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Connecting Engineering Open Source Software: New Horizon of Modeling Oportunities

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Abstract

Open source tools become more and more popular for computer-aided engineering (CAE) tasks since they are free and have no license limits for parallel computing. Nevertheless, the engineers still frequently suffer from the lack of handy pre- and post-processing routines in open source software. Moreover, the access to multi-physics is still limited using only one open source tool. That all results in significant investments needed in front to use open source software for industrial needs as well as for academic research.

This work presents the integration platform for open source CAE software. This platform allows to connect various software into the single framework, which increase usability of open source and provides access to multi-physics, breaking all performance limits typical for commercial software.

The cases for simulation of the thermal analysis of a printed circuit bard and an induction heating task are presented in this paper. For this purpose, Salome, GetDP and Paraview (all open source software) are connected within the platform.

Introduction

Computer-aided engineering (CAE) approach is replacing physical prototyping in industry since 1970s, when such well-known giant software companies as ANSYS Inc. and Dassault Systemes were founded. The companies and their software growth parallel to the computer power towards approx. $4 billion market today. More than 40 years already passed, but the market is still growing 11% per year mostly due to continues digital replacement of physical prototyping in industry. Moreover, emerging markets, such as China, India, Brasil, Mexico are approaching very fast and have chance to bring another couple of billions within a decade.

There are two opposite trends in software development, which could be recognized from the very beginning of CAE industry: segmentation of software products and generic striving for multiphysics. Sure, the individual chose of each customer depends on the needs of its business. However, one can recognize that the giant public companies like ANSYS, Dassault Systemes, Autodesk, which have been aggressively growing by means of acquisition of various specific software companies, create generic platforms in order to tie together specific software products they have. The mentioned companies already released platforms (ANSYS Workbench, 3DEXPERIENCE). Figure 1 demonstrates historical trending of CAE industry.

Nevertheless, it should be mentioned that evangelists of the opposite trend towards highly customized software for niche industries still is able to find their customers. WindSim, Phoenics, FieldScale, PZFlex and many others can be mentioned here. The generic giants are

trying to take this market segment with app stores, which represents the market place for customized modules.

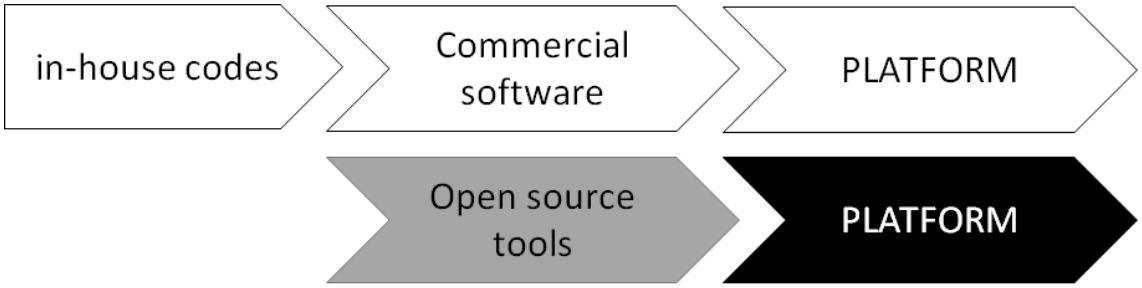

Fig. 1. Historical development of CAE software

1. Power of Open Source Tools

One of the main obstacles, which prevent small and medium size companies from using commercial software, is very high price. A single license may cost up to $200 thousand with subscription fee up to 30% of the purchase price per year. Moreover, the traditional business models of on-premises commercial software contains the explicit pricing model for multi-CPU calculations. Traditionally, the basic package allows calculations only on two-four cores, which makes heavy calculations, e.g. turbulence, near impossible. At the same time, the packages for high-performance computing (HPC), which nevertheless still limits the number of cores with 10-16, significantly increase the price of simulation. Nowadays, when even a laptop may have 8 cores, such limitations seems to be archaic.

Alternatively, there are smart open source CAE tools. Such software mostly were developed in local academic communities for entire needs. Some of them successfully grew to become the strong international communities and leading benchmark positions, like OpenFOAM. The academic users were not happy with closed code of commercial software, which limits its use for scientific and non-standard cases.

However, the users of open source tools face several challenges. 1) The tools are fragmented. Due to the fact they are driven by different communities, they usually have different formats, literary, they do not speak to each other, which bother access to multphysics. 2) Open source tools provide poor user experience and frequently do not have user interface at all, like OpenFOAM or GetDP. 3) Lastly, they are unsupported in commercial sense.

2. CENOS platform

In CENOS, we believe in great power behind open source tools and their communities. Based on our experience, we see that numerous open source codes already contain the smartest algorithms, which were created over the decades of science. In fact, it is our scientific heritage, there is no reason to change for it. Only time-saving interaction layers are worth to pay for. We believe that fixing the issues mentioned in the last paragraph, we shall be able to unleash the power of open source tools and communities behind them to industry.

CENOS is the affordable platform for engineering simulation, which ensures automated inter-connections between various open source tools and provides simplified user interface for engineers. It allows easy integration of new open source tools, in-house codes and routines for automated pre- and post-processing for niche industries and applications.

Actually, as it is demonstrated in Figure 1, CENOS is the new consequent step in development of open source tools, which follows the trend of commercial software. However, the unleashed power of open source gives the new degree of freedom for CAE development.

Figure 2 demonstrates the screenshot of CENOS interface. The simple workflow is created, it will be executed fully automatically after the "run" button is be pressed. The demonstrated workflow contains Salome for pre-processing (geometry creation and meshing), GetDP for the computing part and ParaView for post-processing (visualization). CENOS contains special user interface for definition of the parameters of simulation within GetDP block.

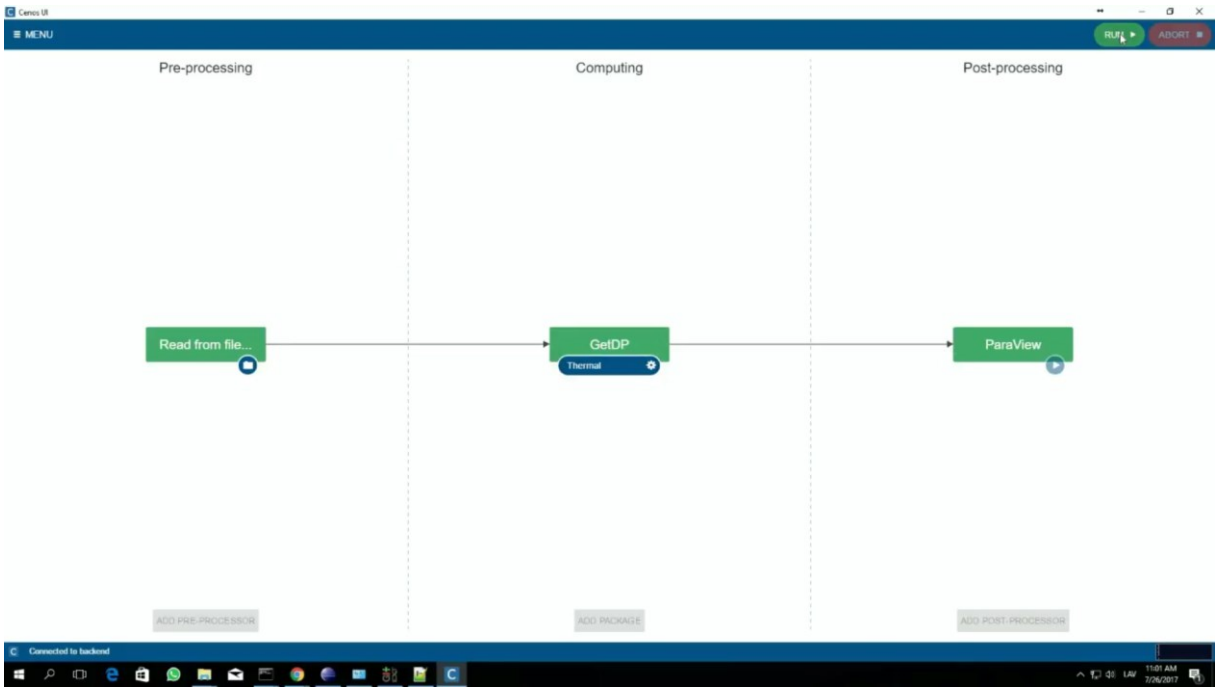

Fig. 2. The screenshot of the automated workflow created in CENOS user interface

3. Examples of Application

This paper demonstrates two particular application of CENOS platform.

Figure 3 demonstrates temperature distribution on the surface of the experimental printed circuit board (PCB). This PCB consists of 6 microprocessors, which are heated up. The slits are created in order to minimize overheating of the central microprocessors due to overlapping of the heat from the neighbouring chips. The graph on right side demonstrates the temperature in the middle of the chip over time. 2W heating was applied in each chip for first 60 s, and natural convection cooling after that.

Figure 4 demonstrates the lines of magnetic field in the system of simple induction heating: cylindrical billet and solenoidal inductor around it.

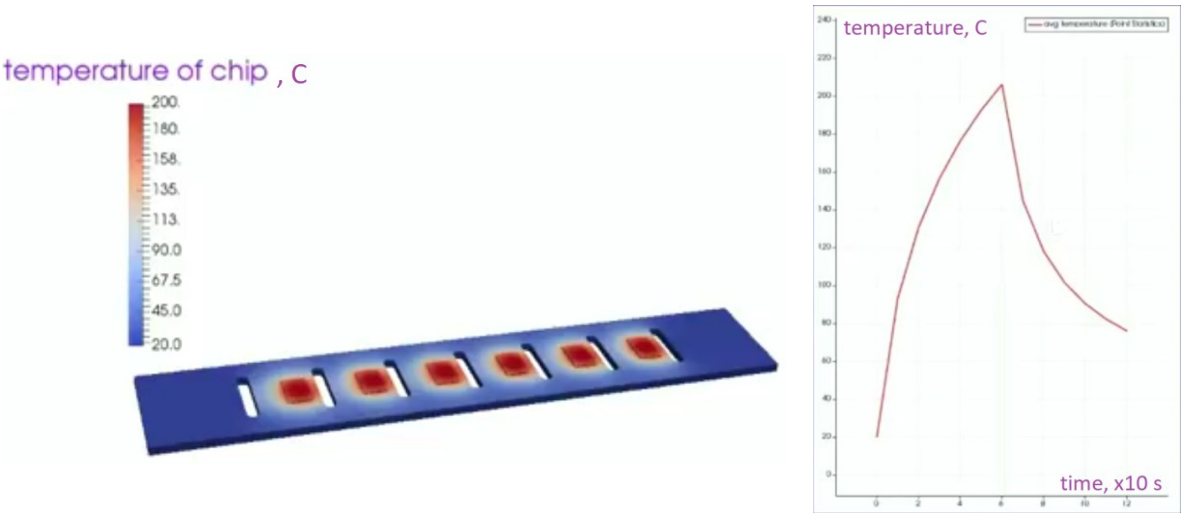

Fig. 3. Thermal analysis of the experimental printed circuit board (PCB). Left: temperature distribution on the surface. Right: temperature in the middle of the chip over the time – 60 s heating, then cooling

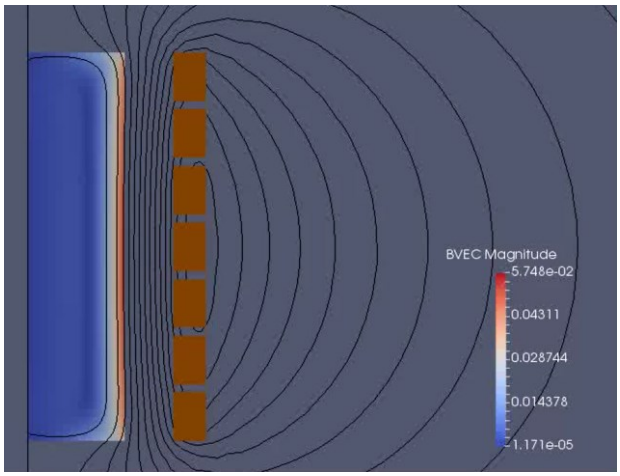

Fig. 4. Distribution of magnetic field in case of the axial symmetric induction system

Conclusion

Open source tools are powerful instruments for CAE tasks, which unleash the community and breaks limits for parallel computing. CENOS is the platform, which allows to use the best of various open source tools simultaneously, providing access to multiphysics and saving engineers' time with user friendly interface.

CENOS platform supports the tasks of thermal analysis and induction heating calculation now.

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