CASE STUDY
Intel® Xeon® processor 7500 series
Performance: Data-Intensive Computing

Reaching for the stars

French institute turns to Intel® Xeon® processor 7500 series to accelerate their research concerning the dynamics of the planetary systems

The Institut de Mécanique Céleste et de Calcul des Ephémérides (IMCCE) researches celestial mechanics and the dynamics and astrometry of solar system objects. It can trace its origins back to 1795 when it produced ephemeris charts in almanacs. These charts show the positions of solar system celestial bodies on given dates and in regular sequence. Today the IMCCE still produces these charts, which are used by astronomers all over the world. In 1988 the IMCCE helped develop an application called TRIP* – www.imcce.fr/trip – an interactive computer algebra system specially adapted to celestial mechanics, which is still in use today. To increase the performance of TRIP, IMCCE implemented HP ProLiant* DL980 G7 servers powered by the Intel® Xeon® processors 7500 series.

Institut de Mécanique Céleste et de Calcul des Éphémérides

"The Intel Xeon processor 7500 series clearly made a significant difference to the speed and number of calculations we could carry out. Furthermore, we gained more computing variables and also moved from batch processing to interactive processing."

Mickaël Gastineau, Research Engineer,
Institut de Mécanique Céleste
et de Calcul des Ephémérides

CHALLENGES

- **Research imperatives:** IMCCE wanted to increase the speed at which it carried out astronomical research
- **Software optimization:** IMCCE uses TRIP, software designed specifically for celestial mechanics, which needed to be optimized for enhanced performance on servers with more than 32 cores
- **Memory needs:** TRIP is a memory-intensive application, so besides greater CPU performance, IMCCE needed a system that provided large memory caches to ensure top performance

SOLUTIONS

- **Benchmarking:** IMCCE benchmarked the Intel® Xeon® processor 7500 series against its existing servers powered by the Intel® Xeon® processor 5500 and 5600 series
- **Tuning tools:** It also utilized Intel® C++ Compiler and Intel® vTune™ Performance Analyzer to optimize the TRIP code and trace any potential performance bottlenecks
- **Helping hand:** The benchmarking was carried out on an HP ProLiant* DL980 G7 server, which HP fine-tuned to ensure optimal performance

IMPACT

- **Seven times faster:** The HP Intel Xeon processor 7500 series-powered system provided up to seven times faster[1] performance than IMCCE's existing system
- **Memory depth:** Up to 24MB of last level cache for each processor ensured top performance for the memory-intensive TRIP application
- **Built-in flexibility:** The HP ProLiant* DL980 G7 server has good socket scalability and can deliver up to eight cores per socket, as such it is easily expandable so further memory can be added

Star gazing

In 1988 IMCCE helped develop an application called TRIP, an interactive computer algebra system devoted to perturbation series computations and specially adapted to celestial mechanics.

TRIP's development started as an upgrade of the special-purpose Fortran* routines outlined by J. Laskar to demonstrate the chaotic behavior of the solar system. Today TRIP is an essential application for IMCCE, which conducts research activities in celestial mechanics and planetary dynamics.

IMCCE's research also includes generating ephemerides of solar system objects on behalf of the Bureau des Longitudes, the organization responsible for publishing the official French ephemerides. These star charts show the position of heavenly bodies on given dates and at regular periods. IMCCE also contributes to international space exploration endeavors and is contracted to several space agencies and companies that operate within this field.

To enable IMCCE to reach its research objectives, the TRIP software is upgraded almost every year. The application has approximately 400,000 lines of code and, because of the large number of computed variables, some calculations could take more than 20 hours to complete. Given that IMCCE carries out several million hours of calculations every year, it wanted to find a way of improving performance to speed up computational research.

Large level 3 cache memory ensures top performance for memory-intensive applications

Seeking the new

Mickaël Gastineau, Research Engineer at IMCCE, said: "We study planetary systems and newly discovered extra-solar planets, for example, analyzing the dynamical stability of the planetary system candidates. New extra-solar planet candidates are discovered very frequently, so as you can imagine we have a lot of work to do, which specifically centers on numerical simulations and symbolic computations."

Previously, IMCCE had been using servers powered by the Intel® Xeon® processor 5500 and 5600 series. However, the Intel® Xeon® processor 7500 series has many cores and a large last level cache. As a result, IMCCE decided to benchmark this processor on an HP ProLiant* DL980 G7 server running a Linux* operating system and the TRIP software.

IMCCE made use of Intel® C++ Compiler and Intel® vTune™ Performance Analyzer to optimize the TRIP code and trace any potential performance bottlenecks.

Helpful tools

Intel C++ Compiler compiles C++ source files on Linux operating systems. It has a breadth of advanced optimization, multi-threading, and processor support and also provides a highly optimized math library. Intel® vTune™ Performance Analyzer offers insight into the performance of software at the system, application, and microarchitecture-levels, enabling the identification of performance bottlenecks.

Before beginning the benchmark tests, IMCCE considered data reports from HP which provided an insight into the performance of the Intel Xeon processor 7500 series. HP also set up the system and helped identify the best performance parameters for TRIP software, and then fine-tuned the system to ensure optimal performance.

The benchmark tests revealed a performance improvement of up to seven times when compared to the servers powered by the Intel Xeon processor 5600 series. For example, an average TRIP calculation on these systems sometimes took 20 hours to complete. The same calculation on the HP system powered by the Intel Xeon processor 7500 series was completed within approximately three hours. However, some calculation times were reduced to just a few minutes or more.

Maximum performance

Mickaël Gastineau said: "The Intel Xeon processor 7500 series clearly made a significant difference to the speed and number of calculations we could carry out. Furthermore, we gained more computing variables and also moved from batch processing to interactive processing."

The last level cache and processor core count were instrumental in the performance increases. Gastineau adds: "TRIP is very memory-intensive and, because we had eight cores on each socket and each core had a last level cache, we gained extremely good performance."

Generally, the Intel Xeon processor 7500 series provides a dramatic increase in performance, efficiency and reliability and scales to take on the toughest tasks.

Following the successful completion of the benchmark, IMCCE implemented HP ProLiant* DL980 G7 servers powered by eight Intel Xeon processors 7500 series, providing it with a system consisting of 64 cores.

Secrets of the universe

One of the further benefits of the HP system powered by the Intel Xeon processor 7500 series is its flexibility and potential for easy scalability. If required, IMCCE can theoretically scale the TRIP code up to 512 cores. Furthermore, because the servers have eight sockets each they are easily expandable. Gastineau says, "We can now simply add more memory as and when required."

Before the system was fully implemented, HP carried out further support work to enable optimal efficiency for the TRIP software. IMCCE also made further use of Intel® C++ Compiler and Intel® vTune™ Performance Analyzer. This ensured that IMCCE would gain maximum performance for its software.

IMCCE now provides results much faster to the academic research community and is helping accelerate research into new planetary systems and celestial bodies.

Spotlight on the Institut de Mécanique Céleste et de Calcul des Ephémérides

The Institut de Mécanique Céleste et de Calcul des Ephémérides (IMCCE) – www.imcce.fr – is part of the Observatoire de Paris, the foremost astronomical observatory in France, and one of the largest astronomical centers in the world for research in astronomy and astrophysics. The IMCCE is also supported by the Ministry of National Education and the Centre National de la Recherche Scientifique. It can trace its roots back three centuries to a time when it produced ephemeris tables in the form of almanacs. Today, it is still involved in this type of research, though its principal areas of research are celestial mechanics and dynamics and astrometry of solar system objects.

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[1] Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

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