Scentific application - *Seismic simulation*

Introduction

With the **simulation software** developed by **CEA's** Environmental Assessment and Monitoring Department, a new modelling method is now available for estimating the propagation of seismic waves and their effects on buildings,namely the **Mka3D**.

Traditional method

Earthquakes have been modelled using the finite element method,which consists of discretizing the ground into virtual cells and then simulating wave propagation through the geologic layers represented by this mesh.However it is difficult to apply such a method to processes dealing with fracturing and subsidence, when there is loss of contact between the environmental constituents, which become separated.

New method

Rather than discretizing structures into virtual cells, the idea is to **discretize them into solid and rigid particles,**which interact with their neighbouring particles according to **Newtonian Mechanics.** The load-bearing structure of buildings – floors,shells, pillars – is divided up in the same manner, even if the particles are 100 times smaller here (1 metre in diameter for buildings,100 m for the ground). The method is demanding in terms of computing performance: to simulate the alpine earthquake 3 million polyhedral particles need to be accounted for, each equipped with 6 degrees of freedom (translations and rotations) and relating to ten neighbouring particles.Around **sixty equations** need to be solved per particle, at each stage of the calculation, not forgetting that **each stage has had to be iterated 100,000 times** to simulate a one-minute tremor.

Technical details

The simulation was carried out at the end of 2007 on the CEA's Tera 10 supercomputer. The operation took **500 processors 40 hours, totalling 20,000 computing hours,** making it possible to model the earthquake **over a 11 x 11 km zone, 2 kilometres** deep, for a time lapse of one minute, long enough to estimate the impact of the tremor. Today, technological progress has reduced computing times and we are already preparing for migration to the CEA's future Tera 100 supercomputer which will represent a factor-10 gain in speed.

TERA 100 Supercomputer – fastest in Europe

With a theoretical computing power of **1.25 Petaflops,** Tera 100 **ranks** among the three most powerful supercomputers in the world.Tera 100 consists of **4,300 bullx S Series servers**, the model announced on the market by Bull in April 2010. It features **140,000 Intel® Xeon® 7500 processing cores, 300TB** of central memory and a total storage capacity of over **20PB**. Its **500GB/sec** throughput to the global file system is a world record for a system of this type.

Tera 100 offers **exceptional processing capacity.** By way of comparison, it can effectively carry out more operations in a single second than the world's population would be capable of performing in 48 hours if each person completed one operation a second, day and night.

Its ***capacity to transfer information is equivalent to a million people watching high-definition films simultaneously*** and its ***storage capacity corresponds to over 25 billion books.***

It uses the SLURM resource manager for scheduling batch jobs.Tera 100 uses Bull XBAS Linux,

a Red Hat Enterprise Linux derivative.

References:

http://en.wikipedia.org/wiki/Tera_100
http://www.top500.org/blog/top500-slides-from-sc12-are-now-available/
http://www.cea.fr/english-portal/news-list/tera-100-the-first-european-supercomputer-to-br-43426