

# 64-bit Computing With Rocscience Software

Although 64-bit computing has been around for a long time in research environments, it is now entering the mainstream due to the introduction of 64-bit versions of Microsoft's operating systems ([XP](#) and [Vista](#)) along with inexpensive 64-bit processors from Intel and AMD. We at Rocscience are frequently asked questions such as:

- Will Rocscience software work on my new 64-bit computer?
- Will I see any improvement in performance?
- Can I get a 64-bit version of my Rocscience program?

This article will address your 64-bit concerns.

## 64-bit computing

The term '64-bit' means that an integer is made up of 64 binary digits. Since integers are used to store memory addresses, the maximum integer size an operating system can accommodate dictates the amount of memory (the total number of addresses) that can be accessed.

For a 32-bit architecture, the maximum integer is  $2^{32}$ , meaning that approximately 4 billion addresses are accessible, or 4 GB of RAM may be used. Regardless of how much physical memory you have in your 32-bit computer, you will never be able to use more than 4 GB in your applications. In practice, there are generally further limitations due to your hardware or operating system so you can usually not use all of the possible 4 GB. For the new 64-bit architecture, the maximum integer is  $2^{64}$ , which yields a maximum memory of 17.2 billion GB!! With a 64-bit operating system and 64-bit processors, the amount of RAM you can use is limited only by the amount of physical memory you can put into your system (or by [limits imposed by your operating system](#)).

What are the implications of all this? It means that with a 64-bit system you can run programs requiring significantly more memory than you could with a 32-bit system. Will a 64-bit system make your programs run faster? The jury is still out on that one. To try to answer this question (and others), we investigated the performance of one of our programs, *Phase<sup>2</sup>*, in 32-bit and 64-bit environments.

## *Phase<sup>2</sup>* on a 64-bit machine

Although the current release of our finite element program *Phase<sup>2</sup>* (version 7.0) is compiled for a 32-bit architecture, it runs perfectly well on a 64-bit machine. However, this means that the program does not take advantage of any of the 64-bit technologies and the maximum amount of RAM memory that can be used by a *Phase<sup>2</sup>* model is quite a bit less than 4 GB (since some of the available memory is reserved for the operating system and other key functions).

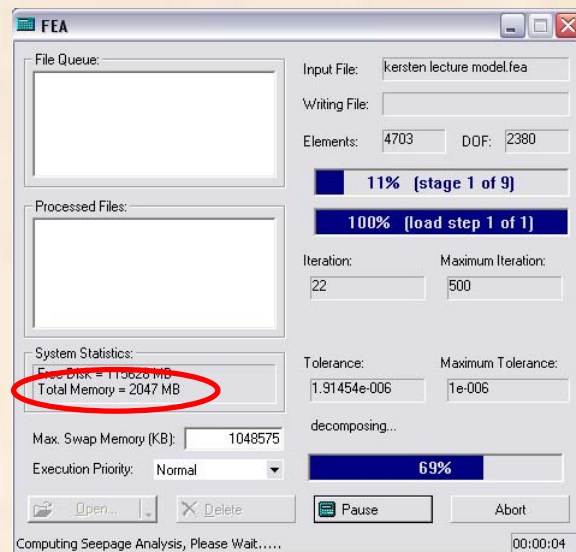
To test for *Phase*<sup>2</sup> speed differences in the different operating environments, we ran a series of models on a 64-bit computer with the following specifications:

- Processor: Intel Core2 Duo CPU E6550 @ 2.33 GHz 2.33 GHz
- Memory (RAM): 8.00 GB
- System type: 64-bit Operating System, Windows Vista Business

and a 32-bit computer with the following specifications:

- Processor: Intel Core2 Quad CPU Q6600 @ 2.4 GHz 2.4 GHz
- Memory (RAM): 3.25 GB
- System type: 32-bit Operating System, Windows XP Professional

It is interesting to note that even though the 32-bit computer has 3.25 GB of RAM installed, only 2GB were available to *Phase*<sup>2</sup> as shown in the screen capture below.



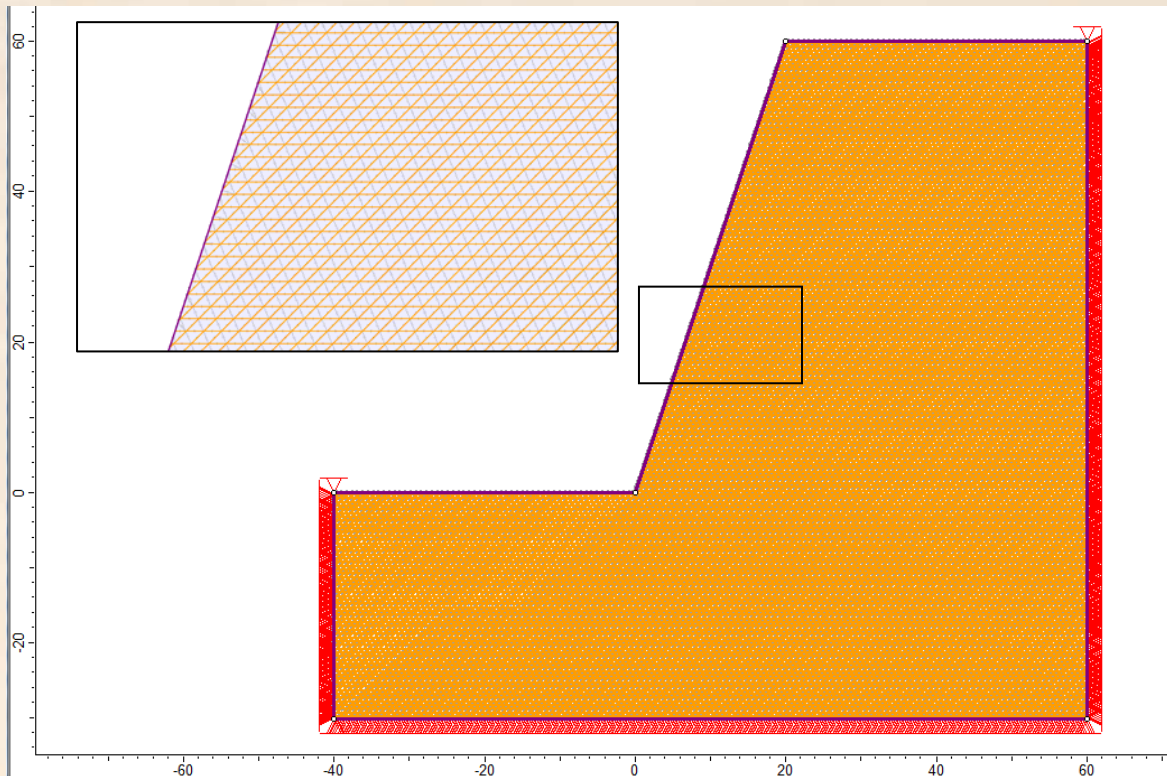
The comparison of results is shown in the table below. All models were run using the fast Intel solver. The first two models are from the 'Examples' directory that installs with *Phase*<sup>2</sup>. The third model is a contrived example created to push the limits of the computer and is shown in the figure below.

| Model     | Degrees of Freedom | 32-bit computer |             | 64-bit computer |             |
|-----------|--------------------|-----------------|-------------|-----------------|-------------|
|           |                    | Time (s)        | Memory (MB) | Time (s)        | Memory (MB) |
| Kersten   | 4,820              | 189             | 34          | 195             | 45          |
| Open Pit  | 2,972              | 54              | 23          | 57              | 36          |
| 60m slope | 311,914            | 1239            | 961         | 1215            | 972         |

*Comparison of speed and memory use for 32-bit version of Phase*<sup>2</sup> *running on a 64-bit computer vs. a 32 bit computer.*

You can see that the 32-bit computer is generally slightly faster than the 64-bit machine, as you would expect from the slightly faster processor speed. The 64-bit computer uses more memory than the 32-bit machine, but the difference narrows as model size increases. The model results (displacements and stresses) on the two machines are

virtually identical. These tests show that the 32-bit version of *Phase*<sup>2</sup> runs well on a 64-bit machine, however no benefits are observed in terms of speed or memory use.



The model '60m slope'. A close-up of a portion of the slope is shown inset.

## 64-bit version of *Phase*<sup>2</sup>

*Phase*<sup>2</sup> 7.0 was recompiled as a 64-bit application. This involved a small amount of recoding. In particular, 64-bit versions of the Intel solver libraries were used in the new compilation.

Performance of the 64-bit version of *Phase*<sup>2</sup> is compared to the performance of the 32-bit version run on the same computer (the dual core Vista machine described above). A fine-mesh version of the slope model was created to push the computational limits. Speed results are shown in the table below.

| Model             | Degrees of Freedom | Time to solve (s)    |        |         |
|-------------------|--------------------|----------------------|--------|---------|
|                   |                    | 32-bit               | 64-bit | speedup |
| Kersten           | 4,820              | 195                  | 161    | 17 %    |
| Open Pit          | 2,972              | 57                   | 43     | 25 %    |
| 60m slope         | 311,914            | 1215                 | 943    | 22 %    |
| 60 m slope (fine) | 533,924            | aborted <sup>1</sup> | 1807   | -       |

Comparison of speed for 32-bit and 64-bit versions of *Phase*<sup>2</sup> running on a 64-bit computer. <sup>1</sup>The 32-bit version of this model aborted due to insufficient memory

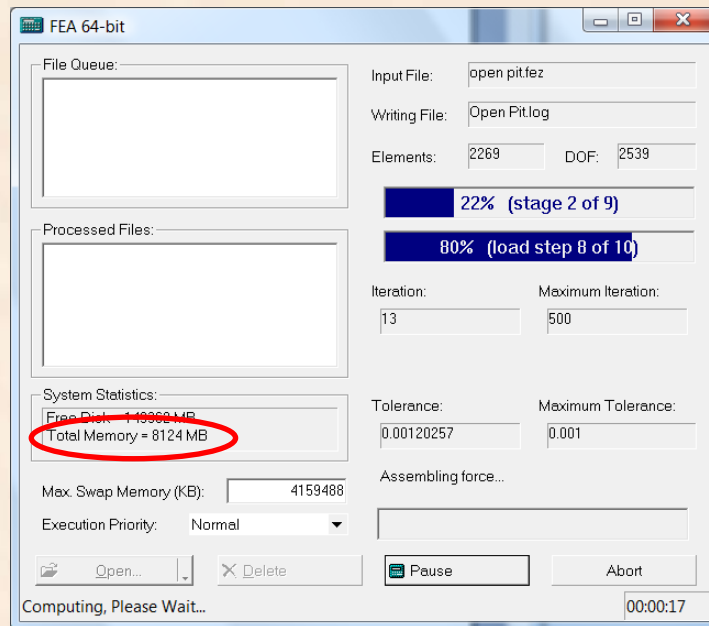
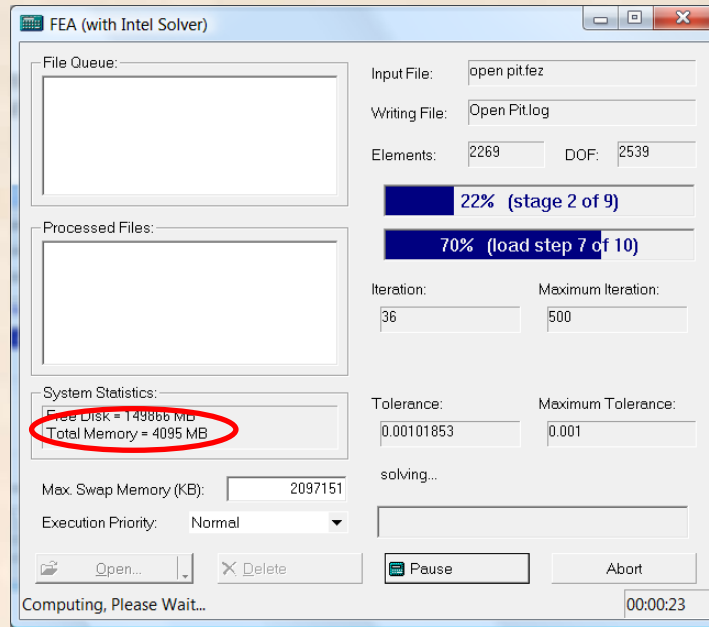
You can see that there is about a 20% speed up in going to the 64-bit version of *Phase*<sup>2</sup>. However the real improvement comes in the fine mesh version of the 60m slope model. With the 64-bit version of *Phase*<sup>2</sup>, significantly more RAM memory is available to the application, so it is capable of solving these very large models. The 32-bit version aborted due to insufficient memory. Even though the model attempted to solve the problem 'out of core', where memory was swapped to the hard disk, it was still impossible to solve this problem with 32-bit *Phase*<sup>2</sup>.

The 64-bit version of *Phase*<sup>2</sup> uses about 10-20% more memory than the 32-bit version. This is not really a concern though due to the extended memory available to the 64-bit version. To emphasize this further, the figure below shows screen captures of the two solvers during calculation. You can see how the maximum amount of memory available to *Phase*<sup>2</sup> is significantly greater for the 64-bit version.

Model results (displacements and stresses) calculated with the 32-bit and 64-bit versions were essentially identical.

## The future

The future is 64-bit, and the improvement in performance observed with these tests clearly justifies the development of 64-bit versions of our computationally intensive software programs like *Phase*<sup>2</sup>. The 64-bit version of *Phase*<sup>2</sup> used in this article is not yet available. It still requires extensive testing and benchmarking. As well, different versions may have to be compiled for different types of 64-bit processors (e.g. Intel 64 Architecture versus Itanium). Keep your eyes open for a release sometime in the near future. In the meantime, you can use the 32-bit version of *Phase*<sup>2</sup> with confidence on your 64-bit machine.



*Screen captures of the Phase<sup>2</sup> computation engine for the 32-bit version (top) and 64-bit version (bottom) for the same model on the same computer.*