Excelsior JET Embedded Case Study

Greenland Wind Turbine Monitoring

Powered by Excelsior JET Embedded

By

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Summary

Lagoni Engineering is using Excelsior JET Embedded to power our high performance and mission critical embedded energy-monitoring device for wind turbine analysis on Greenland. Excelsior proved the best choice for performance improvements with their Ahead-Of -Time compiler (AOT) for the native platform, reducing the hardware requirements and cost compared with “normal” Java.

The overall performance numbers compared with Oracle’s JVM were:

	Excelsior improvement on Oracle’s JVM
Start-up	45% improvement
Response	15-30% improvement
Footprint	60% improvement

Introduction

The Institute for Arctic Technology at the Technical University of Denmark (DTU) continuously research green energy alternatives on Greenland. In a recent project where the objective was to determine the impact of combining renewable wind energy with existing diesel generators for small villages with independent electrical grids, Lagoni Engineering provided, in partnership with the institute, the solution for the monitoring system, which enabled the researchers back in Denmark to analyse the data historically and in real-time.

The solution provided by Lagoni Engineering was our in-house developed Monatar product, which is a Java powered datalogger with a built-in web-server that provides the user interface for the researchers. The Monatar is based around an x86 architecture, which makes it easily available (under normal/non arctic conditions). Besides the challenges for the hardware to withstand the extreme weather conditions on Greenland during the winter period, the key challenge was to ensure data logging real-time streaming performance of the data from the wind turbine and read/write ability to the underlying solid-state flash card medium. The operating system for the Monatar is Lagoni’s version of Linux kernel 2.6, which has been developed to ensure high reliability.

During the early stages of the project the software was running using the JRE 1.6 from Oracle. Although it was running reliably we were trying to optimise the code to improve the performance and make deployment easier. In terms of the performance the key areas which were focused on were:

- Start-up and operational performance (seen from the user)
- Disk footprint size
- Ease of deployment to embedded flash device

The typical front end user interface is shown in Figure 1.

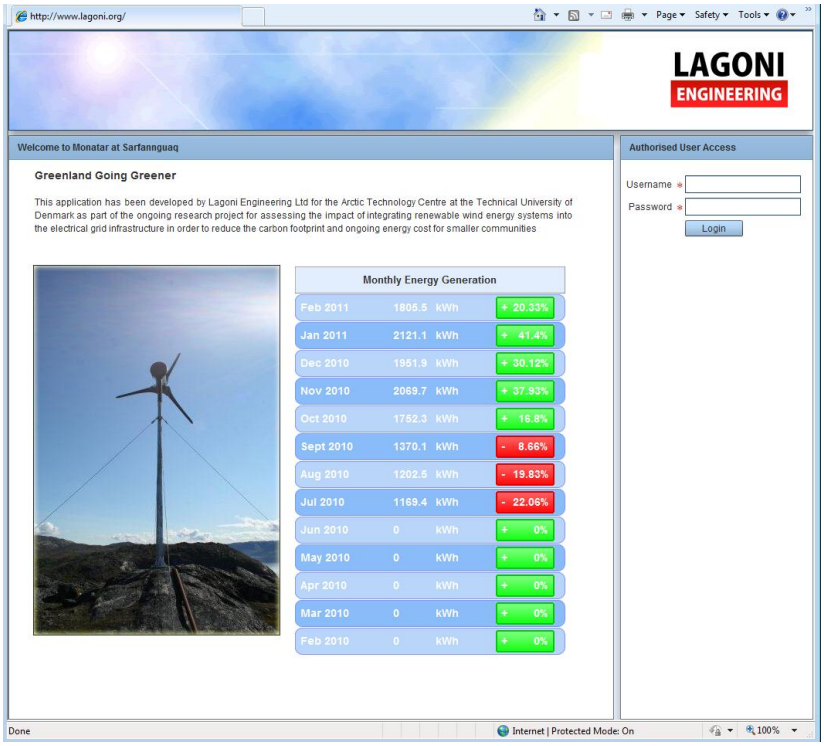

Figure 1. The login page for the web frontend user interface for Lagoni Engineering's Monatar

Excelsior – The best choice

Since the software already had been implemented in Java and was in an operational state, we were looking to find ways of achieving performance improvements using the existing software as the basis. For the single project the obvious choice would have been to enhance the hardware platform from a 500MHz CPU with 512Mb ram to something much more powerful. Thankfully (in terms of discovering Excelsior JET Embedded), we were restricted by the arctic conditions and had to stay with the platform already chosen, which made us look for alternatives. Our development team had heard about various Java native compilers, however, none of them seem to have been certified by Oracle, which made both support and compatibility very difficult. As our solution had been designed to be extremely reliable we did not want to introduce any risk in our mission to improve the performance. Then we came across Excelsior. Right from day one, their help and support was outstanding and from having tried other "free" java native compilers, without any success whatsoever, we managed to download the free Excelsior JET Embedded trial version, install it, have our application natively compiled and successfully deployed within an hour.

Ones we started measuring the performance difference between the JRE from Oracle and our newly compiled Excelsior JET Embedded application we saw impressive results.

As one of our key objectives was to reduce the start-up time we measured this first. As a result, our entire embedded products overall start-up time was improved by 45% when using Excelsior JET Embedded. This was based on rebooting the Monatar logger and measuring the time from when the application was launched until the webserver was successfully started (this is the worst case scenario).

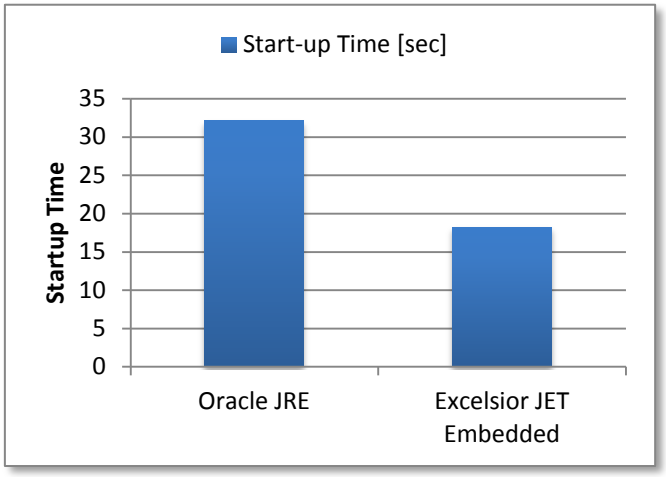

Figure 2, Embedded application start-up time

The other aspect of the performance testing was to monitor the response times during generation of large datasets by reading from the underlying file system (using a binary search algorithm, allocating the raw dataset on the heap and filtering the dataset). In order to ensure that Excelsior JET Embedded performed consistently we devised a number of tests for varied dataset sizes as well as the number of files that it would have to read the data from. Again, the performance improvement was very impressive as can be seen from Figure 3. The overall improvement was between 15 – 30% better with Excelsior JET Embedded.

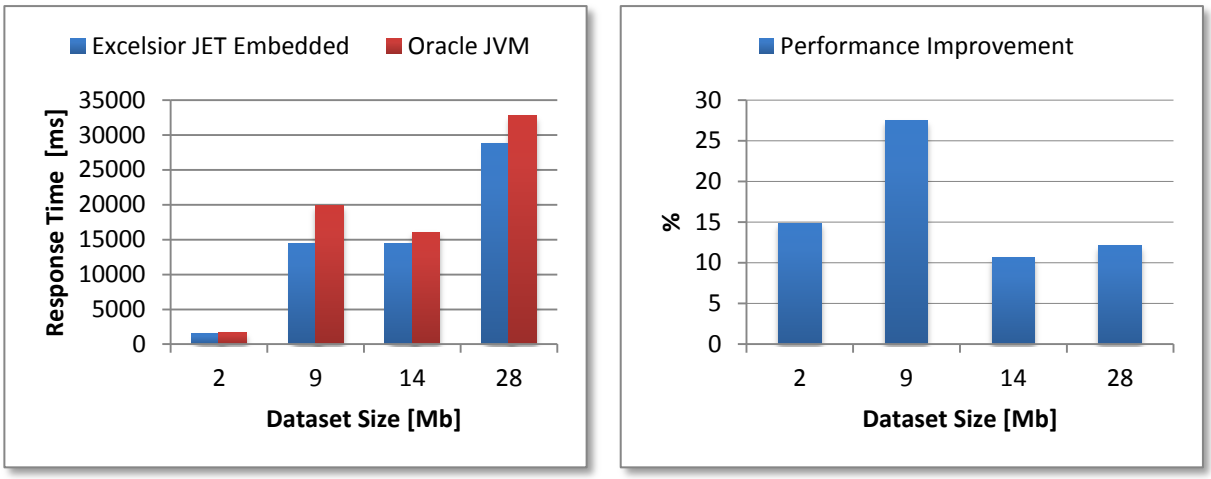

Figure 3, Embedded application performance times for various dataset sizes

During the performance testing, we also monitored the memory usage to ensure that the Excelsior JET Embedded didn't take up all the systems available memory resources, never to release it again. This has been a typical "feature" of the Oracle JVM, although the garbage collector had performed its duty and released the memory resources back to the JVM, the JVM would not necessarily release the memory to the operating system. Hence after continuous running of the JVM it would have allocated a significantly amount of the available memory. As it turned out we found that during the performance testing the Excelsior JET Embedded would allocate a large portion of the available memory, but it would also release it again shortly after the garbage collector has run. This means that our software application is more deterministic with Excelsior JET Embedded in performance and resource usage under specific operational conditions. The consequence is that we have more robust evidence to support the software reliability of our product, which plays a big factor when considering that manual intervention to reset the system is extremely costly for these remote deployed systems.

The second important aspect of our evaluation of Excelsior JET Embedded was to consider the footprint size of the final application. During the compilation and build, various optimisation options are available, which can be configured to optimise for speed or footprint. Our configuration is a compromise between the size and footprint; however, even as a compromise the final outcome (combined with the performance improvement described earlier) was a reduction in footprint size by 60%. Figure 4 shows the footprint size difference between the two Java implementations.

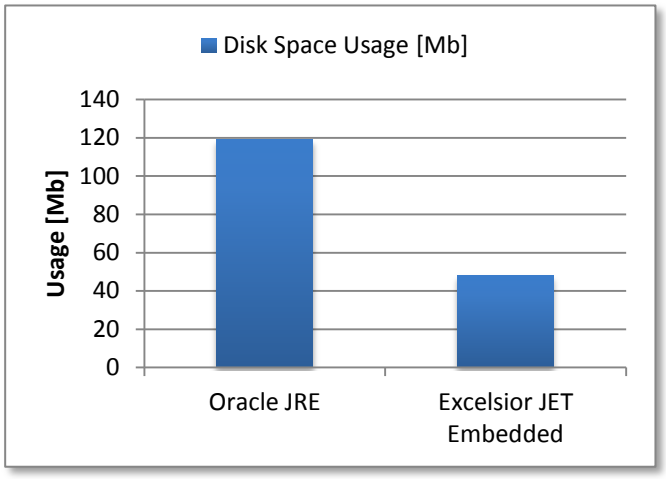

Figure 4, Embedded application disk space usage

The final aspect of our consideration was the ease of deployment. Our normal deployment is done to a flash card device as part of the product build stage in the factory. As both the operating system and the application software is transferred to the flash card at this stage it didn't cause too many problems having multiple files during this stage of the product life cycle. However, once the product is set up in a remote location, equivalent to the Greenland installation, it is important that the deployment is made as easy as possible, to avoid any types of software corruption. Excelsior JET Embedded builds the entire application dependent JARs into a single native application, which makes it much easier to deploy and maintain the software revisions and the dependencies. A typical update only requires transferring a single file with Excelsior JET Embedded rather than the typical

change control checks on the entire dependent JARs. As an added bonus the final deployed Monatar application is now virtually impossible to reverse engineer, which also gives us peace of mind.

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