VECTOR

Collecting Code Coverage in Constrained System Test Environment

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1 Introduction

This case study provides details about a recently completed services engagement for a global manufacturer of industrial control systems. Our client engaged Vector Services (VS) to perform unit testing and collect Code Coverage information within their System Testing Environment. The device under test is a system which monitors the content levels for oil tankers. Monitoring the content level is not only extremely important for billing purposes, but it can also detect leaks or seepage. Depending on atmospheric conditions (heat and humidity), the tanker's volume can change. Due to the huge size of the tanks, any slight miscalculation can cause significant revenue loss or undue gain.

1.1 Customer Challenge

The standard coverage tool offered by Vector (VectorCAST/QA) assumes that some type of output device is in place to stream the coverage data as the code executes. For this client, however, there was no dedicated output device available in their system test environment. The client considered a couple of options. One option would be to share an output device with the system software, but this would require software modifications on the client's code. In addition, if the output device was rendered out of service by a software error, the coverage data would be lost. The other option would be to connect a JTAG debug device to collect the data, but that would require trained personnel to operate the debug device during system test. If any problems occurred with the debug device, or an operational error occurred by an untrained user, data could be lost. Given the issues with either of these options, the client engaged VS to explore other solutions.

1.1.1 Customer Requirements

System testing for this client would be comprised of a group of tests tied together in a series or test suite. Between each individual test in the series, there may be a system reset or power cycle. With this in mind, the client requirements boiled down to the following:

- Coverage data should be captured in real time to ensure no loss of data due to system errors (i.e.; the coverage data cannot be buffered in volatile RAM)
- No output device would be available during System Testing
- Coverage data should be preserved across power loss or system restart
- Coverage data would be collected post mortem after all tests were complete
- No special training for system test personnel should be required

1.2 The Vector Services Solution

Vector Services presented multiple cost-effective solutions to the client. Since no output device would be available, the client decided to modify their hardware design and include a plug-in module with 512kB of Non-Volatile Memory (NV Ram). This NV Ram would effectively replace the need for an active output device and would hold the coverage data. The client chose this solution because of its cost-effectiveness over the long term. All future systems would now have the ability to capture the test results by storing them on the NV Ram module. This module could then be carried over to a development workstation where the data could be uploaded for display in the VectorCAST/QA tool. A key advantage to the client is that the data can now be preserved in NV Ram. Uploading the data could be done post mortem and would not have to be done during system test. Also, adding a memory module had minimal impact on the client's software, as it only had to enable the memory. Vector Services has a team of highly experienced engineering consultants who look for solutions from all angles and can think outside the box to deliver innovative solutions to make sure our clients are successful in any of their endeavors.

2 Project Details

2.1 Plan

VectorCAST/QA is a very powerful solution that's proven itself in the multiple decades that it has been out in the field. For this client, once the memory was enabled, the onus was on VectorCAST/QA to manage the memory. Because VectorCAST/QA is designed to run on custom hardware, it provides an open software module that can be built into any client's software. This software module typically contains code to manage the output device and any other details that are unique to the client's design. Modifications to this module are minor and can be coded and verified in less than a couple hours. Typically, these changes can be done by the client, but in this specific situation, the changes were significant because of the persistent nature of the output device. For example, the coverage data would need to be preserved across reset, whereas normally it would be cleared on reset. Also, indexes and other variables would need to be preserved in NV Ram and managed across reset as well. For this particular solution VS implemented a design change, as opposed to just changing a few lines of code. Still, all changes could be made without requiring any patches or customizations to VectorCAST/QA. To reduce risk and to eliminate time-to-market concerns, the client requested VS to complete the work.

2.2 Execution

Since VS was breaking new ground and the NV Ram module was a new hardware component, a two person-week services contract was arranged. Coding changes were made within the first two days and testing began. It appeared that things were working well at first, but upon detailed review, it was discovered that some lines of code were falsely being shown as not covered. It had all the characteristics of a software error, but after running diagnostics on the NV Ram, a floating address line was discovered. The hardware fix would be minor but it required that the board be reworked with a minimum three-day turnaround. To make use of that time, VSGS developed a work-around that allowed testing of the other aspects of the design.

3 Project Results

After the hardware was fixed, two days were spent on exhaustive system testing and a final report was delivered to the client. In all, the project was completed in eight days, including the three-day wait time for the hardware update, two days ahead of schedule. In summary, VS delivered a solution that met all the client requirements and in turn received the client's formal blessing. Vector Services dedicates itself to its client's success making sure any testing challenges are resolved and a quality service is delivered.

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