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Teratec 2019 Forum

HPC: one priority for Europe

One truly unique event in Europe in terms of scale and quality, the 14th edition of the Teratec Forum allowed the 1,300 participants to get a synthesis of state of the art progress in high-performance computing (HPC) and digital simulation, as well as more innovative technologies such as Big Data processing and data learning (AI). It also showed that these subjects have become crucial for the European institutions which are setting up EuroHPC as one major programme, bringing about more than a 6 billion Euros investment.

Focusing on high-performance computing (HPC) and digital simulation as well as Big Data processing, and Machine learning (AI) in these areas the **Teratec Forum** spans over two days, bringing: plenary sessions; thematic and application workshops; an exhibition of hardware, software and services; and the presentation of the Digital Simulation Trophies.

For its 14th edition, this unique in Europe brought together more than 1,300 participants from all over Europe, meeting once again this year at **Ecole Polytechnique**.

The **plenary sessions** on first day marked the commitment from the European institutions to these technologies, whose development and mastery will be at the heart of the competitiveness of our companies for the coming years. A digital transition becomes imperative to succeed in all areas, whether aeronautics and space, automotive and mobility, health or industrial production. Plenary sessions also provided an opportunity to discover those technologies under development, such as the exascale that will make it possible to meet all these challenges.

MAKING EUROPE ONE OF THE LEADERS IN HPC

At the opening of the plenary sessions, **Daniel Verwaerde**, the new President of **Teratec**, recalled the current context of high-performance computing (HPC) and computer simulation, and then discussed the new emerging perspectives. «*The ongoing digital revolution is impacting all economic sectors. It is boosted by the rapid development of Big Data processing and machine learning technologies, whose performance will be increased tenfold with rapid upcoming of exascale machines. European authorities have decided to facilitate this digital revolution by investing massively through the* **EuroHPC** *programme, to make Europe one of the world leaders in HPC. This is what the European Commissioner for the Digital Economy and Society,* **Mariya Gabriel**, *will explain further in the morning."*

In addition to the traditional uses of HPC in industry, health, services or defence which are increasingly demanding in terms of performance, he highlighted societal changes (changes in ways of living, training, thinking, caring, etc.). Environmental changes (global warming, scarcity of natural resources as well and ever more intensive agriculture, Smart Cities,... already create new needs that considerably increase the demand for high-performance computing and high-performance data analysis (HPDA). «*Such new uses require processing and resources both material and applicative, of 2 to 3 orders of magnitude more powerful than those currently available, that Europe intends to provide us with through the EuroHPC programme*».

THERE IS NO STRONG INDUSTRY WITHOUT DIGITAL

Philippe Varin, President of **France Industrie**, then came to explain the conditions for the French industry to succeed with its digital transition. «*Since 20 years ago, we have seen a deindustrialization of France industry from 20% to 12% of GDP over this period, while Germany has remained stable at 23%. This represents a destruction of one million industrial jobs. Fortunately, this decline has been halted for the past 2 years. Even if an improvement is coming, we must remain vigilant and be obsessed with competitiveness. Industry, the Regions, the State and Europe are all mobilized to move forward in this direction, with the definition of 9 strategic value chains, one of which is dedicated to the HPC.*»

He also recalled the French paradox in terms of digital technology: «In France, we have among the best brainpower, the best integrators, the best solution providers and we are the''start-up nation''. Out of the 25,000 industrial SMEs and ITEs, however, only 20% have made a digital diagnosis to enter the first phase of digitization. And in the leading 16 industrial sectors we have identified, only aeronautics, automotive and electronics have set up digital platforms. This is not brilliant! Moreover, France is ranked 18th by the European Union on the penetration of digital technology into industry. It is therefore necessary to share the development of basic building blocks across sectors to catch up and quickly create the digital platforms that we lack: 5 or 6 sectors should be able to do so by the end of the year».

As close as possible from the field, France Industrie has set its target of 10,000 SMEs and ITEs to be diagnosed from a digital point of view, with a budget of €80 million from BPI (Banque Publique d'Investissement) with guidance from the Regions. Assistance is also provided to get them off the ground taking first steps towards owning digital tools (computation/simulation, robotics, 5G...).

But this transition to digital will not happen without people. «*We must work on both: the skills of employees by finely analyzing the needs of industrial sectors and training people as accurately as possible; appetite by giving young generations the desire to work in industry; access to industrial jobs in terms of transport, housing, mobility, etc.*».

Finally, Europe must continue to play its role in terms of connectivity, data standardization and cyber-security, with increased participation of French industrialists in working groups and standardization committees. «So many crucial subjects because there is no strong country without a strong economy, no strong economy without a strong industry, and there is no strong industry without digital technology,» concluded Philippe Varin**.**

TOWARDS A NEW BUSINESS MODEL AROUND SPATIAL DATA

Among the many focus sectors, space industry is undergoing a real upheaval with the arrival of new players, main ones coming from the development of the Internet. A phenomenon called **NewSpace** that spurs the actors in place. **Jean-Yves Legal**, President of **CNES**, came to explain how Space Europe is reacting to stay at the forefront of this industry.

«NewSpace is often defined by 3 statements: the emergence of innovation in a space domain ruled by sclerotic agencies, dominated by large companies that work more like arsenals than start-ups; private financing, wise and efficient, instead of public investment considered outdated and unproductive; the asserted reign of Silicon Valley start-ups which would replace the dinosaurs of the old economy».

Statements being far from the truth: «Since the beginning of the space conquest at the end of the 1950s, the various space agencies have been constantly innovating to meet the multitude of challenges they have faced.

*This is still the case since, last November the **InSight** probe landed on Mars with the French seismograph SEIS developed by **CNES** to probe the heart of this planet. Shortly before the **Mascot** robot developed by CNES and its German counterpart **DLR**, landed on the asteroid Ryugu. Examples that remind us that innovation is to space, what research is to science that is, an essential driving force and NewSpace does not have a monopoly on it..*

On the side of private investment, more than 80% of the space industry's turnover comes from public procurement, whether from established or emerging space industrial powers in India, China, Japan, Australia or the United Arab Emirates.

« *Finally, the myth of start-ups changing the world is undermined by the reality of numbers. According to US statistics, its national start-ups account for 3% of total employment in this economy and destroy as many jobs as they create. And it must be said that if they innovate strongly, they also join large established groups to industrialize and produce their innovations.* »

From these three perspectives, we can see that we did not wait for NewSpace to come to space and that it does not fundamentally change the situation. «*But I am far from being unaware of the current developments and I intend to take full advantage of the momentum brought by **NewSpace**. It is part of the 4th industrial revolution described over the past 15 years, characterized by the digitization of the economy its globalization with emergence of new players alongside established ones.*»

In particular, digitization has made it possible to miniaturize satellites and thus reduce the cost of putting them into orbit. While the **Envisat** earth observation satellite, launched by the European Space Agency (**ESA**) in 2002, weighed 7 tons, the **Copernicus** programme satellites weigh 500 kg today, waiting for the arrival of 50 to 100 kg of''nano-sat'' in the near future. «*But even more than digitization, what counts and revolutionizes our industry is the right data. Whether for telemedicine, autonomous vehicles, territory development or natural resource management, spatial data gives a decisive competitive advantage. From a supply economy (satellites and launchers) we are moving at high speed towards a demand economy driven by the right data on a profitable market. Satellites and launchers have become utilities for data. Galileo is no longer a satellite infrastructure but a positioning and temporality offer."*

Tout cela se fait dans un contexte de mondialisation, qui est une évolution structurante du secteur spatial. En 30 ans, on est passé de 4 agences spatiales (USA, URSS, Europe, Japon) à plus de 50. Le spatial est devenu un monde ultra-compétitif où finalement chacun se spécialise, apporte ses compétences et développe de nouveaux marchés.

All this being done in a context of globalization, a structuring evolution is under way for the space sector. In 30 years, we have gone from 4 space agencies (USA, USSR, Europe, Japan) to more than 50. Space has become an ultra-competitive world where everyone finally specializes, brings their skills and develops new markets.

The ultimate goal of the space conquest is to turn man into a multi-planet species. If there is a high probability that man will return on the Moon in the 2020s, he will not go to Mars until the end of 2030 because he will have to support a journey which requires 2 years, under the current conditions.

Today, a state can no longer finance the major scientific exploration missions and the necessary orbital systems alone. Thus, the USA offers a gateway around the Earth-Moon system, a public/private partnership mobilizing both the historical partners of the international space station, probably India, perhaps China and especially the major global companies. France is the main contributor to ESA's budget, and CNES also being partner of 5 other major space powers: the USA for the trip to the Moon; China for science and astronomy; India for climate and manned flights; Japan around Mars and Russia for launchers. «*These partnerships bring a lot to us by broadening our scientific and economic base, while allowing us to participate as specialists in particularly ambitious missions*»

Finally, the French space ecosystem around CNES will need to be further integrated to maintain French scientific and industrial excellence. «*In this respect, CNES collaborates with more than 100 start-ups and has been able to transfer*

a number of technologies to develop activities that are now flourishing and creating jobs. We also have more targeted collaborations with Competitiveness Clusters around digital technology in Paris, health in Lyon and we are directly in contact with start-ups on **Campus Station F**. *It is also the creation of an investment fund to support innovation in the space sector.*»

LARGE COMPUTERS FOR BIG EUROPEAN DREAMS

Unfortunately, following the recent European elections, **Marya Gabriel**, the **European Commissioner for the Digital Economy and Society**, was unable to leave Brussels but she insisted on making a specific video communication for the Teratec Forum.

«*High-performance computing is at the heart of my concerns as a European Commissioner. These technologies are of strategic importance for the competitiveness and innovation capacity of our Union. The context is simple. In an increasingly competitive world, today's competitive advantage is called mastery of Big Data, Artificial Intelligence, innovation capacity and industrial productivity. All these aspects have a common foundation, high-performance computing. But the context is also worrying. Europe is no longer the privileged playground for these major technological advances which would enable it to be at the forefront of industrial developments, as well as scientific research in personalized medicine, climatology, or the conquest of space. In short, big dreams require big computers."* ».

«*This is why Europe made it one of its priorities. We need to build the necessary infrastructure wihtin upstream value chains, i.e. the underlying technologies that we have lost leadership in, while ensuring that they are properly exploited downstream. This is the recipe for our 21st century autonomy from the USA, China and Japan. Currently our computing capacity is half that of the Americans or Chinese, while the demand is constantly growing!* ».

« *This is why Europe has been undertaking a major project since the beginning of 2018. The first step, which was not very*

visible but very structuring, was to set up a legal structure in order to be able to work in practice. It's EuroHPC. On this basis, 4 projects are in progress:

• First and foremost, for the first time, Europe has pooled its resources to acquire its first supercomputers, in order to make them available to researchers, whether university or industry. Two of them should rank among the 5 to 10 most powerful machines in the world.

• Second, we must ensure that Europe maintains its lead in terms of application software for these super-machines. If we are champions in areas such as climate change, the exploitation of natural resources, or the development of new medicines, we must ensure that the same is true for Artificial Intelligence or the Internet of Things (IoT).

• Third, Europe must return to the excellence in the supply chain that it had recently mastered. These supercomputers must be based on European technology. This is a major challenge since we currently estimate this share at only 5%. This is the current initiative of a European processor with low power consumption.

• Finally, it will be necessary to ensure that these supercomputers are available to everyone (SMEs, ETIs, research, etc.) which requires improving human capacities to control these processes through a fine network of competence centres capable of raising awareness among potential users who often ignore each other. Teratec's role will be fundamental to this in France.

This translates into the mobilization of 1.4 billion euros over the 2020/2021 period and 5 times more over the 2022/2026 period (see insert - e.n.). European autonomy is essential, both scientifically and industrially. Our citizens will be the first to benefit in terms of better medicine, safer products and a society that is more in tune with the major challenges of our era, including climate change."

A very proactive and mobilizing speech, that gives a definite roadmap to the field of HPC in the coming years. Europe certainly has a real political ambition in this area. The audience was not mistaken and widely applauded this presentation.

PREPARE THE IT ARCHITECTURE OF VEHICLES FOR AUTONOMY AND ELECTRIFICATION

If there is one sector in full mutation that HPC, Big Data and Machine learning will revolutionize, it is that of mobility and in particular the automotive industry, forcing manufacturers to develop new architectures for embedded electronics. This was explained by **Matthias Traub**, Head of Automotive IoT and E/E architecture at **BMW**.

«*In 2015, we launched the **Number One > Next program** to completely redesign the digital architecture of our vehicles, preparing them for 2025 with future connectivity and autonomous driving needs. Connectivity is defined as means between the vehicle and infrastructure, between different vehicles and between the vehicle and the Internet for multiple shared services. Similarly, the electrification and energy management of batteries, as well as autonomous driving, will fundamentally change the information technology embedded in vehicles. «In 2021, we will launch an autonomous level 3 vehicle using this new architecture, which is also designed to accept levels 4 and 5 as soon as they are sufficiently reliable to be placed in the general public domain.*»

This major change requires a review of hardware and software development processes, both internally and with third-party suppliers. «*Until now, each party, or even each department of a manufacturer, had its own specific solution to meet the challenges they faced. This did not facilitate integration, even if there are standards specific to our industry such as **Autosar**. This is why we had to define a homogeneous structured architecture as well as the technologies to be used, based on the current IT standards used for smartphones or connectivity in the cloud. This has forced us to define new and more agile development methods to cope with the scalability of these standards."*

«We have a three-step approach. Although we are a long-established company with legacies and compatibility issues, we have chosen a Greenfield Approach, which does not hesitate to question previous architectures. Secondly, we started from what we had learned from these previous architectures. Finally, the new generation of architectures is developed on the basis of the current one but, integrating our vision of the future.»

This new architecture must satisfy many challenges in terms of: cost; customer input; compatibility; adaptation to different ranges; standardization and reuse of functional blocks; energy saving so as not to penalize autonomy; testability; security by design; possibility of evolution over time, once in the customer base. *«Giving up individual module developments that can be integrated into a unified architecture in favor of a more homogeneous overall development, we significantly reduce the total development cycle, while offering an architecture that is compatible with our various product lines **BMW** Auto and Moto, **Mini** and **Rolls-Royce**."*

*«Beyond the use of microcontrollers and microprocessors, whose cost/performance ratio is constantly increasing, hybrid IT architectures allow an energy-efficient allocation of the necessary performance through optimal interaction of general purpose processors (**GPPs**), dedicated hardware accelerators (**HWAs**), for example for functions based on Artificial Intelligence, and user programmable gate arrays (**FPGAs**), allowing systems to be up-graded throughout their lifetime. In addition, an optimal composition at the system level could be achieved by practicing hardware/software co-design.»*

*«The big challenge for us is to move from an essentially mechanical product development to a very strong digital component product development Company. This is why we are heavily involved in a number of **European Horizon2020** digital initiatives, such as the **European Processor Initiative** (EPI), aimed at developing a general-purpose HPC processor that could, among other things, find its place in the automotive industry by 2021.»*

MOVING FROM CURATIVE TO PREVENTIVE MEDICINE

A new feature of this 14th edition of the Teratec Forum, as the morning plenary sessions closed with a roundtable on the theme "**My Health and Digital Technology**", moderated by journalist **Sophy Caulier**. She received:

- **Jean Michel Rondeau**, Project Manager, **Atos**
- **Jacques-Charles Lafoucrière**, Department Leader, CEA
- **Thierry Pellegrino**, VP & General Manager of HPC, **Dell EMC**
- **Jean-Luc Assor**, Worldwide Manager Hybrid HPC/ HPC Cloud, **HPE**
- **Valère Dussaux**, Health and Life Sciences Sector Director for Western Europe, **Intel**

A surgeon operates with the help of augmented reality, a pharmacist checks the compatibility of treatments prescribed to a given patient, a patient follows a treatment for a chronic disease while staying at home, an expert doctor remotely assists a colleague in a refugee camp... Digital technologies will allow the implementation of e-health and personalized medicine. These applications will process large volumes of data that will require physical and logical security.

Computing power is critical in this field, as for storage technologies (fast access memory, long-term storage, etc.) and software. But it will be necessary to simplify to the extreme in order to ensure the adoption of applications by health workers. Similarly, it will be necessary to train people in the new professions required by digital health such as, for example, genomics experts capable of deciphering results of genome analysis. It will also be necessary to train doctors and care givers in artificial intelligence, so that they can understand these tools practically and develop confidence while keeping a critical eye.

Digital technology does not exclude the human dimension of the patient-physician relationship, far from it! It is a way to better treat the patient, in an individualized way, to clarify the diagnosis, to accelerate the development of a treatment, in short to evolve today's curative medicine towards a preventive medicine. This, in fact, could help reduce health system costs.

GPUS BOOSTING AI APPLICATIONS

When resuming plenary sessions for the afternoon, **Marc Hamilton**, **NVidia'**s Vice President, Architecture & Engineering Solutions, discussed the value of GPU acceleration in processing the massive amounts of data used by applications using Artificial Intelligence.

«*The promises of AI have attracted many economic sectors (Smart Cities; public safety; health; industry; transport...) and start-ups are numerous. According to experts, it must be said that the economic stakes are colossal: $16 trillion for the domestic consumer goods market; the creation of 58 million new jobs by 2022; etc. To meet the huge computing needs that this will generate very quickly, we announced in early June the Automatic Mixed Precision for Deep Learning which:*

• *Accelerates mathematical computation through intensive operations such as linear and convolution layers, using Tensor Cores;*

• *Accelerates limited operations in memory by accessing half the number of bytes compared to single accuracy;*

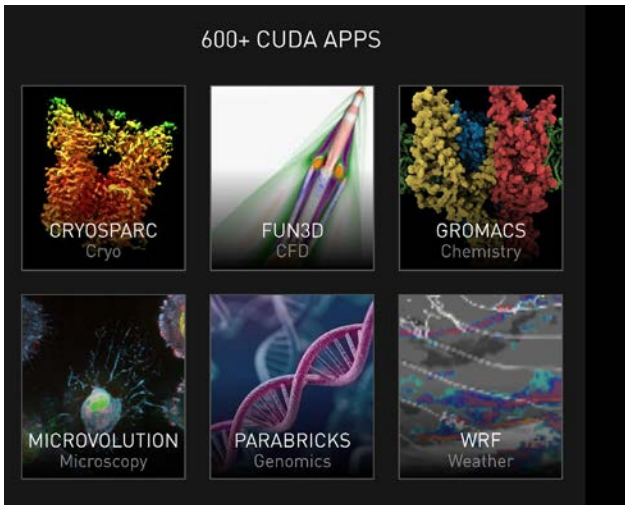
• *Reduces memory requirements for learning models, opening up to larger models or larger datasets.*»

The analysis of massive data flows via Machine Learning techniques makes it possible to create models for Artificial Intelligence. However, it is necessary to rely on relevant technical means to process them quickly. «*We have named our family of GPUs dedicated to AI SaturnV which we created using the largest infrastructure dedicated to AI. It has 1,500 DGX nodes equipped with 12,600 GPUs distributed in half a dozen computing centers for a total power of around 1.5 ExaFlop/s.*»

This performance is already benefiting sectors such as health care where an instrument can generate 3 TB of data per day and a hospital 50 PB per year. «*AI helps to address the shortage of specialists to process and interpret this information through the Clara AI network. Currently, more than 70% of the research conducted using medical*

imaging data worldwide is processed via AI. This is also true in the field of research into molecules for new drugs, which is carried out through the Atom Consortium.» Many structures in which NVidia is already involved. But NVidia GPUs are not only used to create supercomputers, they can also be integrated into small devices such as Oxford Nanopore's portable DNA sequencers.

Other sector platforms using AI on GPUs are also being developed, such as **Drive** for the transport sector, **Isaac** for robotics and **Metropolis** for Smart Cities.



DATA IS AT THE HEART OF THE FACTORY OF THE FUTURE

The manufacturing industry with the concept of Factory of the Future or Smart Factory is also a major user of data. This is what **Mustapha El Bouchouafi**, General Manager of **Hexagon Manufacturing Intelligence**, reminded us.

Hexagon originates from measurement sensors, particularly in the field of very high-precision 3D metrology which generates very large volumes of data. *"Since 2001, if we have acquired multiple companies in the field of metrology (**Brown & Sharp**, **Leitz**, **DEA**, **Tesa**, **Leica Geosystems**...), we are now focusing on data processing, in order to transform large amounts of manufacturing data into real knowledge, to boost companies' productivity. The objective is to achieve intelligent production solutions that integrate detection, reflection and action functionalities.*»

It is about merging both real and digital worlds. Thus, sensors analyze in real time the evolution of the physical world and create a data flow that feeds simulation software which will have acquired an experience, thanks to Machine Learning, allowing them to act on the physical processes in real time and guarantee the conformity of the parts produced.

«If we knew how to make 3D measurements on parts in a metrology room after the fact to analyze drifts and correct the machining parameters to return to optimal parts, the tools that we have today allow us to make these measurements in real time during machining directly on the workstation, in order to correct the machining parameters permanently and guarantee the accuracy of each machined part. Quality drives plant's productivity."

A virtuous loop made possible by the integration of Vero Software, Q-Das, MSC Software or Spring Technologies into Hexagon's portfolio.

«The complexity of the parts to be produced and the complexity of machine tools are constantly increasing, the introduction of additive and hybrid processes is essential, the availability of competent human resources is decreasing so manufacturing must become more agile while taking into account the availability of resources. Data analysis through AI only provides the means to support this digital transformation process."

AUTONOMOUS AND MOBILITY OF TOMORROW

The afternoon went on with the second round table moderated by journalist **Sophy Caulier** on the theme Mobility and autonomy for tomorrow. She welcomed: : **Jean-Tomas Acquaviva**, Senior Researcher, **DDN Storage**; **John Morelle,** Business Development HPC Manager, **Bechtle**; **Ulrich Plechschmidt**, Worldwide Storage Marketing, **Cray Computer**; **Yossi Elbaz**, EMEA Director of Sales, **Mellanox Technologies**.

Advances in calculation, deep learning and data availability have given new impetus to autonomous transport projects. Already driverless cars roam on the roads of several American cities carrying passengers or delivering packages for experiments... UAVs or other delivery «vehicles» may soon offer an answer to the problem of the «extra mile». In agriculture or in the maintenance of engineering structures, drones provide effective solutions to optimize watering or ensure maintenance.

Technological, economic and societal issues are closely linked here. Technologies involved in battery life are partly available or will soon be available: wireless communications, particularly 5G, components, sensors, powerful and low energy-consuming processors. There is still a need to improve acceptability to users which depends on their confidence in autonomous vehicles.

Several aspects still need to be addressed. Which regulations should apply? How can we reconcile the traffic of autonomous vehicles with that of two-wheelers, pedestrians and delivery transport? How to empower traffic in dense urban centers? How can current experiments (campuses, airports, etc.) be scaled up to scale 1? We will always need much hardware and software developments, better still we will need «co-design» associating hardware and software developers in order to accelerate processes but above all, we have to ensure their consistency.

PROCESSING EXPONENTIAL AMOUNTS OF DATA, FASTER AND FASTER

After the break, **Thierry Pellegrino**, VP & General manager of HPC at **Dell EMC,** spoke about the explosion of data and the importance of HPC for processing it.

«*The increasing digitalization is disruptive in many areas compared to the traditional world we have known thus far. Large commercial chains have disappeared or are in great difficulty because of online commerce such as* **Amazon***; the chain offering most choice of hotel rooms is* ***booking.com;*** *taxis disappear in favor of* **Uber***; traditional banks are closing their branches one after the other, while online banks are expanding. All of this unveils one common factor: the massive use of data made possible with ever-increasing IT performance, while prices are falling.*»

Processors are only one part of the hardware evolution which also includes system architectures, and the multiple memory technologies that provide granularity to facilitate computation. The same scheme applies to **SmartNIC** (Network Interface Card) network cards with an **ARM** processor for computing. GPUs widely used for highly parallel computing are now highly favored by AI applications. Finally, FPGAs provide fast access to processors that are perfectly adapted to specific processing while specialized processors, such as **Intel's Nervana** or **Graphcore's**, will allow us to go even further in computing performance.

«*This rapid evolution of technologies will make it possible to cope with the explosion in data volumes and the ever shorter time left to process them. In 2005, humanity generated 0.1 ZB of data, in 2010 it was 1.2 ZB, in 2015 8.5 ZB and it is expected to reach 40 ZB in 2020. At the same time, the faster the data is analyzed the more valuable it is.*»

«*The calculation has also changed from being a data generator to a data consumer. Hence, the very definition of HPC has evolved. Originally limited to computation for design, weather forecasting or petroleum exploration applications, it has evolved into more data-centric applications such as genomics, financial modelling or signal processing, to become High Performance Data Analysis (HPDA) widely used in personalized medicine, fraud detection or economic intelligence. Finally, HPC is now also widely used for Machine Learning and Deep Learning at the heart of Artificial Intelligence applications.*»

This year, HPC market will be worth around $13.5 billion with a steady 10% annual increase. But we don't invest in HPC for the sake of data processing. This is done in multiple economic sectors to add market value, to advance knowledge and better meet user expectations, whether in life or earth sciences, research, knowledge of the universe, defence, manufacturing, finance or meteorology.

«*Thus, at the* ***Gustave Roussy Institute****, Europe's leading control center for cancer, the ability to analyze human genome as quickly as possible is a key factor in the treatment of patients. The implementation of an HPC solution has made it possible to multiply by 8 the number of genomes calculated per day, accelerating research on pediatric cancers, while reducing waiting lists. Tumor samples taken from the patient are analyzed to determine their molecular profile and which molecules are affected. This makes it possible to create a much more effective personalized therapy. Incidentally, this has been done by reducing energy consumption by 23%, which is not insignificant in a sector where financing is still lacking.*»

In a completely different field, closely related to finance with **MasterCard**, the **MosaicCrown project** aims to make data anonymous and secure data exchanges between multiple actors. Such a technique could have many applications in many different sectors. «*To develop autonomous vehicles, imagine progress that car manufacturers could make if they not only had access to data collected on their own test vehicles any longer, but to all data collected by all manufacturers after they had been cleared from each manufacturer's own proprietary information?*»

In summary, many technologies are already available to quickly and intelligently analyze large amounts of data. It is critical for the advancement of science and research. And there are techniques available to anonymize those data and share them widely in order to progress even faster to benefit the community.

INNOVATION, THE SPEARHEAD OF FRENCH DEFENCE

Emmanuel Chiva, Director of the Defence Innovation Agency (AID) at the **Ministry of the Armed Forces**, closed the plenary session by explaining how simulation, HPC, and innovation are being part of the spearhead of France's strategic autonomy.

«*As the Minister of the Armed Forces said, innovation is a matter of survival. It is no longer a choice indeed, but an imperative necessity of upmost importance which has been clearly identified in the Military Programming Law 2019/2025 to guarantee the ultimate goals of our defence policy, i. e. with operational superiority of our forces and the strategic autonomy of France, by remaining in the very closed circle of military powers that count in the world.*»

The world is changing, with civil innovation that has never been so fast, dynamic and accessible. «*For example, the Chinese manufacturer **Huawei** spends 20 billion dollars each year on R&D which is more than half of the budget of the French Ministry of the Armed Forces. And same is true, with 15 billion dollars for Alphabet (**Google**) and 11billion dollars for **Apple**. For example in the past, Space conquest launched in October 1957 with **Sputnik**, and the ensuing struggle for technological supremacy between the United States and Russia was what drove civil and military innovation for decades. Today, thousands of virtual Sputnik satellites are being launched every day, both by states and transnational industrialists or investors even attracted by the expected economic benefits.*»

These strong signals in terms of innovation must therefore be taken into account and these advances must be exploited. «*We must seize this civil innovation which offers us remarkable opportunities, running the risk of levelling because they are also available to our opponents. In the Sahel-Saharan strip, for example, there are 3D printers producing weapons and mines, or swarms of civilian drones attacking Russian bases in the Middle East. Not to mention biotechnology, cyber security, artificial intelligence, and HPC becoming easily accessible to terrorist groups. We must therefore innovate, moving around our own challenges to guarantee our independence and maintain our defence industrial and technological framework in the long term.*»

Several steps have been taken, including the modernization of the **Délégation générale à l'Armement (DGA)** with the creation of the **Agence de l'Innovation de Défense** with an annual budget of €1.2 billion. It invests in all types of innovations, from capturing civil innovation, to preparing our future weapons systems and funding fundamental research. It is now a single focus contact point for all innovators wishing to work with the **Ministry of the Armed Forces**.

This agency started with writing a Defence Innovation Guidance Document (DOID) which describes the objectives to be achieved and all mechanisms involved to support them. «*The first component of DOID is to detect and capture innovation, because the shift of the gravity center of technology development towards civil market, particularly in the digital domain, requires a strategy that aims to improve their detection and acquisition closely fitting our needs. This will be done through an open innovation cell that contributes to multiple events such as the **CES** in Las Vegas, **VivaTech** or the **Teratec Forum**. We are also setting up a network of ''sensors'' and references to complete this cell.*»

Another element is the **Innovation Défense Lab** which is not intended to replace the many existing laboratories within the Ministry of the Armed Forces ecosystem but to federate their work. It is currently being complemented by a national innovation meshing system, based on the clusters of the DGA's technical department and the Army's experimental centers. Finally, the Agency also manages four incumbent operators: Onera; the Institut de Saint-Louis; and the dual research bodies of CNES and CEA.

«*The second major component of DOID is to **stimulate and guide** by displaying our main areas of interest and major needs in a relatively transparent way, and by having an active intervention policy by funding projects through thematic calls or by acquiring studies on a number of specifications in order to guide efforts. The main themes are: the future air combat system (SCAF); the new generation aircraft carrier; the Main Ground Combat System (MGCS) and then Space, Artificial Intelligence and Quantum.*»

Quantum is a subject of rupture for sensors, cryptography, hardware and software, to such an extent that an inter-ministerial mission has been set up to lead to an inter-ministerial strategy with a defence component in the foreground.

«*We wish to enrich our contribution to academic research in this field, i.e. to have a balanced portfolio of scientific and technical research actions which includes DeepTech on subjects of very low maturity level yet of promising breakthroughs, as does the* ***American Darpa****, without there being any military outlets in sight at the moment. Because the best way to prevent strategic surprise is to create it before others do!*»

To this end, AID will strengthen the effectiveness of instruments to support academic research, use public research institutions and take into account the proliferation of start-ups, reasoning like an investor to know which ones to better sustain. «*Beware though, as innovation should not be confused with "ever present start-ups", because it is not their prerogative. Innovation is everywhere in large groups, IT companies, SMEs, research laboratories. And that is good, taking into account the average survival rate of 58% for a start-up over 5 years' time. And it's much weaker in the defense world! We must therefore take into account the entire innovation landscape and take advantage of this Darwinian approach, by detecting and supporting societies that are considered critical and able to survive. To this end, we will therefore launch a call for partnerships with incubators and funders in order to work together to promote the various levers at our disposal to develop this critical innovation activity.*»

Last component of the DOID, **execute, accelerate, scale up and commission**. «*It means going fast and accepting failure which is very new in the culture of our department. To do this, it is necessary to select and label projects, then accelerate thanks to the synergy of all our resources in order to move as quickly as possible to integrate innovation into long-lasting weapons programs via open architectures. We will also strengthen international cooperation because France is finally being looked at with great interest in areas such as science, mathematics, digital technology and calculation.*»

In this context, the fields of simulation and HPC are central at a time when a new strategy for Artificial Intelligence is being launched under the impetus of the Ministry of the Armed Forces. «*This is the way to ensure the credibility of our deterrence. These are areas of excellence in the French innovation ecosystem which is essentially dual in nature and whose economic benefits will have impact on Simulation both within the computing industry and the defence sector. In terms of AI, the real breakthrough is that today it works. Algorithms have been known for some time but the convergence between the availability of massive data, algorithms and a computing capacity to use them at their full power makes it possible to speak of a breakthrough. The recent announcement of our strategy by the Minister in this area will result within IDA in hosting of an AI project manager at ministerial level, and an AI coordination team that will result in the hiring of approximately 200 specialists with an operating budget of approximately €100 million per year.*»

A number of actions have already been launched, such as the **Artemis project**, the objective of which is to provide a demonstrator for a secure distributed Artificial Intelligence platform for the specific needs of the armed forces, or the **Man Machine Teaming (MMT) project** where, as part of the definition of the air combat system of the future, the pilot is allowed to interact with the Artificial Intelligence of the cockpit of the future. A cognitive air-system herewith brings together industrialists, laboratories, start-ups and SMEs.

AID also launched a wave of accelerated projects on four AI sub-themes in early 2019. 160 proposals were received in one month, 8 projects were selected and funded.

«*Thanks to this ambitious strategy, with the support of schools such as Polytechnique and a proactive policy, France intends to remain a leading scientific and military power. Obviously, given the rise of the AID, all this will not give rise to immediate results but my obsession today is to move from logic of profession of faith to first tangible results. Undoubtedly linked to the themes that are addressed at this Forum, Artificial Intelligence, Simulation and HPC are areas of French excellence. It is no coincidence that France is the second country in terms of Fields medalists. It is also no coincidence that we are now bringing together in this Forum a community of researchers, entrepreneurs and innovators, reflecting the dynamism of this sector in France.*»

«*We are counting on all of you to help us maintain our operational superiority, strategic autonomy and economic competitiveness. I would like you to know that AID stands by your side to dare, imagine and accelerate our innovation for the benefit of all those who work for our defence and security, for the success of France's weapons.*»

THE 5 WINNERS OF THE DIGITAL SIMULATION AWARDS

The day ended with the presentation of the 5th Simulation and Digital Technology Awards, hosted by **Stéphanie Mundubeltz Gendron**, editor of **L'Usine Digitale**.

Start-up Award

Sponsored by **CEA**
Nominees: *Ambiciti, Hub Vacataire, Numix*

Winner: **Ambiciti** for its smartphone mobile application,- **TeamShout Supporter**, which allows the fan, watching a match, wherever he is in the world, to measure his support for the club and turn it into a value for him and his club.

SME Award

Sponsored by **Intel**
Nominees: *Mokili, Savoie Transmissions, Serious Factory*

Winner: **Mokili** for **Emergencies**, modeling and decision support system for real-time monitoring or anticipation of toxic and / or explosive atmospheric releases, accidental or malicious, in any city.

Innovation Award

Sponsored by **Inria**
Nominees: *ESI Group, Solystic, Worldline*

Winner: **ESI Group** for the development of a concept allowing a predictive simulation, a predictive maintenance usable and configurable in real time thanks to the Digital Twin.

Co-design Award

Nominees: *DC Brain / Daher Aerospace, Ingeliance Technologies / Laboratoire Jean Kuntzmann, Liebber-Aerospace / Jolibrain*

Winner: **Ingeliance Technologies** in collaboration with **Laboratoire Jean Kuntzmann** for the **Coll'hybrid project** which deals with the development and industrialization of an open-source HySoP simulation library for the resolution of complex specific problems in fluid mechanics.

Grand Prix du public

Sponsored by **Atempo**

Winner: **ESI Group** for the **Hybrid Twin project.** In a world of personalization, the hybrid twin combines prediction, personalization and the knowledge provided by physics and data**.**