

Testing Times



March 2004

The IPL Software Products Newsletter

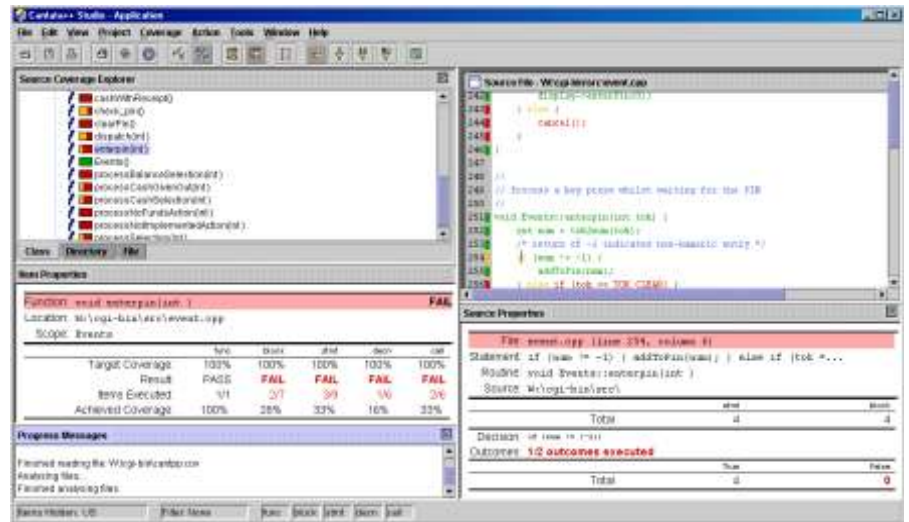
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Cantata++ Studio

Development work on Cantata++ Studio is nearing completion: the product is now entering user testing. Studio is part of Cantata++ version 4, which will be released in spring 2004.

Cantata++ Studio allows users to view both dynamic testing and coverage analysis results interactively. Studio, shown on the right, has some unique facilities to allow users to optimise test cases and minimise redundant testing effort. The features include the ability to 'filter' results on test case, inheritance context or user context.

Cantata++ V4.0 also includes support for Microsoft Visual Studio .NET (unmanaged C++).



TestDriver

The work of software testers continues to get easier with the latest releases of Cantata++ and AdaTEST 95. The new TestDriver GUI contains the powerful wizards for defining test data and selecting coverage and static analysis rulesets. TestDriver, makes it possible to enter all test data and rulesets, and generate a complete working test script.

These new facilities should not detract from the fact that test scripts can be generated in other ways : Cantata++ and AdaTEST 95 are uniquely flexible in the way they allow tests to be prepared, generated and modified.

Cantata++ V3.1

In addition to the full script generation features mentioned above, the recent release of Cantata++ V3.1 incorporates the latest C and C++ parsing technology from the Edison Design Group and is now available for various new platforms and compilers, notably Borland C++ Builder 6.0, the Symbian operating system and various target environments, including WindRiver's VxWorks.

AdaTEST 95 V2.0

In addition to TestDriver, AdaTEST 95 now provides automated test script generation from simple Test Case Definition (TCD) files. Another new feature, Test Support Packages (TSPs), provides automated checking for global data corruption using generated support code.

Both of these features offer users of the original AdaTEST product a smooth upgrade to AdaTEST 95.

Cantata++ for Symbian

Cantata++ is now available for Symbian and is integrated with leading compiler IDEs such as Metrowerks Code Warrior, Microsoft and Borland BuilderX. The product is available for most platforms including UIQ and Series 60. For more details please see www.iplbath.com/pdf/p0019.pdf.



Bugz Bunny

An 'insignificant' software bug paralysed **Japan's air traffic system**, leading to cancellation of 200 flights. It does not seem that 'insignificant' to us! *New Scientist, March 2003*

A software error was blamed for the accidental shooting down of a UK Tornado plane by a US **Patriot missile** in Iraq. *New Scientist, 15 April 2003*

Software glitches in **Microsoft's Smartphone** were given as the reason for T-Mobile not adopting it. *Computing, 22 May 2003*

The landing of the **Russian Soyuz spacecraft** 285 miles away from its planned location was attributed to a software fault. *Aviation Week and Space Technology, 12 May 2003*

A bug caused chaos in the computer system running the **Oystercard** London pre-pay passenger transport scheme. *This is Local London, 23 Jan 2004*

The communications failure afflicting the **NASA Spirit rover** on Mars is attributed to a software bug. *The Guardian, 26 Jan 2004*



*Inside: Cantata++ in Medical Systems
- featuring the FDA Software Verification Guidelines*

Cantata++ at GE Medical Systems

- *Critical Software for Critical Care*

This Case Study features Datex-Ohmeda, now part of GE Medical Systems, whose business is systems, equipment and services for anaesthesia and critical care. Their products include patient monitors, anaesthesia machines and ventilators.

Patient monitors are used to measure and monitor several clinically important patient parameters, such as heart rate, blood pressure, oxygen saturation of the blood, body temperature, inhaled and exhaled gas concentrations, ECG waveform, EEG waveform, and depth of anaesthesia. Anaesthesia machines administer a selected mixture of gases and anaesthesia agents to the gas stream that the patient inhales helped by an inbuilt ventilator.

All Datex-Ohmeda's products are required to meet the strict quality requirements imposed on software in safety-related medical devices, by the US Federal Drug Administration (FDA). This means that a detailed risk assessment exercise is conducted, in line with the FDA's General Principles of Software Validation; Final Guidance for Industry and FDA Staff [1]. This process identifies safety-critical components that require thorough unit testing, and those that can be less rigorously tested.

Datex-Ohmeda has developed a software platform for a new generation of medical devices. This platform will allow shorter development cycles for new products and new features, such as new measurement parameters. We examine how Datex-Ohmeda selected and used Cantata++ for the platform project and how its testing strategies have developed.

Safety-Critical But Flexible Testing Requirements

Most of Datex-Ohmeda's products are classified at the highest level defined in the FDA guidance for software contained in medical devices (Major Level of Concern). For example in patient monitors, a failure to raise an alarm can cause harm to a patient. The software platform underwent a risk assessment that identified approximately 10% of the software as implementing safety-critical functions.



Patient Monitoring and Anaesthesia

Full white-box unit testing of this code was therefore required, in addition to functional black-box testing of all of the code at sub-system level. The software was developed in C++ on a Windows NT host using the Microsoft Visual C++ compiler, and cross-compiled using the Diab Data and CAD-UL C++ compilers. The target system is a Mpc823e PowerPC target running the Nucleus Plus RTOS. Risto Repo the Software Process Improvement and Verification Officer of Datex-Ohmeda said "We needed a C++ testing tool that was flexible enough for testing both object-oriented C++ components and whole sub-systems in both host and target environments, and also across different sites".

Selection

Risto Repo had known about Cantata++ from his previous job with Space Systems Finland. In December 2000 he requested a competitive evaluation of Cantata++ against another tool on two sites: Helsinki and Louisville, USA. The evaluation resulted in early 2001 in the selection of Cantata++. Risto Repo explained the reason: "Put simply, Cantata++ did what it promised for C++".

Datex-Ohmeda and IPL then worked closely together undertaking a detailed capability investigation of cross-compilers. At the time, these were far

from being ISO C++ compliant. A decision was taken to carry out testing with Microsoft Visual C++ and the Diab Data cross-compilers, despite the latter compiler's limited support for templates (at that time). Datex-Ohmeda purchased Cantata++ in June 2001 for use at Helsinki, and Madison and Louisville in the USA.

Cantata++ In Action

Cantata++ was put to use in white-box component testing of the safety-critical code in both host and target environments. These components were first unit tested on the host (Windows NT) and then the same tests were re-run on the PowerPC target. All tests required 100% coverage of entry-points, statements and decisions. The non-safety-critical code was subjected to black-box functional tests at sub-systems level, using Cantata++ coverage analysis. Sub-systems typically contained between 10 and 80 classes.

Engineers at the three Datex-Ohmeda sites were soon up and running, as Jutta Luosta, a leading test developer in Helsinki put it "Cantata++ was very easy to get to know" adding that "development testing of subsystems was really quite fast with Cantata++". Tuomas Jyrskke who attended IPL training courses said "Working for a time with Cantata++ before coming to

the training courses was better, as I brought lots of questions and was able to get really good answers at the training.” He then acted as the Helsinki technical lead, and passed on his experience adding “After the training course at IPL, I passed on my experience with help from the training materials”.



Critical Care Monitor in Use

The C++ code became more object-oriented with the growth of source code generated by the project’s UML modelling tool. Cantata++ was shown to work well with both manually and automatically generated source code. Risto Repo points out that while each site started off with different approaches to testing, “We learned later from colleagues at different sites what conventions worked and what did not”.

Easy, Flexible, Well Supported

One particular reason for the easy acceptance of Cantata++ by developers is well expressed by engineer Erno Muuranto “For testing with Cantata++, it is nice that I can stay in the same environment (Microsoft Visual C++) that we use for programming.” He adds that “Cantata++ has a lot of powerful features, but the tester can use as much or as little as you need to get the job done.” Risto Repo put it a different way: “A real benefit is that Cantata++ makes people write tests in a consistent way because it gives engineers a proper framework, but it does not require everyone to use it in the same way, so it is still flexible”.

For many of the developers the introduction of Cantata++ has also had other benefits that we have seen at many companies before. Tuomas Jyrskke comments that “Cantata++ testing has had a positive impact on the way we write the code, reducing coupling between objects and making isolation testing with stubs easier.” Tuomas added that such a full-featured testing tool needed good support for developers to trust it, and he was pleased to say that “Cantata++ Technical Support always gave a quick response to enquiries”.

Outsourced Testing

From the very beginning Datex-Ohmeda, knew that even with three development sites they were going to need to bring in additional resources, especially for testing. One early problem that they faced was the lack of implementation detail in the System Requirements Specification. When implementing these requirements the detailed design specifications (from which test cases for the safety-critical classes were derived) lacked stable interface definitions. As Risto Repo explains this became a problem when outside companies were given batches of code to unit test: “The design of interfaces was fluid, and development changes were so rapid that component tests became quickly out of date. We were a little bit surprised at how much of a problem this was.”

Datex-Ohmeda actually used both Finnish and Indian companies for outsourced testing work on the software platform. The most instructive lessons came from the functional sub-system tests: as Jutta Luosta describes “Initially we just did not specify coverage requirements because there were so many things that were new being introduced”. After initial tests had been delivered to Datex-Ohmeda she re-ran the functional tests from both companies using Cantata++ coverage analysis. She says “We got very descriptive results from the comparison of subsystem level coverage figures”. The results actually ranged from 65% to 92% entry-point coverage; with one company’s tests producing much lower coverage than the others. Having also analysed in detail the statement and decision coverage metrics, Datex-Ohmeda then revised the terms and conditions of the outsourced testing contracts to require specific entry-point and statement coverage targets. Jutta Luosta comments, “Now, for upgrading the tests as new changes are made, we always set coverage targets”.

Conclusions

Since the initial phases of the project, Cantata++ use has been successfully extended to further phases such as New Patient Monitor targeting Renesas H8S, and other projects such as the safety-critical Non-Invasive Blood Pressure measurement unit. Risto Repo concludes by explaining Datex-Ohmeda’s positive views on using Cantata++ in the future: “I expect that use of Cantata++ will continue to grow at GE Medical, as I hope that all new projects will consider using Cantata++.”

IPL would like to thank GE Medical Systems for permission to report on their experiences with Cantata++ and take this opportunity to wish them well with their products and services.

[1] General Principles of Software Validation; Final Guidance for Industry and FDA Staff, issued 11 January 2002 available at www.fda.gov/cdrh/comp/guidance/938.pdf

Software Testing the FDA Way

In 2002 the US Food and Drug Administration (FDA) issued an important set of guidelines on the validation of medical devices containing software. These guidelines are having a significant impact on the way developers test their software. Here is a summary of some of the main requirements:

- *Testing should always be carried out on the basis of predicting expected results from known inputs and checking that these match the actual results.* This is the fundamental rationale of Cantata++ and AdaTEST 95, which provide extensive facilities for checking expected data and checking that unexpected changes have not occurred.
- *Testing should be carried out at all levels of development, principally unit, integration and system testing.* IPL’s tools are aimed at unit and integration testing but are also effective for higher levels of testing in embedded devices.
- *Structural or white-box testing is a particularly useful technique in unit testing.* Our tools offer powerful support for white-box testing.
- *Coverage analysis is an essential technique for measuring the completeness of tests.* Cantata++ and AdaTEST 95 provide an extensive set of coverage metrics and allow coverage analysis to be automatically verified as part of the dynamic testing process.
- *Changes to code demand that a policy of regression testing be in place.* Our tools facilitate regression testing.
- *At the coding stage, the guidelines recommend use of coding standards.* Enforcement of these is supported by Cantata++ and AdaTEST 95’s static analysis metrics.
- *The guidelines suggest that all testing tools be themselves verified to an equivalent standard as the code being tested.* The IPL tools have been produced to the ISO 9001:2000 standard, and have been audited many times as suitable for safety-critical and high-integrity work.

For a detailed analysis of how IPL’s test tools can help satisfy conformance to the FDA Guidelines please see www.iplbath.com/pdf/p0802.pdf

Customer Quotes

"Cantata++ is very good indeed, even more thorough and reliable than we expected." **Agusta Sistemi**

"That is a wonderful effort from IPL in the shortest possible time and we at AKS express our profound thanks and appreciation for the same." **AK Aerotek Software**

"We have been (and continue to be) satisfied users of AdaTEST for about three years." **Lockheed Martin**

"(With Cantata) I have been able to achieve fairly easily, a good set of test cases on one of our code modules. The reports generated are very good and easy to read. I am putting a proposal to the Chief Engineer with this product as a recommendation." **Boeing Australia**

"The evaluation of the tool is complete and we are very satisfied with it. Previously we were writing manual drivers in Ada83; with AdaTEST that effort has reduced a lot." **RelQ**

French Department

IPL a le plaisir de vous annoncer la création de son département « France ». Nos clients francophones pourront désormais obtenir une assistance technique et commerciale en Français. Vous pouvez contacter IPL France à l'adresse E-mail suivante france@iplbath.com ou appeler directement le: +44 (0) 1225 475213.

Meet Us

Here are some of the forthcoming events where you can meet us:

- 1-9 March: Embedded Systems, China
- 30 March - 1 April: RTS Embedded Systems, Paris
- 21-23 April: ICS Test, Dusseldorf
- 28 June - 1 July: DASIA, Nice
- 6-9 September: AsiaSTAR, Canberra
- 6-7 October: ICS Test, London
- 30 Nov - 3 Dec: EuroSTAR, Dusseldorf

New Distributors

IPL is pleased to announce that AI Corporation (AIC) will act as IPL's exclusive distributor in Japan. IPL has also signed an agency agreement with EtnoTeam SpA of Milan, Italy.

For the contact details of all IPL distributors and sales agents see: www.iplbath.com/tools/partners.

News In Brief

In the last 10 months:

- Cantata++ has been ported to the Symbian OS (UIQ and Series 60).
- Cantata++ has been ported to the ERC32 target.
- AdaTEST 95 has been integrated into the GPS (GNAT Programming System).
- AdaTEST 95 was, yet again, customer audited for use on a DO-178B project, this time with the conclusion "AdaTEST 95 ... is documented, controlled and verified to a level beyond that required for DO-178B."
- By popular demand we have produced a paper entitled "Software Testing Tools Return on Investment (RoI)". This can be seen on the website at www.iplbath.com/pdf/p0839.pdf.
- IPL has signed a partnership agreement with WindRiver Systems, for integration of our tools with VxWorks. We have a similar arrangement with a number of partners including QNX Software Systems.
- IPL now has the facility to offer webinars (internet-based live demos), using Microsoft Live Meeting.
- We've appointed two new technical support engineers - photograph below: Pete Lewis (left - Cantata++) and Steve Walton (right - AdaTEST 95).



New Customers

Over recent months we have been pleased to accept business from the following new customers:

- Alcatel Transport Services Division
- Boeing Australia
- Continental Teves
- China North Equipment Research Inst
- China Shipbuilding & Offshore Int
- East China Inst of Computer Research
- Energo Promimport
- GE Transport
- Indian Space Research Organisation
- Ishikawajima-Harima Heavy Industries
- Korea Aerospace Industries
- Marconi Selenia Communications
- Mechatronic GmbH
- Mitsubishi Space Software
- Oberli Engineering GmbH
- Philips Digital Systems Laboratories
- Prolan RT
- Rheinmetall AG
- Shanghai Aerospace Control Engineering
- Shipara Technologies
- Siemens Medical Systems
- Taiji Computer Corporation
- The Railway Engineering Company
- Wu Xi Control System Institute
- Wu Xi Leihua Electronics

Training

We continue to regularly run our one-day courses on:

- Cantata++ for C++
- Cantata++ for C
- AdaTEST 95

For further details see: www.iplbath.com/tools/training.

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Testing Ted

Gilchrist & Downing

