sequana

Live innovation to the fullest

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Bull atos technologies

Why do we need the exascale?

High Performance Computing, or HPC, has gradually become a part of our daily lives, even if we are not always aware of it. It is in our medicines, our investments, our cellphones, in the films we go to see at the cinema and the equipment of our favorite athletes, the cars we drive and the petrol that they run on. It has a direct impact on our quality of life, making our world a safer place, with ever more accurate and precise weather, climate and seismic forecasts, and, thanks to researchers, a world we can more easily understand.

A never-ending need for more compute capacity

All sectors, in industry and in the academic and scientific community, demand ever more powerful computing systems, involving ever growing volumes of data.

Generating finer-grained weather forecasts, designing cleaner aircraft engines, leveraging genomics to implement personalized medicine… all of these innovations require more computing power than currently available, and will advance considerably thanks to exascale systems.

Designing more environment-friendly engines

The aeronautical industry is relying on simulation to reduce the quantity of pollutants emitted by aircraft engines, the noise they make, and the quantity of fuel they consume.

Aircraft designers must tackle the following challenges:

- Reduce Co2 emission by 2 in 2020, and by 4 in 2050
- Reduce fuel consumption by 15%
- Reduce noise

To achieve this ambitious goal, finer and more complex models are required, in particular to simulate combustion chamber performance with more precision.

Aircraft engineers reckon that they will need their high performance computing resources increased by 70% to 100% each year to reach their objective.

Leveraging genomics for better diagnosis and treatment

Genome sequencing and analysis are complex tasks that demand powerful analytics platforms. The compute time needed for sequencing has been reduced considerably in recent years, making it possible to drastically increase the amount of genomic data collected on large study populations.

This opens the way to a new genomic-based healthcare service, leveraging in-depth and comprehensive genomic analyses for a predictive and personalized medicine. The challenge is to achieve:

- Better and predictive diagnosis
- More efficient treatments
- Customized dosing

To implement such a promising project, sequence analysis must be available on an industrial scale, and complex analytics must be supported. This requires computational power on an unprecedented scale.

Re-inventing agriculture to meet 21st century demand

With global populations rising rapidly, worldwide agriculture faces the challenge of producing enough food to meet increasing demand in conditions of changing climate and scarce natural resources. A new agricultural revolution based on a strong scientific foundation is needed to tackle the challenge of increasing production while also meeting environmental, economic, and social goals:

- Feed a world population that will reach 8.5 billion by 2030 and 9 billion by 2050
- Reduce of the use of pesticide by 30%
- Take into account climate change, ground quality alteration and plant behavior

The solution: the development of precision agriculture; leveraging the large variety of data obtained by sensors to build models with fine ground mesh, and leading to better use of fertilizers and agricultural inputs.

This requires massive computing resources and Big Data resources.

Imagining smart cities for high-quality urban services

"Without a serious shift in urban thinking, the consequences of escalating climate change, pollution and resource depletion pose an ever more serious threat to the resilience of cities right around the world." Jon Lovell, Deloitte

Cities are faced with the following challenges:

- Enhance quality and performance of urban services
- Reduce costs and resource consumption

Smart city projects can address issues such as:

- Data-driven real-estate valuation
- Parking analysis for urban planning (capacity planning, variable pricing...)
- Monitoring of the motion of citizens around city
- Monitoring of disease spread
- City-level traffic management.

Smart city projects leverage emerging developments in Internet of Things and Big Data. They gather large-scale data and transform this data into knowledge that helps address real-world challenges in an urban context.

Relying on fine-grain weather forecasts to anticipate severe phenomena

Without supercomputers, weather forecasting as we know it today would not be possible. And as the computing power available to meteorological agencies increases, weather forecasts improve in many ways.

Between 1992, when Météo-France invested in their first supercomputer, and today, the compute capacity increased by a factor of 500.000 – and Météo-France expects to keep the same trend in the future.

Weather forecasting agencies worldwide need to:

- Issue forecasts every hour
- Use a finer mesh size for finer and more reliable predictions
- Enable the prediction, exact location and time of severe weather phenomena.

These objectives require increased model resolution and the incorporation of a greater quantity of data and observations in the forecasting process. This means more computing resources and the capacity to handle massive data efficiently.

It's time to shift to a new computing scale

Discover sequana:

the new generation of supercomputers designed to capture, store, compute, analyze and visualize very massive data sets at a completely unprecedented speed.

Second compute cabinet

Up to 144 compute nodes and the hydraulic modules to cool them

Switch cabinet

Includes the level 1 and 2 interconnect, as well as the management modules

First compute cabinet

Up to 144 compute nodes and the hydraulic modules to cool them

The open exascale-class supercomputer

With the new Bull sequana range of supercomputers, Atos confirms its strategic commitment to the development of innovative high performance computing systems – the systems needed to meet the major challenges of the 21st century.

Designed by the Bull R&D in close cooperation with major customers, the Bull sequana X1000 supercomputer leverages the latest technological advances, so as to guarantee maximum performance for a minimized operation cost.

The race to exascale calls for technological breakthroughs. With Sequana, Bull delivers an innovative solution that matches the exascale technological challenges. The Atos R&D designed sequana around the following guidelines:

- Open and multi-technology
- Ultra dense and scalable
- Ultra-energy efficient
- Easy administration

Open for future technologies

Bull sequana is designed to be able to integrate the most advanced technologies in terms of processors, interconnect networks and data storage – both current technologies and future technologies that will make it possible to reach the exaflops level. The sequana supercomputers have an open architecture and are based on industry standards, for both hardware and software. They propose customers **a large choice of technologies** and will be compatible with successive generations of future processor technologies (CPUs, accelerators, low-power processors...) and different interconnect technologies (BXI, InfiniBand...), thus offering maximum i**nvestment protection**.

Limit energy consumption

Controlling energy consumption is the main roadblock on the path to exascale. Sequana is ultra energy-efficient: it targets a PUE very close to 1. Its energy consumption is 10 times lower compared to the previous generation of supercomputers

100% of the components of sequana – both compute nodes and switches - are cooled using an enhanced version of the **Bull Direct Liquid Cooling** (DLC) solution. DLC is a proven cooling technology that minimizes the global energy consumption of a system by using warm water up to 40°C.

Sequana is also an energy-aware system that integrates fine-grain energy sensors and a new generation of the High Definition Energy Efficiency Monitoring implemented in previous bullx systems to facilitate optimization.

Handle the data deluge

Exascale is not just about exaflops, it also involves dealing with exabytes of data. How data are organized, moved, stored and accessed can have a considerable impact on performance, especially as the volume of data is increasing exponentially.

Sequana features a hardware and software architecture designed to tackle the most complex data processing, and based on Bull research in distributed systems management and data access

Accelerate application performance

Exascale application performance requires massive parallelism. Bull sequana features the Bull Exascale Interconnect (BXI) developed specifically for exascale. BXI introduces a revolution in data movement processing with a hardware acceleration technology that frees up processors from all communication tasks.

Moreover, the software environment provided with Bull sequana allows for fine-grain management of resources at scale, and offers optimal efficiency in a production environment.

Deliver a resilient platform

The frequency of failures increases with the number of components, so that in an exascale-class supercomputer, the sheer number of components - tens of thousands – is a risk in itself, unless the system incorporates high quality resilience.

The architecture and packaging of sequana were designed with resilience in mind:

- Redundancy of critical components and switch-over capabilities to make of sequana a self-healing system
- Efficient software suite and management tools, providing hierarchical management, and including an embedded and redundant management server
- Resilient interconnect with adaptive routing and reliability features
- Automatic configuration, with node recognition.

Focus on sequana innovation

The sequana cell

In sequana the computing resources are grouped into cells. Each cell tightly integrates compute nodes, interconnect switches, redundant power supply units, redundant liquid cooling heat exchangers, distributed management and diskless support.

Large building blocks to facilitate scaling

This packaging consisting of large building blocks facilitates high-scale deployment - up to tens of thousands of nodes, by optimizing density, scalability and cost-effectiveness.

Each sequana cell is organized across three cabinets: two cabinets contain the compute nodes and the central cabinet houses the interconnect switches.

Compute cabinet

Each compute cabinet houses 48 horizontal compute blades, with the associated power modules at the top of the cabinet and the redundant hydraulic modules for cooling at the bottom of the cabinet.

24 blades are mounted on the front side of the cabinet, while the 24 other blades are mounted on the rear side.

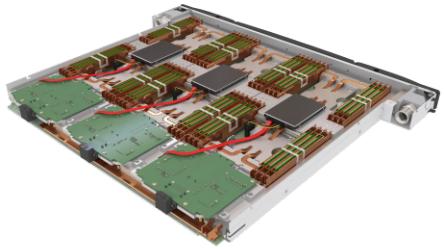
Each cell can therefore contain up to 96 compute blades, i.e. 288 compute nodes, equipped either with conventional processors (such as Intel® Xeon® processors) or accelerators (e.g. Intel® Xeon Phi™ or NVIDIA® GPUs).

In each 1U blade, a cold plate with active liquid flow cools all hot components by direct contact – the sequana compute blades contain no fan.

The following compute blades are initially available:

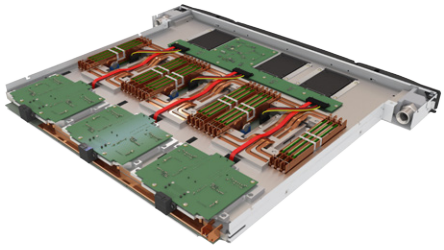
Bull sequana X1110 blade

The 1U Bull sequana X1110 blade integrates 3 compute nodes, each powered by 2 future generation Intel® Xeon® processors (code named Broadwell



Bull sequana X1210 blade

The 1U Bull sequana X1210 blade is composed of 3 compute nodes each powered by an Intel® Xeon Phi™ x200 processor (code-named Knights Landing).

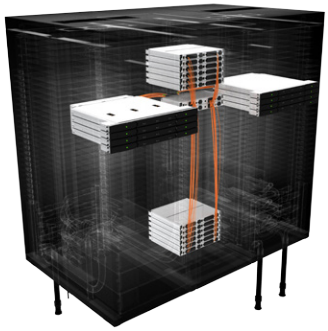


Switch cabinet

The interconnect components located in the central cabinet form the first two levels of a fat-tree interconnect network. External nodes (such as I/O nodes and service nodes) plug directly into the system fabric at the cell level.

The switch cabinet contains:

- the level 1 Direct Liquid Cooled switches - BXI or Infiniband EDR;
- the level 2 Direct Liquid Cooled switches - BXI or Infiniband EDR;
- the switch power group;
- two optional Ultra Capacity Modules that compensate power outages up to 300 ms;
- the management modules, including the Ethernet switches for management and the Rack Monitoring and Administration (RAMA) module - redundant management server with shared storage
- the backplane octopus, a highly innovative column that provides connections between L1 & L2 switches and compute nodes.



Bull Exascale Interconnect (BXI)

The core feature of BXI is a full hardware-encoded communication management system, which enables compute processors to be fully dedicated to computational tasks while communications are independently managed by BXI. This interconnect offers:

- sustained performance under the most demanding workloads;
- revolutionary hardware acceleration;
- designed for massive parallelism - up to 64k nodes, up to 16 million threads;
- designed to support exascale programming models and languages.

Atos in Extreme Computing

As Europe's only computer manufacturer through its Bull brand, Atos operates in the ultra-high processing power market, to liberate its customers' ambitions. With its Bull Extreme Computing solutions – focused around its bullx™ and now sequana supercomputers – Atos delivers all the benefits of a leader in HPC technologies to everyone from research centers to the design offices of major multi-nationals, or to innovative SMEs.

Over the years, Bull supercomputers have gained a strong presence in the list of the world's top supercomputers.

With more HPC specialists than any other player in Europe, Atos is recognized for the technological excellence of its Bull systems, its HPC applications expertise and its ability to manage large-scale projects. Atos's Center for Excellence in Parallel Programming supports customers to re-engineer their applications for the exascale.

Across the world, numerous institutions (SURFsara in the Netherlands, GENCI in France, LNCC in Brazil, CSC in Finland, DKRZ in Germany, the Universities of Dresden, Düsseldorf, Grenoble, Reims Champagne Ardenne and many others) and companies (Météo-France, Dassault-Aviation, Cenaero) have turned to Bull to implement powerful, robust systems that are easy to manage and use, and are designed for round-the-clock operation. Every day, thanks to their Bull systems, their researchers and engineers are pushing back the boundaries of the possible.

About Atos

Atos SE (Societas Europaea) is a leader in digital services with revenue of €10 billion and 86,000 employees in 66 countries. Serving a global client base, the Group provides Consulting & Systems Integration services, Managed Services & BPO, Cloud operations, Big Data & Security solutions, as well as transactional services through Worldline, the European leader in the payments and transactional services industry. With its deep technology expertise and industry knowledge, the Group works with clients across different business sectors: Defence, Financial Services, Health, Manufacturing, Media & Utilities, Public Sector, Retail, Telecommunications and Transportation.

Atos is focused on business technology that powers progress and helps organizations to create their firm of the future. The Group is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and is listed on the Euronext Paris market. Atos operates under the brands Atos, Bull, Canopy, Worldline, Atos Consulting and Atos Worldgrid.

For more information, visit **atos.net**

About Bull, the Atos technologies for the digital transformation

Bull is the Atos brand for its technology products and software, which are today distributed in over 50 countries worldwide. With a rich heritage of over 80 years of technological innovation, 2000 patents and a 700 strong R&D team supported by the Atos Scientific Community, it offers products and value-added software to assist clients in their digital transformation, specifically in the areas of Big Data and Cybersecurity.

Bull is the European leader in HPC and its products include bullx, the energy-efficient supercomputer; bullion, one of the most powerful x86 servers in the world developed to meet the challenges of Big Data; Evidian, the software security solutions for identity and access management; Trustway, the hardware security module and Hoox, the ultra-secure smartphone. Bull is part of Atos.

For more information, visit **bull.com**
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