain work. The objectives are, firstly, to better detect and treat certain illnesses (neurodegenerative diseases for example) and, secondly, to take greater consideration of the disabilities of patients with brain injuries, particularly following an accident (stroke, trauma). In return, this greater understanding should enable us to develop ‘better’ digital systems that are more suited to users’ cognitive capabilities.
Again in the field of health but on a global scale, it is also necessary to address the growing extent of pandemics within a context of greater human mobility. In this case, the digital stakes are high. Indeed, the aim is no longer to model a restricted biological or physical phenomenon but to integrate biological data (medical and veterinary data), geographical data (rain, hydrology) and economic data (the settlement and movement of populations) into global epidemiological models with the objective of predicting or at least detecting the appearance of fresh outbreaks, simulating their spread and assessing effective ways to curb them and limit their human but also economic consequences.

Taking disabilities into account, whether they be physical or mental, genetic or accidental, is a particularly important goal. In close collaboration with actors on the frontline (clinicians, families, associations) and by scrupulously abiding by the ethical principles of respect for privacy, the digital world can and must offer support (for mobility, changing position, engaging in activity) or simply facilitate digital accessibility.

In this general context, an emphasis needs to be placed on the extent of large-scale population ageing, currently in wealthy countries, that is now resulting in major societal problems (both in terms of comfort and cost). One important goal is to encourage home support for the elderly under the right conditions. In this area, but also as far as able-bodied individuals are concerned, the digital enhancement of physical and even mental capabilities will over the next decade raise scientific and ethical questions relating to human augmentation.

Energy and natural resources

Due to the finite nature of fossil fuel resources, restricting the production of greenhouse gases, the rise in the production of renewable energies and the issues of smart grids and nuclear power produced by fission or fusion are universal challenges.

In all of these contexts, the development of mathematical models, their effective simulation and the processing of data volumes, both at the input and output stages of these systems, are crucial.

We need to gain an understanding of how to produce and distribute the power necessary for human development: whether the goal is to control a wind turbine, optimise electricity production or devise new, more environmentally friendly combustibles or fuels, digital models play a major role. For example, this concerns the implementation of control and optimisation-related models for the production of biofuels, or digital models for controlled thermonuclear fusion that will enable tokamak implementation. New problems based on decentralised and ubiquitous electricity production, and the optimisation of electricity transmission and consumption have resulted in the concept of smart grids.

The digital domain is also raising its own questions linked to energy consumption. The energy costs of implementing digital systems such as data centres, peta- then exaflop computers and the billions of information acquisition and processing devices – from sensors and actuators to phones, tablets and PCs – is generating global electricity consumption that is currently close to that of the US. This means that these factors need to be taken into account in the design of machines, algorithms and programmes, as energy optimisation is becoming a critical criterion. In addition, work on the thermodynamics of computation and zero-energy computing is promising.

These elements are very often linked to models in the physical and chemical sciences, several aspects of which are worth mentioning: the recent possibility of describing phenomena using new formal languages, research into quantum information science and research into nanomaterials.
The environment and sustainable development

Preserving the environment is a fundamental challenge facing the whole of humanity. Digital sciences have a key role to play in this field, both in terms of understanding the changes under way and predicting their consequences. They can also help us to devise radically new scenarios, then (in a relatively new development) convince politicians and citizens of their relevance in order to foster their adoption. This highly cross-functional problem can be broken down into more specific questions about biodiversity, climate, natural and industrial hazards and sustainable food, among other examples.

Like any living organism, man forms part of a complex ecosystem that he alters through his activities (industrial or farming activities, for example). Studying the impact of our activities on the environment and biodiversity has become a major societal subject of our time. From a scientific viewpoint, the objective is to understand the relationships between biodiversity and the dynamic of ecosystems in order to predict their response to change, restore a viable state and, more generally, preserve their heritage value for future generations.

Research in this field is primarily multi-disciplinary and aims to develop predictive digital models on large scales of time and space that also (and this is one of the main difficulties) include highly varied levels of description, ranging from a molecule (genetic diversity) to populations (functional diversity).

The problem of climate change and, more generally, natural ‘unforeseeable events’ (floods, droughts, fires, earthquakes, etc.) is an old one. However, the impact of natural disasters on man has been exacerbated in modern times by urban and industrial expansion. Although natural hazard is, by definition, inevitable, it is important to try to reduce its random nature (predictions) and limit its consequences for individuals and their environment (risk management). This necessarily involves the development of predictive models and digital simulations on a geospheric scale (oceans, land, atmosphere) and a local scale (landslides, floods, complex geophysical flows) that usually require large computing resources.

The issue of the damage caused by human activities (pollution, industrial hazards), both from the viewpoint of their production and their impact on health, the environment and biodiversity in particular, remains a major concern far beyond industrialised countries alone. The fight against this damage is taking place both after it is caused (decontamination of soil and water, waste storage) and before (implementation of cleaner and less hazardous production processes or taking place at better controlled sites). The goal here is to model phenomena such as the spread of pollutants in the atmosphere (ozone, aerosols), water or soil, possibly combined with chemical or biochemical reactions.

Lastly, with the global population due to reach 9 billion by 2050, the global challenge of food production has major consequences for the environment. Indeed, one of the key issues is to feed the world’s population without exhausting natural resources and at the same time controlling the environmental impact. Once again, the digital domain has a central contribution to make. Examples include determining fishing quotas through optimal control approaches, modelling plant growth to optimise resources, using micro-algae to produce food proteins and controlling the spread of pests through biological pest control methods.
Anatomical model of the vascular network reconstructed from medical images. SHACRA team.

Urban pollution map: assimilation of NO2 concentration measurements into the ADMS Urban/Numtech model. CLUME team.
Society and education

The relatively recent development in which digital sciences have opened up to human and social sciences is liable to break major new ground. Historically, the collaboration was initiated with linguists concerning the automatic processing of languages and with archaeologists concerning 3D reconstructions of destroyed monuments. More recently, it has been engaged with economists, artists, etc. The new dynamic will now come from modelling the psychological and sociological aspects of living organisms, including of course human beings. These models will aim to adapt to individuals and take group behaviours into account. They will also enable us to improve our understanding, design, utilisation and control of social networks at levels of accuracy whose consequences, particularly in ethical terms, are extraordinary fields of multi-disciplinary research. Combining bio-inspired models, particularly from neurosciences, with psychological and sociological models is likely to result in realistic simulations of individual and group behaviours.

Legal, economic and political systems are vastly complex systems that human expertise is often no longer capable of controlling. Indeed, many actions in these domains cause effects that are difficult to predict, require knowledge of a large number of rules and often apply in numerous scenarios of a specific nature. Under such circumstances, even the very best experts have trouble predicting the exact effects of the measures or actions that an actor may undertake. These systems engage a multitude of actors and are often interconnected at a global level, albeit with significant differences from country to country. In this respect they share characteristics with digital systems. Although comprehensive modelling is still out of reach, partial modelling is becoming possible and should enable certain aspects of these domains to be studied. One example is studying the cohesion of different areas of law, which can be purely legislative or include a regulatory or even jurisprudence dimension. Another example is the study of fiscal or public intervention systems that are the most suitable for achieving objectives such as protecting jobs or industrial growth.

Elsewhere, the emergence of 3D printing – the creation of physical objects based on 3D models produced by computer-aided design (CAD) tools – will profoundly affect our societies. The production, logistics and distribution models of manufactured objects will be significantly altered and our relationship with objects will be permanently changed. The digital domain will be the cornerstone of this new type of production, from which it will probably adopt collaborative design models and licensing methods similar to those now common in the world of free software (the right to produce with or without modification an object based on its model).

Lastly, one key concern is for a major focus to be placed on education. Teaching methods and usages will radically change, bringing into play digital tools and approaches based on digital media that combine the real and the virtual, using digital lesson and communication materials, and drawing on techniques that digital research is continuing to enrich, such as social networks and simulations such as serious games. Research in this field will generate a radically new approach in the transmission of knowledge and skills. It will also enable detailed adaptation to the needs of society, businesses and of course individuals, their interests and their capabilities.
9 BILLION HUMANS IN 2050

How to Feed Them?

ENVIRONMENTAL IMPACT

FISHING QUOTAS

NATURAL RESOURCES

PREDICTIVE MODELS
INRIA’S STRATEGIC OBJECTIVES
Immersia: an immersive virtual reality platform. 
Visualisation of seismic waves. VR4i team.
As described in the first section, digital sciences face multiple challenges in a context of constant technological revolutions. These mainly concern computer and mathematical sciences, in interaction with other scientific disciplines. They also arise from weighty questions raised by society in all its forms, particularly its economic and organisational aspects. Lastly, they are central to the imperatives of competitiveness, continual adaptation, the 2.0 culture and the challenges of collaboration in order to achieve even better innovation.

This section states the institute’s strategic objectives: scientific objectives, technology transfer objectives, development objectives and objectives in European and international relations.
Inria's scientific strategy is built around two complementary dimensions, based on which the institute's contribution will be articulated:

- Digital sciences and technologies that serve individuals, society and knowledge.
- Priority scientific developments at the heart of our sciences.

The implementation of a foresight and strategy unit (see page 65) will facilitate the monitoring of developments in the topics addressed and their update on an annual basis.

The scientific strategy's positioning

Given the far-reaching and overarching transformation of our society, Inria's strategy is to develop research in computer and mathematical sciences that enables it to play a major role in resolving scientific, technology transfer and innovation challenges. As a national public institution, Inria's aim is to make the individual the central component of the impact of its research in order to, firstly, generate and support ground-breaking technological developments and, secondly, to resolve issues arising from domains that are critical for citizens - society, the economy, employment and the environment - while at the same time remaining particularly vigilant regarding ethical questions pertaining to research and the resulting usages.

In this context, the principles that guide Inria's efforts are as follows:

- Inria's activities must in their large majority contribute to at least one strategic objective and Inria must devote its resources to these activities as a priority.
- A significant proportion of Inria's activities must address scientific subjects that do not relate to current strategic objectives but whose originality and quality are deemed excellent.
- Experimentation and the development of platforms and services for the benefit of public research within an open societal framework and positioned at the top tier of international competition must receive additional resources.

The principles of scientific engagement

More than ever, it is essential for public research to factor in the major questions and problems raised by society and, in particular, its digital evolution. For example, it is necessary to explore the numerous overlaps of digital systems and in particular how they behave in the event of cascading failures, address issues related to data confidentiality and help to resolve issues raised by population ageing. The research to be undertaken stems directly from these issues, which are often scientific and technological challenges, as well as problems with major consequences: for example, digital risks and the spread of epidemics. Inria plans to make outstanding contributions to these issues in close collaboration with all of the concerned actors.

In addition, as a research institute, Inria also needs to act as its own source of questions and developments that break new ground. The institute
needs to play a lead role in undertaking research whose impact we do not initially know how to measure in terms of application or technology transfer, but that will be able to provide input for future innovations. It is a strategic concern to continue developing very high-quality fundamental research. This forms part of a desire to contribute to the advancement of knowledge in an original way and with the intention of creating genuine technological breakthroughs.

The role played by experiments and developments has become crucial in digital sciences. As in other sciences, the goal is to validate hypotheses and gain an understanding of the theories developed in practical settings. Experimentation and development are two fundamental components of the advancement of computer and mathematical sciences, in connection with technology transfer and innovation. Having been given strong impetus over the last five years, they will continue to be encouraged and structured. They will constitute a firmly identified part of our work.

Sciences that serve individuals, society and knowledge

As highlighted by the principles stated above, our research is directly (but not solely) stimulated by societal, economic and environmental contexts. The major areas of work in which Inria is involved consider the individual as a central element in digital problems.

— The human as such: health and well-being

The modelling of living organisms and its application to health have led to remarkable advances. The major challenge is now to integrate the various scales (spatial and temporal) of living organisms, from cells, organs and the individual through to populations and ecosystems. This requires the development of multi-scale and hybrid digital models (in the sense that they combine several formalisms) that can be configured by multiple data sources (genetic, metabolic, biomedical images, clinical, environmental). An unavoidable aspect of this configuration will be taking into account interindividual variability (‘personalised’ models), as well as uncertainties (pertaining to knowledge or measurements). Our digital contributions will have to encompass the major challenges in health (cancer, cardiovascular and neurodegenerative diseases, pandemics). This will need to happen in terms of developing tools to describe biological and physiological phenomena, diagnosis and prevention support tools (multimodal imaging) and treatment tools (pharmacological, surgical procedure support tools), as well as in terms of supporting re-education.
What's more, moving beyond the field of physiological modelling, the digital modelling of cognitive and psychological mechanisms constitutes a groundbreaking multi-disciplinary research field. Being particularly attentive to the underlying ethical issues, Inria will significantly develop its scientific partnerships on this subject with the human and social sciences. Combining physiological, psychological and sociological models (addressed in the following section) will generate a broad range of research questions whose resolution will enable a better understanding of the notion of well-being in particular.

Brought together, these elements will be capable of fostering the well-reasoned development of digitally enhanced natural entities, including adaptive and self-programmable pacemakers and devices to manage stress and well-being. Support for offsetting deficiencies resulting from age or illnesses will also be the subject of specific research.

Digital sciences and technologies also have a role to play in supporting healthy individuals to prevent or delay the appearance of illnesses or disabilities. This is the focus of fitness and well-being preservation efforts linked to the monitoring of activities (sporting for example), advice or recommendation schemes (related to food for example) or preventive alerts (if certain indicators are non-compliant).

— The human and its environments: from the individual to society and from habitats to the planet

The challenges posed by the relationships between human beings and their environments are all around us. The goal will be to address the problem of cyber-physical and cyber-social systems, such as transport systems and security systems or issues related to habitats and smart cities. This will encompass both their consumption and energy production, as well as their social organisation and their advanced adaptation to the needs of individuals and organisations.

Inria's focus will be on issues relating to human beings' impact on the planet, in its climate and environmental aspects, and once again the institute will collaborate with scientists from the appropriate fields.

Lastly, special attention will be paid to social aspects. The phenomenon of social networks will continue to expand and become further refined. The consequences could be particularly far-reaching for the evolution of our societies, including economic applications such as virtual currencies and political consequences for the organisation and sovereignty of states. The study of social networks and their utilisation will draw on far more advanced psychological and sociological modelling, as well as on computer and mathematical models (graph theory, stochastic models of large groups of individuals, etc.) that already exist, need to be adapted or are yet to be devised.

— The human and knowledge: emergence, mediation and education

The very development of knowledge is becoming digital. In particular, extracting relevant information from the vast volumes of available data is a fundamental scientific issue that requires responses. Connected with very high-performance computing, this work clearly lies beyond our current scope of knowledge.

Training, technology transfer and the dissemination of knowledge and know-how have formed part of Inria's missions since its creation. The digital revolution is drastically changing these elements. We are seeing significant changes in how knowledge and learning is conveyed, assimilated and appropriated: Wikipedia and globalised teaching trials (MIT, Berkeley, Stanford, etc.) are the first examples of this. Inria will play a lead role in computer science education initiatives and in the mediation of digital sciences, and will ensure to be associated in research into these fields.
Priority research within our sciences

— Computing the future: models, software and digital systems

Achieving a comprehensive command of digital systems whose complexity and interdependence is continually growing requires the design of informatic and mathematical models, software and processors capable of executing the computations. One of the key advantages of their implementation is that it enables us to better understand and plan. It also generates the following challenges:

The challenge of multi-scale modelling integrating uncertainties

Inria is involved in extensive explorations at all levels of the simulation process. Indeed, due to the very significant increase in the size of problems, it is generally not known how to perform a complete calculation with sufficient accuracy in order to observe phenomena across entire sets of data. A multi-scale approach including a hierarchical methodology that accurately simulates ‘where needed’ and modelling that is judiciously adapted to each level of the scale (of time and/or space) is a major challenge for the success of future large simulations. This modelling therefore needs to be of different types (discrete or continuous, deterministic or stochastic), and the relevance of the data necessary at each scale will also be a critical point. The ability to accurately interpret the dynamics of simulated systems and to eventually enable their control necessarily requires extensive integration of the consideration of uncertainties from the modelling stage. Indeed, these are omnipresent, both in relation to data, computations themselves and communications.

The design of these kinds of hierarchical, hybrid and multi-scale models that integrate the consideration of uncertainties, of course together with the design of the associated algorithms and software, is crucial for the various scientific challenges studied at the institute, whether they are of a strictly scientific nature or a societal nature. It is worth noting that this hierarchical approach to modelling and creating algorithms and codes will of course be able to take advantage of the hierarchical structure of the hardware systems on which these simulations will be performed.

Work on uncertainties is decisive, from the characterisation of uncertainties (measurement, transmission, processing, human, etc.) to their integration into the very design of models, systems and languages. Another source of uncertainty is linked to the accuracy of calculations; this could lead our research to take into account the ability of certain processors to perform more accurate calculations if they are provided with more power.

Meanwhile and in a way that complements description models, new models and computation procedures (probabilistic, quantum, biological and chemical to name only the main examples) are being developed. Their scientific and technical impact is difficult to assess at present. However, they are providing important alternative insights that Inria intends to support in their phase of emergence, study and implementation.

The challenge of very large digital, embedded and buried systems, and of systems of systems

Very large socio-technological systems primarily draw on digital sciences and technologies and are characterised by extensive and often real-time interactions with physical systems. From electrical network systems on the scale of a country or a continent to telephone networks, the global air traffic control system and, on a smaller scale, systems for
managing a city, a building or a home, all of these systems are often critical, particularly complex, politically sensitive and raise technical questions ranging from embedded systems to systems of systems. Their connection with a growing number of embedded and buried systems will become even more pronounced.

As with architectures, it has become essential to consider the applications from the design phase of these systems and this is one of the reasons why we are in a position to influence this large-scale deployment. Consequently, consideration needs to be given to the vast complexity of these systems, the interaction with asynchronous, dynamic and distributed environments, communications in sensor networks for example, the merger of often heterogeneous data, energy constraints, the composition of services and the requirement of critical safety.

The interconnection of most digital systems is in itself an additional cause of major problems if failures accumulate. It is therefore fundamental to take these sequences into account from their design phase. Action can be taken at two levels: either directly in a digital system specialised in a sector of activity (medicine, energy, etc.) or as specialists in modelling, analysis and simulation by considering all systems generically.

Regardless of the quality of the results observed when designing new digital systems, it is essential to develop risk prevention and management methods for existing digital systems. This approach cannot be exclusively restricted to researchers in digital sciences and technologies. Our objective will therefore be to establish close relationships with human and social sciences (sociology, economics, law, etc.) in order to carry out this work.

The challenge of programming very large software systems while taking into account the imperatives of reliability, safety and security

The institute has very extensive experience in developing software, which is a key part of its history. Together with implications in the design of new architectures, Inria will contribute to the development of programming models that make the best use of new processing capabilities, whether for networks, supercomputing, multi-core architectures or embedded systems. Taking into account the properties of programmes by design, such as correction, dependability, reliability, confidentiality and energy efficiency, in contexts that involve massively distributed and uncertain systems will be a central theme of our research.

The proliferation of basic components in large digital systems poses the key problem of fault-tolerant design. Whether in terms of algorithm design or the creation of programming environments, it will be necessary to integrate the ability to take failures into consideration in largely distributed and uncertain environments. Programming the billions of processors installed in all of the objects around us, a process that needs to factor in very inexpensive but unsafe devices that need to run weak encryption algorithms for example, is a challenge that the designers of programming environments need to address. Meanwhile, concerning large simulations, Inria's teams will intensify their work both on runtime state backup protocols, by limiting as much as possible the cost overrun of such an operation, and at an algorithmic level, where the goal will be for example to devise algorithms that are «naturally» tolerant to faults as soon it is possible to detect them.

The growing use of digital systems has been accompanied by a greater awareness of the importance of design errors and their sometimes dramatic consequences. Embedded or buried systems create a particularly complex framework, as this is often difficult and sometimes impossible to dynamically reconfigure following a software failure during execution. It is therefore fundamental to continue developing approaches that enable these errors to be minimised by making the shift from verification and proof to certification.
Manipulation of 3D objects for elementary assembly.

MINT team.

Cybus, a smart vehicle.

IMARA team.
Overall, Inria will combine research into security and safety, as digital systems are now subject to attacks that encompass issues ranging from individual privacy to the sovereignty of states and even the very stability of global systems such as the financial system.

— Mastering complexity: data, networks and flows

> The challenge of transforming the tidal wave of data into trustworthy knowledge libraries

The vast quantity of data currently in existence requires the design of comprehensive approaches in the hope of being able to capture, share, retrieve and utilise this data. In particular, methods that convert data into structured and integrated information, then into knowledge, are a central component of this priority. In order to convert data, it first of all needs to be understood. Three complementary approaches are proving promising: the use of meta-data in order to extract its semantics, for example in connection with ontologies, the visualisation of data and the large-scale training of models, for example virtual models, based on large volumes of online data. In addition, the uncertainty or inaccuracy of data cannot simply be ignored. On the contrary, this must be integrated into the various data management stages through staggered, probabilistic and bounding approaches, among others. The large-scale and continual integration of heterogeneous data, with diverse semantics, also requires new automatic classification techniques. Lastly, the social relationships between users must be able to be advantageously utilised in order to improve the quality of searches, notably through recommendation techniques.

Of course, the utilisation of personal data must take place within the framework of respect for fundamental rights, particularly the right to privacy. Privacy protection is an element that needs to be integrated from the design phase of a system by applying the principle of privacy by design. Several approaches will need to be pursued at the same time: the design of techniques that respect the private nature of data (encryption, security protocols), the proposal of alternative models as an alternative to centralised data centres – notably distributed architectures that by nature ensure the decentralisation of data control –, and lastly the definition of techniques to monitor and ensure the accountability of data collectors. How can we ensure that these new architectures come into widespread use? How can all of the interested parties be convinced that they are preferable? These are all challenges facing Inria, which in collaboration with all disciplines and all of the stakeholders concerned will need to contribute to the development of systems (social networks, clouds, etc.) that abide by these principles.

> The challenge of a generalised and safe cyber communication that respects privacy

Networks are at the heart of digital systems. By 2020, several tens of billions of objects will be communicating with each other via wired or wireless networks, creating the need for a major evolution in networks at both a hardware and software level. Firstly, the possibility of programming network elements through open interfaces will enable the testing and rapid deployment of new protocols and services, while also providing a release from the constraints of equipment suppliers’ proprietary characteristics. Secondly, the popularisation of data storage in the network and the design of new content-oriented routing and transmission control algorithms will make access to data and services transparent for mobile users. Breaking free from the fixed location of data while at the same time ensuring interoperability between services established on different heterogeneous platforms will pose a major challenge. The challenge of the observability of networks and in particular the Internet, one of the most complex systems developed
The development of computer technology in fields such as health, energy, transportation and domestic life is a source of progress. However, the dissemination of this technology can have adverse effects on society, particularly when privacy protection and security are not ensured. Indeed, the Internet and embedded systems can enable users to be tracked, monitored and profiled. Security flaws in communication networks and the systems deployed in cars, medical implants and smart grids can be exploited for malicious purposes. Information about information flows is creating a body of data that needs to be protected in the same way as personal data. It is necessary to ensure the confidentiality of all of this data, while also devising and developing new architectures to distribute data. Control over data needs to be returned to users and transparency needs to be enhanced. Citizens need to be aware of the data that is collected, as well as how it is handled. The role of a public computer science research institution such as Inria is to devise and develop systems that factor in the security and privacy for citizens. It is also to monitor developments and alert society in the event of abuses or hazards.

--- Interacting with the real and digital worlds: interaction, uses and learning

> The challenge of unsupervised learning

The problems addressed by the digital world are, like the ‘real world’, particularly complex. It will become increasingly necessary to use automated mechanisms in which a machine will be able to resolve problems beyond the reach of humans. The main idea is to enable a software system to adapt to its context based on past experiences. Machine learning techniques, particularly statistical techniques used to address the uncertainties often encountered in digital systems, are one of the illustrations of this principle, which needs to be improved and expanded.
Recent research efforts have enabled so-called ‘supervised’ machine learning to achieve progress in numerous scientific disciplines, notably in engineering sciences and life sciences. However, the supervised framework only applies in situations in which a machine has been exposed to a sufficient number of examples of correct behavior or correct predictions. Indeed, in most upcoming applications, enormous sets of data will be available and the interesting information will usually be hidden, while few or perhaps no examples of supervision will be available. This is one of the major challenges facing big data. In this unsupervised framework, a large quantity of data is observed by a machine and the learning algorithms have to find the potentially interesting tasks ‘on their own’. They need to establish compact internal representations (such as creating a dictionary of ‘standard profiles’ in approaches based on matrix factorisation) that then enable either a machine to complete a specific task once a small number of examples has been obtained, or a human to interpret and utilise this large database that was previously too complex.

The difficulties and challenges of unsupervised learning lie in the extreme heterogeneity of data, its massive and often incomplete nature and the necessary interaction with humans. The goal is to achieve large-scale ‘semi-supervised’ learning that is capable of making maximum use of both the large sets of available data and human expertise. Of the various existing algorithmic frameworks, techniques based on convex optimisation should enable the prerequisites of robustness and upscaling to be met. In addition, in order to achieve the practical performances and theoretical guarantees expected, it will be necessary to take into account *a priori* knowledge, particularly with the aid of detailed probabilistic and statistical modelling of the structure of the processes involved.

Inria will therefore continue and magnify its efforts to develop, analyse and understand these statistical learning tools.

*The challenge* of transparent interaction between people and their digital environment

As the digital world expands, users must no longer be treated as an afterthought, but placed at the center of the design process. Irrespective their technical merits, interactive systems must be both accessible and usable. They must be adapted to their contexts of use so as to best exploit the complementary capabilities of people and computers. Inria’s research in this domain includes the design of novel *interfaces*, i.e. hardware and software that facilitate the exchange of information between user and computer, and the study of *interaction*, i.e. to observe, describe, evaluate and explain this phenomenon. The goal is to understand interaction and to improve interfaces by providing the knowledge, methods and tools necessary to expand the wealth of interaction techniques and to permit designers of such systems to make informed choices.

Two visions of computer have long been in opposition: either as an intelligent partner or as a tool that empowers the user. These perspectives are becoming intertwined, creating hybrid systems that, for example, delegate operational and repetitive tasks while freeing people to engage in more creative activities. To move to this next level, whether in terms of supervising delegated tasks or controlling others, interaction must become more transparent. Not in a literal sense, since the goal is not to eliminate interfaces, but figuratively: physical and mental effort must be reduced to let users concentrate on what they want to do rather than how to do it.

User interface research must enhance, diversify and adapt the users’ methods of interaction. For example, research is necessary to improve the robustness and efficiency of the interpretation of the user’s behavior and environment through the analysis of visual or physiological data. Other research should explore new concepts for hardware devices, using prototyping tools such as 3d printers and programmable micro-
controllers, and adapt existing interfaces to address the needs of the handicapped. Research should also improve system feedback, particularly in the context of implicit interaction, for example by exploiting audio and haptic modalities.

We must create novel interaction techniques that integrate new forms of input and feedback to address emerging user needs. For example, although mobile devices offer rapid, simple access for consuming information, they cannot compete with desktop systems when creating or manipulating complex data. Research must also facilitate the coordinated use of fixed and mobile devices by individuals and groups. Based on these needs, we must develop new interaction vocabularies and metaphors that reduce cognitive load. When taking the computer-as-tool perspective, interaction research should focus on the strong coupling between perception and action in order to support embodiment and ‘enaction’. When taking the computer-as-partner perspective, research should address error handling and ambiguity in order to enable use in the real world.

Robotic mechanisms are sophisticated digital systems that integrate sensors, actuators and software. They are used in particular to design personal assistance mechanisms and are based on the integration of advanced forms of learning and reasoning that often take their inspiration from human mechanisms.
Inria as part of a French system in the midst of change

Over the last decade, the French research and innovation system has experienced major changes in all of the structures dedicated to industry partnerships and technology transfer, particularly in connection with the Future Investments Programme (2010—2012).

As such, Inria has made a deliberate effort to engage in the competitiveness clusters drive and has also helped to strengthen the connections between clusters in the digital sector by spearheading common actions. Inria has advanced its involvement in clusters by making it a priority to identify innovative SMEs/MSBs that are capable of becoming its technology transfer partners, as illustrated by the signature of a strategic agreement with OSEO in 2010.

The policy of pooled technology transfer between the various actors in public research, which began at university centres starting in 2006, needs to be strengthened through SATTs (Technology Transfer Acceleration Companies) at a regional level or through CVTs (Thematic Development Consortiums) at a national/thematic level. The aim of these tools is to create a structure for the technology transfer landscape in the coming decade, irrespective of possible changes to their status. Inria has positioned itself as a national actor in technology transfer in the field of software by devising and spearheading the digital CVT project CVSTENE as part of a consortium with other actors from the Allistene Alliance. Over the 2012—2021 period, CVSTENE aims to pool numerous actions at a national level and provide regional technology transfer actors with expertise dedicated to software.

At a European level, Inria is playing a lead role in the construction of the Knowledge and Innovation Community (KIC) EIT ICT Labs, the ambition of which is to ‘move beyond R&D’ and create for Europe a structure dedicated to technology transfer and innovation in the digital field, even though implementing a tool that stands apart from the R&D financing rationale is a challenge.

The landscape in partner research between public research actors and private research actors has also undergone far-reaching changes. The certification of the Institut Carnot Inria in 2011 (for the 2011—2015 period) firmly established the priority placed by the institute on bilateral partnerships with industry actors. At the same time, Inria’s involvement in the conception of two Technology Research Institutes, BCom (Rennes, Bretagne) and SystemX (Saclay), as well as an Institute of Excellence on Carbon-Free Energies (IEED Green Stars), illustrates Inria’s aim to establish itself as a key actor in industry partnerships in the field of public research.

A policy of industry and, in particular, technology transfer partnerships is a long-term policy primarily based on appropriate structures. Inria will implement all of these structures, will develop them and will optimise them in accordance with the results obtained.
Industry partnerships

In the field of industry partnerships, Inria will place a priority on bilateral strategic partnerships with the R&D departments of large groups that have an existing French R&D base or want to expand. These strategic partnerships, founded on strong engagement by both partners, the mobilisation of resources, the definition of a joint multi-year roadmap and perhaps the involvement of a significant number of teams, are essential in order to support the institute’s positioning on research subjects that have been identified as strategic by industry leaders and provide a project frequency that would not be available to the institute on its own.

In similar fashion to the commitments of the Institut Carnot Inria, technology transfer-based research partnerships with French SMEs also of course remain a strong priority (see following section), as research and maturation are usually essential steps in a successful technology transfer.

In addition to these priorities, Inria will study the appropriateness and feasibility of a proactive programme for showcasing mature technologies and establishing strategic or periodic bilateral collaboration with a view to knowledge transfer. This will be primarily aimed at large European groups or groups with a strong European presence, as well as SMEs chosen for their abilities to showcase our skills. This programme will position Inria in the face of growing globalisation among large groups, the trend involving the relocation of certain R&D centres and competition between research institutes in their open innovation initiatives.

Technology transfer

As a continuation of the establishment’s long-standing policy, the institute reiterates its role as a national actor in technology transfer in the digital field, and as a leader in technology transfer structures for its own benefit and that of the entire national research and innovation system.

The launch of funds dedicated to venture capital (I Source), then pre-seeding (IT2I) through IT Translation, in order to support technology transfer through business formation, and the conception and leadership of a Thematic Development Consortium dedicated to the digital domain (CVSTENE) are illustrations of this positioning.

Inria’s priority for technology transfer resulting from its teams is placed on innovative SMEs in the software sector. This strategic priority is accompanied by support for structures appropriate for software SMEs (the Software Ambition programme led by Inria together with CNRS, OSEO, CDC Entreprise, the French Association of Software Vendors (AFDEL), the Syntec Federation and the Richelieu Committee, bringing together competitiveness clusters from the field) and involvement in innovation financing tools (I Source, IT2/IT2I).
Modeling sports motions: handball. BUNRAKU team.

Musical information: rehearsal of a musician-computer concert (using Antescofo software). MUSYNC team.
TECHNOLOGICAL DEVELOPMENT AND EXPERIMENTATION STRATEGY

Technological software has a dual role at Inria: it can be the object of a team’s research or a means to validate their scientific results. To this end, Inria has set up Technological Development and Experimentation Departments (SED) in each of its research centres and a national department, whose mission is twofold: to increase the impact of the institute’s technological development and to improve the quality of Inria’s software. Research platforms are playing an increasingly important role in digital sciences, from conducting large-scale experiments, e.g. observation of the Internet, to new interaction models, coming from the virtual and augmented reality domain. For these platforms, Inria will not only participate in the scientific and technological, but also in their governance, management and hosting. Inria’s approach would have these instruments made available to research communities at large, or even to businesses.

Inria’s technological development policy provides a basis for tackling the scientific challenges outlined in this strategic plan. Each of Inria’s technological development actions is assessed according to three criteria: creativity (novelty, originality), value (scientific, use, economic, societal) and ecosystem potential (acceptance by targeted users, companies, marketplaces, etc.). By fostering even greater involvement by engineers from the experimentation and development departments than is the case at present, major developments on a limited number of subjects will need to be made a priority with the aim of implementing effective software integration platforms that bring together software components supporting a large base of research work. This will guarantee the interoperability of codes so as to enrich the possibilities of scientific experimentation and technology transfer, factorise codes in order to increase their robustness and ensure that developments have the required longevity.

The ecosystem potential will be gauged and accompanied by the creation and animation of a community, particularly for free-software actions. The objective is to bring together various actors (developers, users, contributors) to have an efficient, sustainable, software development project. This approach complements Inria activities around free software: the organisation of the FOSSa conference, each year reuniting academics, industrials and deciders, activities organized by IRILL (Initiative for Research and Innovation in Free Software) and the BoostYourCode competition, offering the winning young graduate an opportunity to work on his open source project at Inria.

A technology watch will be organized around major scientific themes, including: computing resources and execution platforms, big data management and visualisation, Internet and security, augmented and virtual reality, and middleware and operability, in addition to development methods and code analysis.

Actions to raise awareness among all technology development actors – researchers, PhD students, post-doctoral researchers and engineers – will take on another dimension through the introduction of a software development school that brings together training resources inter-
nally and externally) and implements both a multi-year strategy and modes of functioning that are capable of fostering rapid adaptation to requirements. One of the key achievements of this will be to maintain and enrich a high-quality development environment and to offer common tools in a pooled manner, potentially with the Allistene Alliance partners.

**Europe: a strategic priority for Inria**

Inria plans to give fresh impetus to its European engagement by establishing special relationships with major actors in order to better coordinate and increase the impact of national and European research programmes. As such, the institute will strengthen its policy of implementing targeted partnerships in liaison with its major «academic» partners such as the CWI in the Netherlands, the MPI and Fraunhofer Gesellschaft in Germany. Special relationships and interconnected dialogue on policy will be developed on a handful of priority thematic fields that are home to a large number of economic and sovereignty challenges and that are liable to make an even more visible contribution to the recognition of a digital priority in Europe.

Inria will make a firm commitment to Horizon 2020, a next framework programme for the 2014-2020 period, with which the institute’s strategic stance is aligned. The aim will be to combine scientific excellence with a more focused consideration of major European and global societal challenges to which Inria can make a key contribution. The institute will be strongly engaged in programmes aimed at fostering the emergence of research problems or groundbreaking technologies (European Research Council, Future and Emerging Technologies, in particular the FET Flagship initiatives) and in themes where a European dimension is pertinent (high performance computing, initiatives connected with exascale computing, etc.).

Inria also intends to play a lead role in issues related to technology transfer and innovation by actively participating in the Horizon 2020 programmes in order to expand its field of action to a European scale, particularly as part of the Knowledge and Innovation Community EIT ICT Labs. At the same time, specific bilateral actions will be put in place to structure the institute’s relationships with major European industry actors in our fields.

**Societal challenges in the European Union’s Horizon 2020 programme**

- It is estimated that around 30% of the resources devoted to information and communication technologies in Horizon 2020 will need to respond to the societal challenges (health, demographic changes and well-being; secure, clean and efficient energy; smart, green and integrated transport; climate action, resource efficiency and raw materials; inclusive, innovative and secure societies).

**European initiatives and networks**

- Inria is currently involved in numerous initiatives and networks that contribute to strategic deliberations in Europe: European Technology Platforms, EIT ICT Labs Science Europe, Informatics Europe, ERCIM, etc. The roles and objectives of these structures are sometimes complementary and sometimes overlapping. Assessment is required and choices will have to be made after examining their impact on the institute’s policy.
The international scene: strengthening the impact of our collaborations

At an international level, Inria is attentive to the context of diversification in collaborations between the developed and developing countries, which are generating new flows of skill circulation and new centres of attraction. It will remain receptive to opportunities that enable direct special relationships to be built with major international actors in the digital field, and will preserve its ability to adapt to an external scientific context that is evolving very rapidly.

The institute’s objective is to strengthen its impact by joining forces with the best partners so as to jointly address scientific challenges or global problems.

This objective will be achieved by supporting in priority strong and balanced partnerships, in a small number of countries, and by leveraging on increased exchanges of researchers through Inria’s various mobility programmes (associate teams, sabbatical stays, exploratory visits, exchanges of interns, PhD students, post-doctoral researchers and guest researchers).

Whenever possible, French and European partners will be associated, as it is pertinent to rely on Europe in order to emphasize the institute’s alliance, visibility and attractiveness policy.

Nevertheless, international relationships can only be developed if certain essential conditions are met: open borders enabling academic exchanges and mobility; budgetary and political support from France and Europe; collaborative research structures; and trust between scientists, ethics and respect for intellectual property.

The main themes are recognised challenges in industrialised countries such as the US, Canada and Japan: it is advantageous to work with them to address, for example, data processing and large-scale computations, neurosciences and augmented human, climate change, etc.

Countries whose economy has emerged more recently have also identified priorities in which they are prepared to invest and which offer opportunities for the balanced sharing of skills and resources. For example, this is the case with India (innovations for the masses), China (health and ageing, digital cities), Brazil (environmental resources), Chile (the development of e-technologies) and African countries (smart and energy-efficient networks, epidemiology).
Inria’s eight research centres (Bordeaux –Sud-Ouest, Grenoble – Rhône Alpes, Lille – Nord Europe, Nancy – Grand Est, Paris – Rocquencourt, Rennes – Bretagne Atlantique, Saclay – Île-de-France, Sophia Antipolis – Méditerranée) are key components of the institute’s organisational structure.

Inria’s ambition is for each centre to act as a catalyst within its higher education, research and innovation ecosystem, notably by enabling it to benefit from the institute’s national overview. The centres therefore need to be placed at the heart of these ecosystems and help them to secure progress in digital sciences, while aiming to accentuate their scientific, economic and societal impact. The added value of an Inria centre also takes shape through a proactive policy of partnerships with all actors - from the academic world, industry and regional authorities - in its ecosystem. As such, the positioning of the Inria centre directors, who are members of the institute’s management committee and benefit from a large delegation of the Chairman and CEO of Inria, is an important factor in the ability of centres to develop strong and lasting partnerships at an outstanding level.

Each Inria centre champions research themes in which it has reached high-quality critical mass. The policy adopted by the institute over many years naturally means that these favoured thematic fields result from a combination of the institute’s main strategic scientific orientations and the dominant themes of the sites and the regions in which a centre is established. As such, these main research themes are set to evolve slowly over the course of years.

In addition, each centre regularly defines scientific priorities on which it aims to place a special focus. These priorities may be diverse in nature, may be purely internal to the centre or involve partnerships, can be connected with computer and mathematical sciences, or may involve a multi-disciplinary aspect. They can involve research, development or technology transfer actions. It is understood that these priorities may only concern part of a centre’s numerous scientific activities. Inria and its centres must continue to demonstrate the ability to take full advantage of unexpected scientific opportunities, for example those provided by the recruitment of talented researchers, particularly in innovative subjects.
Inria Bordeaux – Sud-Ouest

The Inria Bordeaux – Sud-Ouest Research Centre was created in 2008 and is located in Talence and in Pau. In 2012, 320 people worked at the centre (including 270 scientists), 180 people were paid by Inria (including 130 scientists) and 21 project-teams were run there. • The centre’s academic partners are the CNRS, Université Bordeaux 1, Université Bordeaux-Segalen, the Polytechnic Institute of Bordeaux, Université de Pau et Pays de l’Adour, ENSTA-ParisTech, the Institut d’Optique Graduate School and the Institute for Neurodegenerative Diseases. • The centre works in close collaboration with the competitiveness clusters Aerospace Valley, Avenia (Ecotechnologies–Energie) and Route des Lasers. • Its main industry partners include Total, Thales, Rhodia, Sagem, Snecma, EDF, Airbus, France Télécom, Valeo, Immersion.

Main research topics
• Modelling / Computer simulation / HPC.
• Health and life sciences.
• Interaction and adaptation to the human and physical environment.

Scientific priorities
• Supercomputing on new architectures
  - upscaling and factoring in uncertainties for a robust design.
• Modelling and simulation for health: oncology, cardiology, etc.
• Adaptive systems: interaction between the real world and digital world, personal assistance, data acquisition and visualisation, etc.

Inria Grenoble Rhône-Alpes

The Inria Grenoble Rhône-Alpes Research Centre was created in 1992 and is located in Grenoble and Lyon. In 2012, 640 people worked at the centre (including 555 scientists), 350 people were paid by Inria (including 270 scientists) and 35 project-teams were run there. • The centre’s academic partners are the CNRS, Université Joseph Fourier Grenoble-I, Grenoble-INP, ENS Lyon, Université Claude Bernard Lyon-I and INSA Lyon. • The centre works in close collaboration with the competitiveness clusters Minalogic and Imaginove, and is a member of the clusters Lyon-Biopôle and Tennerdis and of the technology research institutes Bioaster in Lyon and Nanoelec in Grenoble. • Its main industry partners include ST Microelectronics, Samsung, Toyota, Thalès, Microsoft, FT R&D, Alcatel-Lucent, L’Oréal, Schneider Electric, EDF, Xerox, Staubli, Expway and Edengames.

Main research topics
• Distributed systems and mobile networks.
• Reliable software and embedded systems for ambient computing.
• Modelling and simulation of multi-scale and multi-component phenomena.
• Perception and interaction with the real and virtual worlds.

Scientific priorities
• Robots sharing our living and working spaces.
• The Internet of things and the Internet of data: digital society.
• Modelling interactions in biology.
• Forms, appearances and movements for virtual worlds.
• Hardware – software interface.
• Learning and distributed optimisation for large-scale systems.
The Inria research centre in Lille was created in 2008 and is located in Lille and Amsterdam. In 2012, 305 people worked at the centre (including 265 scientists), 155 people were paid by Inria (including 115 scientists) and 12 project-teams were run there. • The centre’s academic partners are the CWI, Université Lille1, Université Lille 2, Université Lille 3, Ecole Centrale Lille and CNRS. • The centre works in close collaboration with the competitiveness clusters Picom (retail industries) and MAUD (materials) as well as the clusters of excellence Pôle Ubiquitaire/EuraTechnologies and Pôle Images. • Its main industry partners are Auchan, Alcatel Lucent, Etinéo, Atos Worldline France Telecom, Idées-3COM, Oxylane, SAP and Thalès.

Main research topics
• Data Intelligence.
• Adaptive software systems.

Scientific priorities
• The Internet of data and the Internet of things.
• Software engineering for everlasting systems.
• Patient specific model.
• Perception-action coupling for human-computer interaction.

The Inria Nancy - Grand Est Research Centre was created in 1986 and is located in Nancy, Strasbourg, Metz, Besançon and Saarbrücken. In 2012, 445 people worked at the centre (including 375 scientists), 210 people were paid by Inria (including 160 scientists) and 22 project-teams were run there. • The centre’s academic partners are Université de Lorraine, Université de Strasbourg, Université de Franche-Comté, CNRS and Max-Planck-Institut für Informatik. • The centre works in close collaboration with the competitiveness clusters Materalia, Pôle Fibres, Hydrea, Alsace Biovalley, Véhicule du Futur (in the region) and System@TIC, Minalogic (outside the region). • Its main industry partners are Alcatel-Lucent, Crédit Agricole, EADS, EDF, France Télécom, GDF Suez, General Electric, IBM, PSA, Siemens, Thalès and Acapela, Allegorithmic, ARC Informatique, Artefacto, Diatéllic, eRocca, Fireflies, Smartesting and XWiki SAS.

Main research topics
• Modelling and simulation of complex systems for engineering and life sciences.
• Security, reliability and safety of computer-based systems.
• Understanding and emulating the mechanisms of human cognition and perception.

Scientific priorities
• Impact of Internet and computer security issues on everyday life.
• Imaging, robotics and instrumentation for health and assistance to dependent people.
• Coupling and integrating methods for advanced solving in numerical engineering.
• Knowledge modelling for the design of individualized educational software.
The Inria Paris – Rocquencourt Research Centre was created in 1967 and is located in Rocquencourt and Paris. In 2012, 590 people worked at the centre (including 500 scientists). 375 people were paid by Inria (including 285 scientists) and 39 project-teams were run there. \* The centre’s academic partners are the ENPC, the ENS, UPMC, Université Paris-Diderot, UMLV, UVSQ and the UTT. \* The centre works in close collaboration with the competitiveness clusters Systematic, Cap Digital, Advancity, Finance Innovation, Medicen and Move’o. \* Its main industry partners are France Télécom, Dassault Av., Gemalto, Thalès, Siemens, EDF, EADS, Renault, Crédit Agricole CIB and Natixis in the large group segment, and numerous SMEs - SMIs including Distene, LKZ, Numtech, CryptoExpert, IPSIS, KLS Optim, Vera, Kwaga, Spring Technologie, Mandriva, WebSourcing and Helios Biosciences.

Main research topics

• Communication networks and systems.
• Reliable software and security.
• Modelling of living organisms and the environment.
• Simulation & Learning.

Scientific priorities

• Towards the quantum computer.
• Gaining a better understanding of neurological diseases.
• Self-organisation of networks and systems.
• Environmental and systemic risks.
• Digital sciences for humanities.
• Confidence in distributed systems.

The Inria Rennes-Bretagne Atlantique Research Centre was created in 1980 and is located in Rennes, Nantes and Lannion. In 2012, 670 people worked at the centre (including 585 scientists), 340 people were paid by Inria (including 280 scientists) and 33 project-teams were run there. \* The centre’s academic partners are Université Rennes 1, Université Rennes 2, Université de Nantes, CNRS, ENS Cachan Bretagne, INSA de Rennes, École des Mines de Nantes, IRSTEA, the French National Institute for Health and Medical Research (INSERM), Supélec and soon Institut Curie and IFSTTAR. \* The centre works in close collaboration with the competitiveness clusters Images et Réseaux and ID4CAR. \* Its main industry partners are Alcatel-Lucent, France Telecom, Technicolor, Thalès, EDF, EADS, Airbus, Intel, Microsoft, Canon, Siemens (large groups), BA Systèmes, Artefacto, Genomique X, Keroval, CAPS Entreprise, SenseYou, Golaem, Powedia, Syneika and numerous other SMEs and start-ups.

Main research topics

• Software and hardware for systems and networks with reliability, security and performance requirements.
• Data and interaction: multimedia data, management of large volumes of data, interaction between systems, real or virtual worlds and users.
• Mathematical and symbolic modelling for the environment, climate, energy and engineering.
• ICST for life sciences and health: robotics, bioinformatics and imaging.

Scientific priorities

• Software reliability: from determinism to stochasticity.
• High-resolution and high-speed bio-imaging and large-scale digital biology.
• Connected smart guardian angels.
• Storage and utilisation of distributed big data.
The Inria Saclay – Île-de-France Research Centre was unveiled in 2008 and is located in Palaiseau, on the campus of the Ecole Polytechnique. In 2012, 460 people worked at the centre (including 400 scientists), 250 people are directly paid by Inria (including 195 scientists) and 27 project-teams were run there.  
• The centre’s main academic partners are the Ecole Polytechnique, the ENS Cachan, Université Paris Sud, Supelec, Ecole Centrale Paris, the CNRS and the CEA.  
• The centre works in close collaboration with the competitiveness clusters Systematic, Cap Digital, Medicien, ASTECH, Finance Innovation and with various networks of expertise such as Optiscity and the Centre Francilien de l’Innovation.  
• Its main industry partners are, in terms of large groups, Microsoft, EDF, Alcatel-Lucent, Safran, AstraZeneca, Sanofi, France Télécom, Airbus and Barclays and, in terms of innovative SMEs, Artelys and Sylkan.

Main research topics
• Safety, security and reliability for architectures, software and data.  
• From data to knowledge: modelling, querying and visualisation of distributed massive data.  
• Modelling, control and optimisation of complex systems.

Scientific priorities
• Safety, security and reliability for architectures, software and data.  
• Data processing and modelling for life sciences.  
• Optimisation of energy consumption and distribution.

The Inria Sophia Antipolis – Méditerranée Research Centre was unveiled in 1983 and is located in Sophia-Antipolis/Nice, Montpellier, Marseille and Bologna (Italy). In 2012, 600 people worked at the centre (including 515 scientists). 400 people were paid by Inria (including 320 scientists) and 38 project-teams were run there.  
• The centre’s academic partners are the Université Nice Sophia Antipolis (UNS), Université Montpellier 2 (UM2), Université Aix Marseille (AMU), the University of Bologna, Université Paris 6, the CNRS, the French National Institute for Agricultural Research (INRA), CIRAD (a French research centre working with developing countries to tackle international agricultural and development issues), INSERM, partners with which the centre has joint project-teams, and Université d’Aix-Marseille, the CSTB and the International Centre of Valbonne (CIV), with which the centre has collaboration agreements.  
• The centre works in close collaboration with the competitiveness clusters Solutions Communicantes Sécurisées, Pégase, Optitec, the associations Incubateur Paca-Est, Plate-Forme Telecom (Com4Innov) and Telecom Valley and is present in EIT ICT Labs.  
• Its main industry partners are, in terms of large groups, France Télécom, Thales, General Electric, Alcatel-Lucent, Galderma, Microsoft Labs, Arcelor Mittal, Airbus, Crédit Agricole CIB, EADS, Eiff, Finrisk SAP, Siemens, SNECMA and Technicolor, and, in terms of SMEs, Bertin Technologies, Ipernity, Keeneo, Lema, Mumiscaphe, Mauna Kea Technologies, MXM and Quantaflow.

Main research topics
• Pervasive communication and computing.  
• Computational medicine and biology.  
• Modelling, simulation and interaction with the real world.

Scientific priorities
• Digital sciences for personal assistance and home care.  
• Computational and experimental neurosciences.  
• Modelling and simulation for energy production and management.  
• Processing massive and heterogeneous data.  
• User-Centric Internet.
STRATEGY IMPLEMENTATION
ININVOLVING THE PROJECT-TEAMS IN NEW CHALLENGES TOGETHER WITH INRIA LABS

The French higher education and research landscape has experienced many changes in recent years, one development being the creation of numerous mechanisms and structures. Within this general framework, Inria holds firm in its conviction that the project-team model is extremely well suited to the challenges facing digital sciences, while at the same time being complementary to the more long-term structures, such as Joint Research Units, proposed by its academic partners. Whether internal or shared, the project-teams will therefore continue to form the basic units of the institute’s scientific organisation.

The existence of a real, focused project that is shared by all the members of a project-team is fundamental in the way in which Inria aims to address the challenges facing digital sciences. Each project-team shall ensure to contribute to all of Inria’s missions, first and foremost, research and technology, as well as training through research, technology development and scientific mediation – with the resources devoted to each of these activities of course depending on the nature of the research and collaborations of each project-team. The evaluation of its project-teams is one of the fundamental of Inria, both when project-teams are created and when they are renewed or discontinued. This assessment will of course be kept in place, along with the aim to accentuate, for the relevant project-teams, the consideration of experimentation, technology development or technology transfer activities. In addition, Inria aims to develop the notion of an exploratory team that enables an already recognised researcher to engage in highly original research and explore for a period of one to three years new and uncertain research directions before potentially proposing the creation of a project-team.

Inria is committed to giving each project-team a high-quality working environment and providing it with the necessary support for the conduct of its activities. As such, in the absence of a significant increase in its resources or, in particular, the number of its permanent researchers, the institute believes that the number of project-teams must remain below 200.

Additionally, Inria aims to provide more opportunities for project-teams to collaborate on a long-term basis, potentially with other academic or industry partners, on ambitious projects that require a variety of skills. As such, the institute proposes to create the notion of an Inria Lab, the aim of which is to bring together and strengthen existing tools. The following entities bear special mention:
The ‘Inria Project Labs’

(The new name for ‘large-scale actions’), which aim to foster collaboration between several project-teams, and potentially with other academic teams (French or European), with the objective of working together to address a scientific or technological challenge via a clearly defined joint research project. Under normal circumstances, the number of active Inria Project Labs could be around 15 to 20.

The ‘Inria Joint Labs’

These are joint structures between Inria and a private partner (for example a main company) based on a shared roadmap connected with problems resulting from the company’s R&D and to which Inria could not have access on its own. The existing Joint Labs with Alcatel Lucent, Microsoft Research and Cerfacs are examples. An Inria Joint Lab could eventually be formed with each of the institute’s major industry partners, creating around ten.

The ‘Inria Innovation Labs’

These bring together a project-team and an SME in connection with a joint work programme with the aim of bolstering the SME’s innovation capability. Around ten such laboratories have already been created on an experimental basis and were called iLabs. The goal is to involve a large number of project-teams in order to achieve a significant increase in the number of Inria Innovation Labs by 2020.

The ‘Inria International Labs’

Which organise Inria’s presence in a region of the world and bring together the institute’s teams with those of one or several foreign academic partners. The JLPC in the US, the LIAMA in China, the LIRIMA in Africa and the CIRIC in Chile are examples. Around ten Inria International Labs could be up and running in 2020.

Inria Labs will be created and assessed based on their specific characteristics. Each will aim to receive dedicated human or financial resources on top of those of participating project-teams, with Inria personnel remaining assigned to project-teams.

The institute expects these structures, whether project-teams or Inria Labs, to have a major impact in their field. Being particularly stringent regarding their creation, Inria will allocate resources in priority to ambitious and original projects, either in basic or multi-disciplinary disciplines.

- All of Inria’s actions are subject to regular and independent assessments. These are carried out by assessors external to Inria, namely French or foreign figures from the academic or business world. The assessments are notified to the assessed structures so that the latter can take them into account and respond to them if need be. All of these elements are notified to the Inria Evaluation Committee, then to Inria’s Scientific Council, composed of individuals external to the institute and staff representatives. Ultimately, the chairman of Inria takes the decisions for reconduction, stop or evolution of the assessed structures in the light of these various elements.

- This process applies equally to project-teams and Inria Labs. In the case of the latter, the elements pertaining to the assessment of the project-teams involved are taken into account in order to enable a focus on criteria specific to each action or structure (for example, the reality of team integration, the reality of collective work, common visions developed as added value of the action assessed, etc.).
Inria’s already stated ambition of becoming the benchmark institute in the field of digital sciences is joined by the conviction that Inria will play this role effectively by developing all of its partnerships, both academic and industrial, as well as with regional and local authorities and other actors from civil society. As the only research institute specialising in the computer science and mathematical fields of digital sciences, Inria is the co-founder of the Allistene Alliance together with the CEA, the CNRS, the CPU, the Institut Mines Telecom and the CDEFI. Adopting a mindset of undertaking complementary rather than overlapping actions, it plans to continue playing a lead role in coordinating the leading national actors in digital sciences and also being an active member of coordination efforts in other sectors in which digital technology’s position is gaining ground, for example in the Aviesan Alliance for life sciences and health. Concerning computer sciences more specifically, Inria will bolster its interactions with the INS2I institute of the CNRS, notably through the coordination structure put in place in 2010, in order to conduct joint strategies and enhance their role in leading and giving impetus to the national community.

At a regional level, Inria has set itself the major objective of participating in the construction of world-class academic centres of excellence, with a strong regional foothold, through partnerships officially formed with research and higher education establishments (or the federating structures that they will put in place).

As is the case elsewhere in the world, digital sciences are set to play a key role in these centres. By drawing on its research centres and by taking advantage of the extensive powers delegated to the centre directors, Inria will strive to play a lead role in developing digital sciences in these centres. With this in mind, Inria previously proposed in 2011, together with the CNRS and the CPU, the creation on each major university site of a site committee bringing together all academic partners and responsible for defining a coordinated strategy of actions and site development in the field of digital sciences. Inria will work hard to implement these committees at all sites on which it is present.

Furthermore, the institute will propose to the regional committees of the sites where its centres are established the signature of multi-year Region - Inria contracts. The exact nature of these contracts will of course depend on each region’s policy and priorities and may take into account the new programming of European structural funds. However, such a contract aims to include economic development and innovation actions in the field of software and, in particular, implement a regional aspect of the Software Ambition programme (see section hereafter), together with ways to support the Inria Labs that involve industry players from the region, particularly SMEs. In order to enhance a site’s visibility and influence, the contract may also undertake to provide support for top-flight researchers, for example through the creation of Region – Inria chairs or by funding PhD students and post-doctoral researchers. It may also be pertinent to include in these contracts initiatives that aim to develop computer science education in secondary
Making Inria a Catalyst in the Growth of the Digital Economy

Enhancing the institute’s performance to serve industry partnerships and technology transfer

Inria has established a formal framework for all of its actions connected with industry partnerships and technology transfer. These programmes provide a frame of reference for the practices, processes and objectives shared by all of the institute’s actors. These programmes are primarily aimed at the research teams and structured around six core components:

- Develop industry partnership and technology transfer business skills.
- Disseminate and preserve the ‘culture’ of technology transfer at the institute.
- Foster an increasing number of industry partnership and technology transfer opportunities for the research teams.
- Monitor the partnership activities of the research teams to guarantee the conditions for a possible technology transfer.
- Build and monitor technology transfer projects (as part of the Technology Transfer Action Monitoring Programme since 2009).
- Develop structured relationships with large companies.
Supporting the growth of software publishers SMEs

The objective of the ‘Software Ambition’ project is to enhance and accelerate growth through innovation among software players, with a focus on publishers. Performance indicators are linked with the creation of business value and not with R&D intensity or technology transfer volume.

The programme will take shape through regional structures (Grenoble, Sophia Antipolis, Paris, Bordeaux, Lille during an initial phase), inserted into innovative ecosystems, based around a coordination structure specific to the territory concerned (a competitiveness cluster or/and a cluster, OSEO, public and private financing actors and benchmark actors from public research). A regional structure acts as a catalyst, the objective of which is to enhance and accelerate the effectiveness and impact of existing structures for the benefit of software actors, whom they do not substitute. Each regional structure will support and monitor the growth projects of software actors by drawing on a cohesive set of structures.

Inria will implement this programme and will assess the results and the impact following an initial phase.

Stepping up interactions with global leaders

Inria will use two tools to implement this policy.

The first tool is the conclusion of strategic R&D partnerships with large groups conducting highly intensive R&D in fields of interest to Inria, with bilateral relationships being favoured. The second tool aims to accentuate and speed up access to ‘Inria resources’ (research, human capital, technology transfer) for large groups engaged in an open innovation approach. This takes shape through the Open Inria programme, which complements the R&D partnerships and is similar to a programme of affiliated companies.

These actions align with the Institut Carnot Inria’s commitment to increase the volume of its bilateral partnerships by 40% during the 2011—2015 period.

Assuming the role of the French leader in technology transfer in the field of software

Inria’s ambition is to support structures that benefit the entire French system and will implement the Thematic Development Consortium project CVSTENE, which it spearheads on behalf of all members of the Allistene Alliance. The beneficiaries of CVSTENE are the Technology Transfer Acceleration Companies (SATT) and, in general, all technology transfer actors at university centres, Allistene members as part of a pooling approach and public contractors through a ‘national centre for the monitoring of technology transfer in the digital domain’ led by CVSTENE. A social network for researchers and companies in the digital sector will also be put in place.
Visual analysis: joint publications network (using the Graphdice software).

AViZ team.

Launch of the Inriality collaborative platform, 14 November 2012.
Since its creation, Inria has always been heavily involved in the transfer and dissemination of knowledge and know-how, which form part of its original missions. The digital revolution has profoundly changed how knowledge is created, spread, assimilated and adopted: anyone with Internet access can find out information, contribute and learn directly and at their own pace. Training and scientific mediation, in all their aspects, are taking a new, more collective, creative and interactive direction and are acquiring a global dimension. Inria believes it is essential to develop a digital culture among all primary school, secondary school and further education students, the general public and decision-makers. In this respect, the institute will act as a catalyst and benchmark, as it has done for many years.

As such, Inria will accentuate its scientific mediation effort in connection with research, software developments and the uses of computer and mathematical sciences by running two complementary content and exchange platforms. The institute will continue to lead, as it has done for several years, the scientific culture site Interstices (interstices.info), which is aimed at those interested in science. It will also support the deployment of Inriality (inriality.fr), a sharing and debating structure connected with the digital civilization that aims to provide introductory information, insights and viewpoints to the general public.

In addition, Inria aims to contribute producing massive open online courses (MOOC) as an extension of the Fuscia experiment (http://fuscia.info). Firstly, Inria will consider tie-ups with online course sites run by leading foreign universities (MIT, Stanford, Berkeley, etc.). Secondly, in collaboration with major French or European universities, Inria will ensure a comprehensive command of these technologies and will act as a driving force in the creation of a major platform at a European level. In particular, this platform will help to develop computer science education in primary schools, secondary schools and post-baccalaureate preparatory classes, as well as in the training provided at universities and elite higher-education establishments. Inria feels that this development is essential. It will provide input for the analysis and proposal of actions concerning the correct use of computer science in education at all levels. It may also include a section dedicated to ongoing training, which is so important for economic growth.

Inria will intensify its role as an expert on the technological and scientific problems facing the digital society. The goal is to clarify political choices regarding ethical issues, linked for example to the risk of violating private data for positive ends (the fight against cybercrime or paedophilia) or negative ends (e-commerce or invasive advertising), or regarding economic issues linked to copyright. In this respect, Inria promoted the set up of a committee to reflect on research ethics as part of the Allistene Alliance and is committed to maintaining it and involving its experts. Inria will also continue to draw on the COERLE (Operational Committee for the Assessment of Legal and Ethical Risks) to help researchers, the project-teams and the institute to assess ethical and legal risks linked to research, the development of systems and planned experiments.

As it has done regularly for years, Inria will continue to produce white papers and respond to requests from the government, MPs (for example
those from the Parliamentary Office for the Assessment of Scientific and Technological Choices, or OPECST), public entities (such as the Economic, Social and Environmental Council and industry unions (CIGREF, SYNTEC, AFDEL), and will ensure that it responds to the growing number of ever-more demanding questions posed by the digital society.

**CONSOLIDATING EUROPEAN AND GLOBAL LEADERSHIPS**

The institute will encourage the participation of its project-teams in calls for projects under the Horizon 2020 research and development framework programme in connection with its strategic research orientations and in order to foster the emergence of breakthrough technologies. In particular, Inria intends to remain highly active getting grants from the ERC (European Research Council) programme to bolster its position at the head of European establishments in its fields of expertise and to enhance its attractiveness so as to draw in outstanding scientists. To achieve this, the institute will mobilise resources in order to create junior and senior chairs as part of the ‘Inria Research Positions’. The institute will bolster its presence in the groundbreaking topics of the Future and Emerging Technologies programme by supporting the project-teams involved. Lastly, Inria Project Labs may be created to organise Inria’s participation in the multi-disciplinary projects of the FET Flagships initiative, the societal aspect of Horizon 2020 and in joint programming priority programmes (for example HPC, exascale).

The ‘Inria International Labs’, based on joint research project principles, joint assessment and co-funding, are a key tool in strengthening Inria’s presence and visibility internationally. They are also a key factor in achieving scientific breakthrough and jointly addressing shared research topics by leveraging on the complementary characteristics of partners and exchange of ideas, in a context that promotes interconnected relations.

Scientific and human exchange between France and foreign partners will be furthered through these structures thanks to the associate team and sabbatical programmes, as well as through intern, PhD student and post-doctoral researcher exchanges. The Research-Technology Transfer-Innovation model experimented in Chile could be proposed in other countries to bolster interactions with other research and innovation ecosystems.

The ‘Inria@XX’ programmes – which coordinate associate teams on geographical region or with the CNRS’s international joint research units with which Inria is associated – aim to make the transition to an organisational structure similar to the Inria International Labs. To build these Inria structures abroad, incentives for long visits (such as sabbaticals) and prospective visits (such as exploratory visits) will be encouraged, with the scientific, human and technological results for the institute kept in mind.

To step up international exchanges of students and researchers, Inria will get involved, alongside universities, in the development of international

**strong implication under Horizon 2020**
masters and PhD training. Inria’s PhD and post-doctoral researcher programmes will remain firmly open to foreign visitors and will also encourage long stays abroad. A global structure will be put in place at an institute-wide level to promote invitations of guest researchers by increasing their number and establishing a framework for these visits. Whenever possible, French and European partners will be brought in to accentuate the institute’s alliance, visibility and attractiveness policy.

6

DEVELOPING HUMAN CAPITAL: SKILLS AND POTENTIALS

Given the changing nature of the organisational structure of research, Inria needs to plan ahead for and support the developments facing professions and individuals in order to adapt to upcoming challenges. This applies both to scientific professions and research assistance and support professions, with responses adapted according to the personnel: integration, support for careers, mobility and occupational development plans, and preparation for upcoming career paths.

Remaining attractive

Projecting the institute as an attractive organisation for the best scientists from all backgrounds must remain a core component of its policy. In a fiercely competitive international climate, enhancing the institute’s ability to host and/or recruit brilliant researchers, engineers and students looking to participate in original projects is a fundamental asset. Two researcher recruitment channels will be run at the same time: the statutory competition for permanent researchers and researchers on non-permanent research positions, based on a variety of arrangements: post-doctoral positions, professor secondments, ‘Inria-University joint chairs’, secondment for scientific civil servants from other establishments and/or other disciplines. This diversification of recruitment channels, which is a considerable factor in achieving a more open stance for the institute, also enables it to adapt to the diversity of researchers’ career plans.

On a different note, in the case of activities that are not long-term in nature, the institute will pursue the policy of recruiting engineers that it has conducted for many years and that has proven very positive in terms of the professional opportunities for engineers that have benefited from this policy. These engineers provide temporary support for the conduct of research, development or technology transfer operations; a special programme also caters to young graduates hosted with the aim of providing additional training through research, for one or two years, as part of a technology development action. The attractiveness of these engineer positions will need to be accentuated by collaborating with engineering schools and universities, as well as with technology communities (developers from the open source world, development clubs), using suitable communication tools such as the annual software development competition (Boost Your Code) recently put in place.
Developing and capitalising on skills

For every individual, whether scientists or support personnel, temporary or permanent members of staff, contributing their skills and helping to achieve the institute's missions (over periods of varying lengths) is and must remain a source of enrichment. For the institute, successfully bringing together, mobilising and developing outstanding scientific skills to serve its research missions and ambitions is a key challenge. This also holds true for all research assistance and support roles. The objective to successfully integrate new recruits and to offer extensive and adapted professional training will remain an essential goal, both for research ‘coproduction’ staff (engineers in the experimentation and development departments), assistance staff (team assistantship, industry partnership and technology transfer, international expertise, legal assistance, scientific information, and communication) and for staff in administrative and technical support roles.

To this end, Inria will continue to develop its job description system and will produce a skills map. The job and competency planning structures will be expanded and reinforced. The institute will strive to plan ahead for developments – in particular, by identifying ‘strategic’ skills (in terms of scientific specialities for example) and/or ‘critical’ skills (for example due to their rarity internally or on the job market) – and to accordingly adapt its recruitment methods in order to ensure the continuity of its efforts.

The processes for welcoming and integrating newcomers and monitoring the requests of staff members in terms of career development will be strengthened.

Well-being in the workplace is a key tool of the human resources policy and a gage of the institute’s overall effectiveness. Inria will strive to provide its entire staff with a high-quality working environment by also committing to address diversity issues and the prevention of stress and psychosocial risks.

Cultivating a group mindset

It is essential for all internal actors, whether researchers, engineers, research assistance staff or administrative and technical staff, as well as executives of course, to share the values of the ‘Inria model’: the pursuit of excellence, ethics, independence and accountability, diversity and group learning, which ensures that ‘every individual, through personal growth, helps Inria to grow’.

Enabling every employee to understand and adopt the institute’s policy is therefore a key challenge. Internal communication must be strengthened, particularly through cross-discipline actions between scientists and non-scientists.

This challenge also requires the promotion of a management style that is suited to the institute’s values and ambitions, with every individual helping to achieve the strategic objectives by positioning his or her actions relative to shared reference points, while taking care to encourage and acknowledge the motivation and effectiveness of his or her co-workers. As such, creativity and individual initiative will be stimulated to serve group success. In order to develop a feeling of belonging and solidarity, the institute will encourage the implementation or strengthening of networks or forums for the exchange of practices between individuals sharing a project (pertaining to a team, department, ‘business line’, etc.).

The development of the ‘disability policy’ initiated in recent years and the implementation of a framework of actions to improve health and well-being in the workplace will also be important components of this momentum.
These efforts must draw on open and high-quality dialogue with the social partners sitting on the institute’s representative bodies. The structural and organisational challenges facing the institute (workforce management, mobility, flexible working conditions, etc.) are bringing about far-reaching changes that will over time be more effectively integrated as a result of an extensive social dialogue.

7 ENHANCING THE QUALITY AND EFFICIENCY OF THE RESEARCH ASSISTANCE AND SUPPORT DEPARTMENTS

As a national research institute, Inria is required to implement its strategy by drawing on a matrix-based arrangement that can take into consideration, in a relevant and effective manner, the regional dimensions of the research centres and the general orientations spearheaded by the scientific and administrative departments.

Improving management and implementing suitable methods and processes
The research assistance and administrative or technical support teams serve Inria’s strategy. Greater significance must be attached to the daily work undertaken by these departments so that they are fully aware of the performance and value-creation challenges with which they are associated. Management performance indicators that enable activity and efficiency to be monitored will be put in place in the institute’s departments and its assistance and support teams. ‘Management through maturity’ will be gradually extended throughout the various business lines, and cross-departmental benchmark indicators will enable the best practices identified to be better shared among the group as a whole.

Structuring the service offering and improving its quality
Inria’s proper functioning also relies on the extent and quality of the offering of its research assistance and administrative and technical support functions. Inria’s wants for each of its centres to be able to provide researchers with efficient and local assistance and support services that draw on the scientific and administrative departments. As such, all of the assistance and support lines will provide a service catalogue that will state their service offering. This catalogue will evolve over the years and will enable the life cycle of the services offered to be
Building a more comprehensive and agile information system

The information system (IS), which plays an essential role in all of Inria’s activities, will be made a major priority. The reorganisation of the IS teams is expected to result in the implementation of a national IT service centre, together with a consistent local offering across all of the institute’s sites. The IT service portfolio, which will be put in place from 2013, will state the outline of the offering in line with its resources. This portfolio will evolve over the years, one key challenge for the institute being to improve the tools made available to users. Access to application services must be gradually automated through the implementation of a services portal. The project owners will work in close collaboration with the project managers to respond to three major challenges over the duration of the strategic plan: the construction of a new «Human Resources IS», the creation of a ‘Technology Transfer & Innovation IS’ and an update to the ‘Finance and Accounting IS’.

Inria’s intranet must also evolve in order to enable teams to easily access the data they need, and not only by business unit. The introduction of a corporate social network will be proposed.

Optimising scientific and technical information and the organisation of scientific events

A national ‘unit’ will be responsible for all of Inria’s digital scientific subscriptions and a proactive policy of pooling documentary resources will be conducted at each of the university sites on which the institute is present. Inria has for a long time been committed to disseminating its scientific achievements through open archives, with a special effort being made to promote the open archive HAL, in liaison with the CNRS. The institute will continue implementing tools connected with HAL to interact with its scientific information system, make links with ArXiv even more fluid and facilitate the bibliometric studies that the institute needs in order to respond to external requests or internal management and monitoring issues. In addition, the institute will gain the necessary resources for a continual process of reflection on the issue of meta-data and indexing mechanisms.

Furthermore, Inria will create a unit to organise major scientific events to help its researchers organise the best international conferences in their fields for the benefit of all French research in digital sciences.
In the scientific and technological area of the digital domain, which is evolving very rapidly and has a very high impact on society, research needs a highly responsive observation system. Inria will implement a clearly identified unit to ensure the continuity of its process of foresight and strategy reflection.

This unit will of course draw on all of the institute’s skills, particularly on the various scientific departments, as well as on the Evaluation Committee and the Scientific Council. It will work in close collaboration with similar reflection units at other French and foreign research establishments.

This unit will also play a lead role in ensuring that Inria’s strategic plan is a vibrant and dynamic undertaking throughout its execution. It will also be responsible for producing papers and documents, written by Inria scientists, both for internal distribution and, if necessary, in response to external requests. To ensure consistency in its viewpoints and recommendations, it will also draw on Inria’s activity observatory.
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