

CAE on 64-bit systems

While CAD is seen as a key market for 64-bit computing, the performance benefits can be even bigger for CAE. Greg Corke talked to Team Engineering about running NX Nastran on 64-bit Linux.

→ OVER THE PAST year we've heard from a number of readers who are simply running out of memory when using 32-bit Windows XP. Some of their models have become so large that they can barely load them up into their CAD software, let alone work on them once inside, or carry out downstream processes such as 2D drawing production, rendering or analysis.

For these users the 2GB memory limit for applications imposed by 32-bit Windows is simply too small. The /3GB switch brings a little relief by enabling Windows to access an additional 1GB of memory from disk space using a swap file, but this is a cumbersome solution, and many 'power' users still have to break down their assemblies into bite-sized chunks or, in the case of analysis, simplify or de-feature their models.

It's been well documented over the years that 64-bit computing is the solution to this problem. Indeed, if you've got 64-bit hardware, a 64-bit OS and a 64-bit application, then these limits can be removed instantly. One area that has been benefiting from 64-bit environments for many years is the Computer Aided Engineering (CAE), or analysis and simulation sector. As is the case with 3D CAD, the trend in CAE is for larger, more complex models. Design disciplines are overlapping and the analysis and optimisation of the overall system, rather than a 'snapshot', has become critical in many areas. And where analysts would traditionally de-feature models to get them to run in the available hardware, many engineers are moving away from simplification in the quest for even more accurate results.

While 64-bit CAE originated on UNIX, the introduction of 64-bit Linux and more recently 64-bit Windows (both of which can run on standard PC hardware) means there is now a much more cost effective 64-bit platform on which to carry out complex analyses.

64-bit performance

One company that has been pioneering the adoption of analysis on 64-bit Linux in the UK is Team Engineering, who offers a range of CAD/CAM/CAE solutions based on UGS' NX platform.

Team Engineering has recently carried out research to quantify the benefits of moving to a 64-bit Operating System, when running NX Nastran for a variety of analysis scenarios. We caught up with Mark Sharples, Senior Analyst,

Team Engineering, who has been at the forefront of this project, to find out more. "Over the past six months we've had a number of customers who have simply run out of power when using 32-bit Windows," explained Sharples. "The obvious advice to give them was to get a 64-bit workstation or Linux box, but what they really wanted to know was how much better they are?"

"So we got hold of a Linux box from HP to find out exactly where NX Nastran on 32-bit Windows XP reached its limits and where NX Nastran on 64-bit Linux really started to benefit."

The workstation in questions was an HP xw6200 which featured two Intel Xeon processors and 8GB of DDR2 memory.

Team Engineering initially ran a large analysis problem which had previously been carried out on a 32-bit Dell Precision M70 mobile workstation with 2GB RAM and compared and contrasted the performance with the new Linux box. "What I found was something that would have taken 1 hour and 50mins on my 32-bit mobile workstation was down to about 6mins on the Xeon," said Sharples.

For this initial run, Team Engineering had tuned the solver on the Linux machines to cram about 7GB of scratch files into the memory, whereas the mobile workstation was having to rely on hard disk swap space as it was only able to utilise 1.7GB of physical memory. "We could see immediately that by taking everything into memory on the Linux machine and seriously reducing disk I/O that is where the major savings were," said Sharples. "If you're paging it to disk then your I/O to and from the disk is pitiful, but if you're doing it in memory and you've got a large chunk of memory then you can really get large throughput."

Encouraged by these initial findings, Team engineering embarked on a much more structured approach to its research and carried out a range of studies in NX Nastran using linear statics (Iterative solver) and dynamics (Lanzcos solver). "Obviously that was just a snap shot, so we decided to take a step back from this and did a range of different static solves with escalating degrees of freedom (i.e. the amount of equations you need to solve), and we found the level where 32-bit died because it didn't have enough memory. Then you move into 64-bit and it just it just goes on and on. Of course, you'll still hit a limit eventually, but this is way into the distance.

Test workstations

Team Engineering used two primary workstations in its test process - a 32-bit Intel Pentium M-based Dell Precision M70 and a 64-bit Intel Xeon-based HP xw6200. While the Precision M70 is a mobile workstation, the Pentium M it uses is still an incredibly powerful processor and our tests at MCAD over the years have shown that it is more than a worthy rival for Intel's Xeon. However, there is a slight mismatch in terms of processing power between the two machines because the HP xw6200 has two Xeon processors and the Dell Precision M70 only one Pentium M processor. NX Nastran 4.1 is a multithreaded application and therefore can take advantage of multiple processors when running analysis jobs, so the HP xw6200 has a slight advantage over the Dell Precision M70.

While the playing field was not completely level, this should not detract from primary findings during the exercise. The increase in the amount of addressable memory is the key factor when going from 32-bit to 64-bit and even if the same HP xw6200 workstation was run in 32-bit Windows mode the results would have been very similar.



32-bit workstation
Dell Precision M70

- 2.26 GHz Intel Pentium M processor
- 2GB DDR2 SDRAM
- Windows XP Professional SP2 (32-bit)

www.dell.com/uk



64-bit workstation
HP xw6200

- 2 x 3.8GHz Intel Xeon processor
- 8GB DDR2 SDRAM
- Redhat Linux WS 4 (64-bit)

www.hp.co.uk/workstations

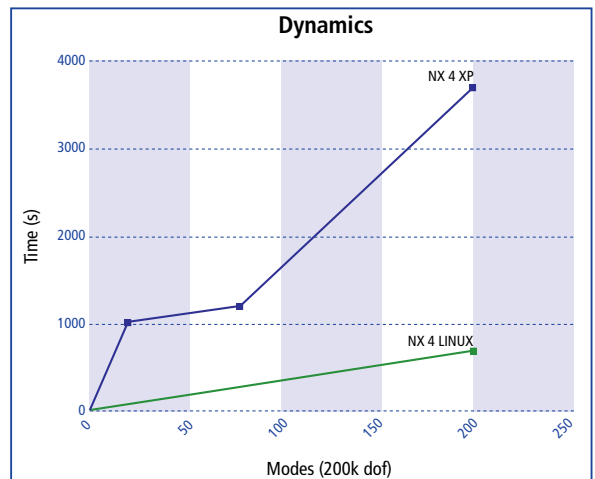
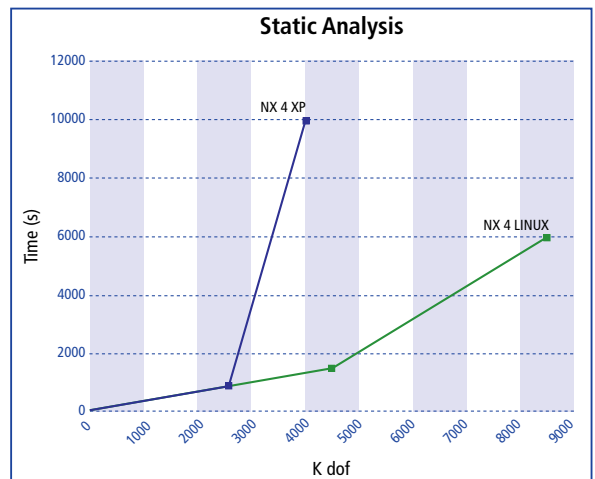
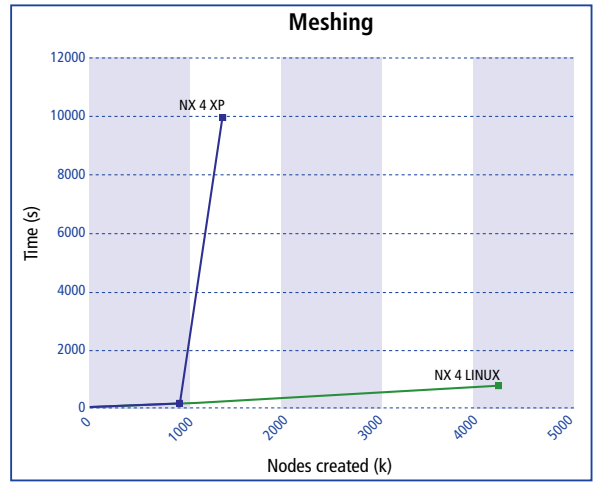
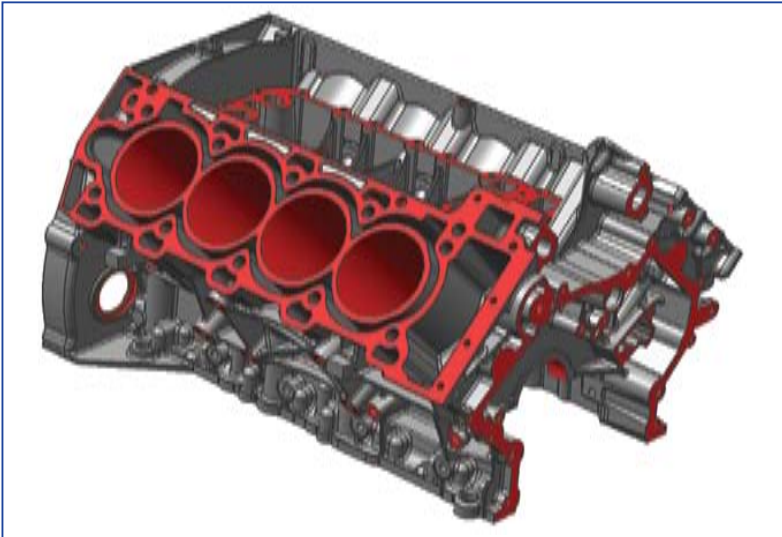


"We found that 1.5 - 2 million degrees of freedom is typically the cut off point for 32-bit. With linear statics you can solve larger degrees of freedom in a shorter time, but if you do dynamics then the time taken goes up by an order of magnitude. If you have a million degrees of freedom for a dynamic solve then obviously it's going to take longer than for a linear static," concludes Sharples.

Meshing performance

Of course, 32-bit systems also fall down when meshing - the first step in the analysis process. Engineers typically get around this problem by 'de-features' or getting rid of all the features they can't afford to mesh without impairing their analysis. However, with 64-bit this is no longer necessary, says





Sharples. "De-featuring can add hours to the pre-processing stage. You can spend a long time cutting it down just so you can physically solve it. With 64-bit you can just bang it in. You can stick the whole model into the mesher to mesh it, and then you've also got the capacity to solve it.

"On my 32-bit machine if I tried to mesh, say around 800,000 or 900,000 nodes, that took about half an hour and it was really starting to struggle with memory, but on the 64-bit Linux solution I could mesh around 4,500,000 nodes in about 10 minutes, and it still kept on going higher!"

Working with customers

Team Engineering works closely with its customers to help them assess their requirements, both in terms of hardware and software. "If a customer comes to us for advice, we look at the size of their problems and the kind of things they do. I.e. if they use more than a certain number of degrees of freedom then we can point them towards 64-bit immediately. However, many already know the limitations of their hardware, particularly if they are already hitting the limits and have to abstract and simplify the geometry for analysis.

"Moving on, we are looking to get customers to give us their typical analysis problems and we will benchmark them and solve them. This way they get a direct measure of performance and we get more data that we can use as collateral," adds Sharples. "We can then say to them, this is how long it took on 32-bit Windows, this is how long it took on 64-bit Linux, and they can easily go off and make the decision themselves. At the same time, we can also help them assess the potential to grow for the future. It's all well and good saying 64-bit is the way forward, but if you can't quantify it and talk sensibly about what they've already got then why move

forward? Customers aren't going to buy it just because you tell them."

The OS question

Linux, of course is only one option when it comes to choosing a 64-bit Operating System, particular if you're running NX Nastran which also runs on Windows XP x64 and UNIX. Team Engineering's studies have not yet gone as far as Windows XP x64, but there are plans for this in the near future and Sharples sees the platform as an exciting proposition. "If Windows XP x64-bit performs anywhere near how it does with Linux then that could well be a logical step up for 32-bit Windows users. Because then you don't have to support dual environments, either as a dual boot or two machines, you don't have to have specialist Linux knowledge, and you get the desktop that most software runs on.

"However, Linux is a more mature platform and it can be easy to use depending on how it is set up," explains Sharples. "If you've got a Linux box set up in the corner all you need is a batch solver. You can be at your 32-bit Windows machine and say 'I want to batch solve it' and it gets sent to the Linux machine automatically. You don't even know what you're solving on, it just gets solved and then you get the analysed results back.

Conclusion

For the past few years analysts have accepted that there is a limit to computational power in 32-bit environments (particularly on the desktop) and as a result have often had to seek alternative routes to get to where they need to go - either by simplifying models or analysing on a subassembly by subassembly basis. This has been a manageable process for the analysis specialist, but for the modern day engineer, who doesn't have this same level of expertise, the process can be fraught with problems.

Since the introduction of Windows XP x64

Meshing: on 32-bit Windows, NX Nastran fails at >1,000,000 nodes, but on 64-bit Linux it can mesh >4,000,000 nodes in 12 mins.

Linear statics solve: on 32-bit Windows, NX Nastran starts to struggle at 1,500,000 DOF and fails at >2,000,000 DOF, but on 64-bit Linux it can solve >8,300,000 DOF in 1 hour 40mins

Dynamics solve: on 32-bit Windows, NX Nastran solves 200 modes in 2 hours, but on 64-bit Linux this takes less than 9 mins.

we, at MCAD magazine, have been preaching about extended memory benefits of 64-bit environments. What Team Engineering's research does is quantify this, and while the data will be of specific interest to NX Nastran users, the concepts can be applied to all areas of CAE. In short, 64-bit not only enables users to solve bigger, more complex problems, but can remove I/O hard drive bottlenecks when memory is in short supply. The bottom line is hours cut off analysis times, more accurate results and hopefully better designed products. ❌

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