# Crash-tests simulations by LS-DYNA code on the HPC AMD64 Cluster

**Authors:**

Prof. Nikolay Shabrov, Computer Technologies in Engineering Dept.,
Saint Petersburg State Polytechnical University, Russia
Prof. Yuri Mikhailov, Computer Technologies in Engineering Dept.,
Saint Petersburg State Polytechnical University, Russia
Iliya Lopatukhin, Computer Technologies in Engineering Dept.,
Saint Petersburg State Polytechnical University, Russia
Dr. Evgeniy Shmelev, AVTOVAZ Company, Russia
Dr. Sergey Kurdyuk, AVTOVAZ Company, Russia

**Correspondence:**

Computer Technologies in Engineering Dept.,
Saint Petersburg State Polytechnical University, Russia

Telephone +7 (812) 552 7770
Fax +7 (812) 552 7770
Email: Shabrov@rwwws.ru

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## ABSTRACT

Crash-test simulations of the car models by LS-DYNA code are carried out on the HPC 16 CPU AMD64 Opteron processors Cluster. Simulations are based on the large 3D finite element car models that contain more then one million DOF. Architecture and benchmark of the HPC 16 CPU AMD64 Cluster were tested by engineering applications with commercial engineering codes LS-DYNA instead of synthetic benchmark. For this purposes several tasks were taken from www.topcrunch.org. The tasks named “3 Vehicle Collision” and “Neon”. Benchmark tests have shown pretty good results for such type of industrial problems and confirmed that Opteron processor on AMD platform is preferable to Itanium processor on Intel platform. LS-DYNA code was used for crash analysis of real modern cars produced by AVTOVAZ in Russia. HyperMesh software was used to create finite element mesh and for a pre-processor for LS-DYNA solver. To visualize simulations as 3D virtual reality objects crash analysis results obtained on HPC Cluster were imported on 3D Virtual reality system named WorkBench. WorkBench 3D virtual reality system contains soft screen, two multimedia projectors, computer with dual heads graphics adapter and tracking system Flock of Birds. COVISE software was used for visualization of CAD models of the cars and crash analysis results as 3D virtual reality objects.


## INTRODUCTION

Computer simulation of crash-tests of the modern automobiles is impossible without application of high performance computing clusters. The choice of cluster architecture plays a vital part in cluster simulation problem formulation. Recently the cluster architecture based on AMD64 platform with Opteron processor takes the dominating position in crash-test modeling. Numerous tests by different users justify that Opteron processor has better performance compared to Itanium processor on Intel platform.

High Performance Computing Cluster Center of the St. Petersburg State Polytechnical University has two Linux clusters: 16 CPU IA-32 based on Intel Pentium III platform (2001) and new one (2004) 16 CPU AMD64 based on Opteron 244 processors. Cluster with IA-32 architecture uses Myrinet communication environment for inter-processor exchange, whereas AMD64 cluster uses Gigabit Ethernet. The choice of AMD64 for new cluster architecture was determined by thorough analysis of the modern condition and tendencies in microprocessors, as well as by the development of system and application software. The special feature of Opteron processor is that it can operate in two modes: 32-bit and 64-bit. The 32-bit applications can run in 64-bit operation system. Moreover, in 32-bit mode the Opteron processor is by command system compatible with Intel processors, which allows using all software developed for these processors including translators Intel that have high quality of generated code.

The clusters have such specialized software as CFD package FLUENT and CAE package MPP LS-DYNA installed.

## Computer Simulation

Simulation of automobile crash-test on the cluster is only one part of the simulation procedure. In total the simulation process includes the development of 3D solid automobile model in one of CAD systems, the finite element mesh generation and simulation using the cluster and then visualization of the results in 3D virtual reality system. At HPC Cluster Center of the St. Petersburg State Polytechnical University the following software is used for simulation of crash-tests: Pro/Engineer (PTC), Hyper Mesh (ALTAIR), MPP LS-DYNA (LSTC) and 3D interactive Virtual Reality software COVISE (HLRS).

Our HPC Cluster Center was invited to take part in Top Crunch (www.topcrunch.org) project funded by DARPA through USC ISI to benchmark high performance computer systems with commercial engineering codes instead of synthetic benchmarks. The commercial code LS-DYNA was chosen for evaluation benchmark.

There are two problems available for the benchmark: 1) a neon striking a rigid wall, and 2) a three vehicle collision. We ran these problems on AMD64 platform and varied the number of processors from 1 to 16. The results were submitted to Top Crunch web site and are shown in the table below.

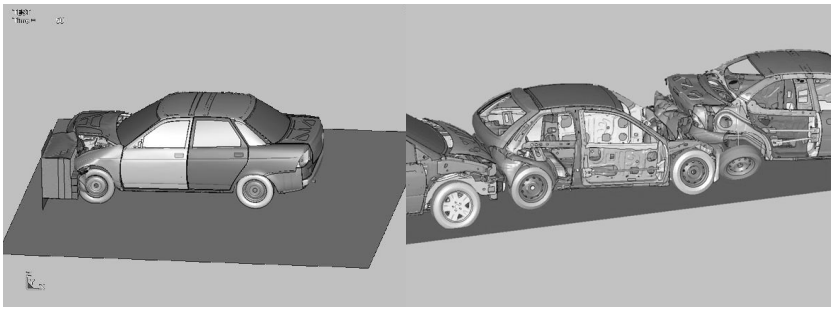
Topcrunch test results.

| Test name | CPU | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 4 | 8 | 16 |
| Neon | 30090 | 17098 | 8989 | 5147 | 3092 |
| 3 vehicle collision | * | * | * | 67013 | 35913 |

HPC Cluster Center takes part in crush-test investigation of modern vehicles produced by “AUTOVAZ”. The large number of simulations was carried out using AMD64 cluster architecture. The dimension of finite element models of “AUTOVAZ” automobiles comprises about 1.5 million DOF. The obtained simulation results prove that the choice of simulation cluster based on AMD64 platform with Opteron processor was correct. The senior students of Computer Technologies in Engineering Department of the Saint Petersburg State Polytechnical University took part in the work.

The natural supplement to modeling the dynamic processes in mechanical systems on clusters is the possibility to visualize the results as 3D virtual reality scenes using WorkBench software and hardware complex installed in HPC Cluster Center. WorkBench includes the soft screen, two special projectors, computer with dual graphics card and special software COVISE.

The examples of crush-test simulation using AMD64 architecture cluster are presented below.



## Summary and Conclusions

HPC Cluster Center has several years of experience in using MPP LS-DYNA code on computer clusters with IA-32 and AMD64 architecture to model complex dynamic processes in mechanical systems. Computer cluster based on AMD64 platform with Opteron processor showed the high level of performance for simulation of crush-tests of real automobiles produced by AUTOVAZ. Our investigations of AMD64 Linux cluster performance justify the data of other organizations on the advantages of Opteron processor compared to Itanium.

## References

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