

# Testing Times

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The IPL Software Products Newsletter

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## IPL Launches Software Testing Service

**IPL is pleased to announce the launch of its Software Testing Service (STS). We can now offer customers a tailored software-testing package. The service will be of particular interest to developers of high-integrity systems who are required to meet the demands of various software development standards. STS will allow developers to concentrate on the more productive processes in their software lifecycle and subcontract the labour intensive parts of the testing process to IPL.**

The STS is available from February 2003. Developers will initially be requested to submit their testing requirements, and a sample of source code and design specifications to IPL for analysis. This will allow us to scope the problem and provide a fixed-price for the work. The STS is available for any level of software testing and for software written in any language or platform - not just the languages and platforms supported by IPL's tools.

Shaun Davey, IPL's Software Technology Manager said "We are very excited that we can now offer this new service to our clients, many of whom are overwhelmed by the testing effort required by the high-integrity software development standards. Clearly, the distraction of 'jumping through the hoops' of the standards can actually detract from the quality of their software. We aim to allow our clients to subcontract a substantial part of the testing effort to us, allowing them to concentrate more on the functionality and quality of their final system. Another key advantage of STS is IPL's independence: many of the standards used by our clients call for independence between the development and testing teams."

In addition to providing the STS, IPL is able to assist with all aspects of the software lifecycle: initial conception,

project definition, requirements analysis, design, implementation and (of course) testing. IPL is an approved defence contractor and is therefore able to undertake classified government work under the STS. IPL's QMS is certificated to ISO 9001:2000 and to TickIT, assuring our customers of an auditable, high-quality testing process.

*For further information, please contact [sts@iplbath.com](mailto:sts@iplbath.com).*

### Product News

#### Cantata++

Cantata++ V 3.0 has been released with the following new features:

- Multi-platform user interface with wizard driven scripting;
- Full compatibility with legacy Cantata scripts;
- HTML Results Viewer;
- Modularised Test Harness for scaleable embedded target support.

This makes it, we believe, "probably the best C++ testing tool in the world", offering support for ANSI C, C99, ISO C++, and EC++, in one package on a variety of host and target platforms.



#### HTML Results Viewer (HRV)

Available free with all maintained product licences on all standard

platforms, the HTML Results Viewer adds a new colourful dimension to reviewing test results and coverage reports.

#### AdaTEST 95

A multi-platform user interface with wizard driven scripting and HTML Results Viewer are now delivered as standard with AdaTEST 95. IPL will soon be releasing a new version of AdaTEST 95 with an Ada 95 Test Support Package (TSP) generator for the tool. TSPs are package-specific testing declarations and procedures, which greatly enhance the productivity and quality of user-generated test scripts. Ada 83 customers migrating to Ada 95 can now also benefit from a migration tool to convert their AdaTEST .ts scripts to a human-readable format, compatible with Ada95 Test Support Packages (TSPs).

### Bugz Bunny

*Continuing the ongoing catalogue of software glitches that should have been tested before their presence became public knowledge!*

June 2002: Renault cars (Laguna 1.6) at risk due to 'software faults' that could lead to engine cut-out at low revs.

August 2002: Software failure 'possibly' at root of failure of \$8.7m Japanese SST rocket prototype, by causing premature separation of upper stage from lower.

September 2002: First launch of the Delta EELV rocket delayed by a month due to a software fault in the last minute of the countdown sequence.

November 2002: A 'software glitch' in Germany led to the bills for phone taps being sent to the alleged criminals instead of being charged to the security services which had ordered them. The mistake was only discovered when the targets complained about the mystery items on their telephone accounts.



*Inside: AdaTEST 95 in Space Systems  
Article on Embedded C++*

# AdaTEST 95 at Astrium

## “There’s No Room For Failure”

Astrium is Europe’s major satellite and space vehicles developer. It has operating companies located in France, Germany, UK and Spain, and is a successful participant in space work all over the world. Two current projects in the UK serve to illustrate both the breadth of Astrium’s work and its commitment to producing on-board software to the demanding standards required for deployment in space.

Funded by the Canadian Space Agency, RADARSAT-2 is planned to launch in 2004; it will carry advanced radar equipment enabling it to perform detailed topographic mapping of the Earth’s surface. The Synthetic Aperture Radar Sensor Electronics it will use is being supplied by Astrium Ltd, based on equipment and systems originally developed for Europe’s Envisat.

A different kind of spacecraft altogether, Beagle 2, is a UK-led Mars lander, intended to carry out a range of experiments to investigate whether life has ever (or still does) exist on Mars. It will be launched in June 2003, as part of the larger ESA Mars Express mission. Beagle 2 is being developed by Astrium Ltd. on behalf of the Open University who are leading the academic investigations of the quest.

### Maximising Reliability

Both projects require the production of large amounts of on-board software. The need for the highest level of software reliability is paramount in both cases, though for different reasons. In the case of the RADARSAT-2 project, the need for reliability is driven by customer requirements for high-availability of the sensing instruments. A significant proportion of the software cannot be changed once the craft is launched, so the very highest standards have to be applied. In the case of Beagle 2, the weight constraints on the craft are such that very few of the usual redundant systems can be incorporated in the design. Hence the systems, including the software, just have to work - there is no fallback.

Quite early on in the software projects’ lifecycle some key decisions were taken to help maximise software reliability. One of these was to use Ada, and in



Beagle 2 on the Surface of Mars

particular the high-reliability ‘Ravenscar profile’ subset. Another decision was to conduct a detailed program of software unit testing. Dave Yetton, Software Project Manager for RADARSAT-2 says, “As a company we are 100% committed to the idea of unit testing. We have done it before and believe it is one of the best ways to gain confidence in our code.”

The choice of software testing tools was fairly quickly resolved because Astrium had used AdaTEST previously on the Envisat programme and other projects. AdaTEST had a good track-record in the company and was liked and respected by Astrium’s software engineers. In the case of Beagle 2, Astrium were not directly involved in writing the software, but were using two software subcontractors (Logica and Coda SciSys). Bill Edwards is Astrium’s Software Manager in charge of the Beagle 2 programme, and says, “Both of these companies had previous positive experience of AdaTEST, so the choice of AdaTEST 95 was easily agreed.” Delivery of the tools took place during early 2000, and work began.

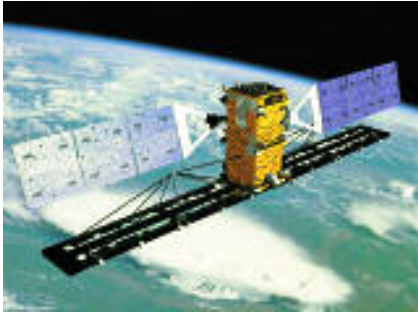
### Testing Productivity

The Astrium engineer most closely involved with the RADARSAT-2

software development work was Dan Marshman. He says that the ease with which his engineers learnt to use AdaTEST 95 was a crucial factor in making the team productive quickly. “In a matter of days, a programmer could be testing code with AdaTEST 95 from a standing start. The product needs little or no training and is quite intuitive to learn, even for beginners.” The total volume of RADARSAT-2 code that needed testing was around 20 KLoC with about 225 separate unit tests to be created and run. Given that the Ravenscar target environment was a new quantity for Astrium, it was important to ensure that tests would also run on the target. This was facilitated by AdaTEST 95’s target features - scripts can be run unchanged in the target environment. It became the project standard that all ‘critical’ code would be tested in this way, while less critical code would be unit tested only on the host.

The total size of Beagle 2 code was about 950 Kbytes with about 80 Objects. The original intention had been to test only on the host but it very quickly became apparent that a lot of the code could only be run on the target. Since the initial AdaTEST 95 delivery did not permit coverage on the target

(due to the Ravenscar restrictions of the compiler) a minor crisis threatened to develop. However, says Bill Edwards, "IPL rose to the occasion and offered to look into the problem based upon an idea provided by the compiler supplier. They quickly implemented a very capable working solution, which most importantly for us did not eat into our limited budget and has proved as reliable as the rest of the AdaTEST 95 product."



RADARSAT-2

### New Ways of Testing

The RADARSAT-2 project was keen to explore new ways of testing which would build on the previous experiences of AdaTEST. Dan Marshman describes some of the innovations they introduced. "The first improvement we made was to use shared stubs. In this way we avoided many of the recompilation issues introduced previously as code changed. The vital enabling technology was our configuration management system which allowed AdaTEST 95 scripts and stubs to be kept in tight step with each other."

A second major issue was that they were making extensive use of OO design and programming techniques. The approach to testing that the team adopted was based closely on the hierarchical integration testing methods recommended by OO specialists. This involves fully testing code for base class implementations and then testing only the added or changed functionality for derived classes. "This worked well for us," says Dan Marshman, "even though we had up to five levels of derived classes." As work progressed they also learnt another useful OO testing trick, namely that of coding tests as child units of the units being tested. This conveniently allowed white-box access to class private components, and is a useful addition to the more well-known test points technique for accessing package body data. They did learn however that Ada protected objects do not fit comfortably into a deep class hierarchy, so some new techniques had to be evolved to deal with these situations.

### Conclusions

Both the RADARSAT-2 and Beagle 2 projects are nearing the end of software production. Bill Edwards has only praise for the contribution of AdaTEST 95. "It gave no problems in use for the entire duration of the project and we could carry out coverage testing on the target with the updated version, even though the compiler supported the Ravenscar Profile." Dan Marshman concurs, "It was productive from day 1. AdaTEST 95 has been fantastic for us. It is easy to use, reliable, and gives us exactly what we want, both from our own point of view as developers, and also looking at the need to give our customers results data which they can understand and depend on."

Dave Yetton has the final word. "My projects have used the IPL testing tools for quite a number of years. Over that period we've come to respect the products, and also IPL's willingness to support them and provide us, the customer, with an exceptional level of assistance. I fully expect that we will be using more of IPL's tools in future work."

*IPL would like to thank Astrium for permission to report on their experiences with AdaTEST 95, and take this opportunity to wish them well with ongoing and future programs.*

## C++ for embedded applications

*In this short article, Neil Langmead reviews the use of embedded C++ (EC++) and considers the testability of this language.*

Has embedded C++ proved to be the panacea for C++'s problems in embedded environments? C++ is one of the most elegant and sophisticated programming languages available to the developer. The downside to C++'s rich feature set is that compiled object code can be several times larger than the equivalent code compiled in C, leading to increased memory requirements and a reduction in execution speed. On host systems, these are perhaps of superficial concern - the benefits of C++ (component reuse and faster development) usually outweigh performance issues. For embedded applications though, memory and execution speed are critical.

EC++ as an industry 'standard' evolved out of discussions among Japanese automotive manufacturers, who recognised the need for a subset of C++ that performed well for embedded

applications. The resulting EC++ standard was designed to take advantage of C++'s most useful features, but at the same time discarding those features responsible for code bloat, such as multiple inheritance, exceptions, runtime type information and virtual method tables.

### Testing EC++

Traditionally, testing solutions are implemented in the form of reusable test 'libraries' of C++ routines. These help a tester by providing a structured framework in which to carry out testing in a controlled, repeatable, auditable manner. For testing to be performed on the target, these libraries must have been compiled with the target compiler. The usual method of dynamic testing is to write a test script (in C++), which uses the test library routines, and calls the software under test. This script is then compiled with the source under test and linked with the test libraries, and any other libraries required by the software under test.

Memory and performance issues apply as much to dynamic test code as they do to released code. Any dynamic test script must itself conform to the embedded subset used for development, because it is to be compiled using the embedded compiler. C++ features not supported by EC++ must also be disabled in test libraries. Much of the code bloat in C++ does not come from using features such as templates, but from referencing templates found in large C++ libraries. Including such references often means compiling and linking-in many parts of the library that simply aren't needed.

Another testing problem to consider is the scalability of EC++ implementations. A further 'standard', ETC++, has been developed. This takes the baseline EC++ definition, and scales it, adding support for more of the original ISO C++ features. Many compiler vendors offer ETC++ support, with the ability to switch on or off individual language features at will. (E.g. templates and exceptions). As PJ Plauger, the man who introduced EC++ to the world, puts it: "Nobody wants a proliferation of dialects. The whole idea behind the formation of the consortium was to avoid such mayhem in the Japanese embedded systems community. Nevertheless, one significant new dialect [ETC++] has already appeared. And it could become at least as popular as EC++."

This proliferation of subsets, particularly when compiler vendors

were struggling to achieve successful ISO C++ implementation, has not aided testing. The ability to scale C++ code at will requires similarly scaleable dynamic test harness solutions.

### Solutions

Cantata++ solves the above problems of code bloat and scalability, through its powerful and highly configurable E[T]C++ compatible test harness. The libraries are implemented very efficiently, minimising the code bloat that blighted many embedded C++ applications in the past. With the Cantata++ libraries, individual features such as templates, exceptions, RTTI, Wchar\_t, and timing can all be switched on or off, according to which C++ features are being used. Additionally, Cantata++ uses the industry leading C and C++ parser from Edison Design Group (EDG). PJ Plauger comments: "EDG supplies the C++ front end for many embedded C++ compilers, and it is at the leading edge. It even has dialect switches already installed for tailoring the recognized language to be EC++ or many other interesting variants."

ETC++ seems a happy compromise between ISO C++ and EC++, giving the developer access to the popular STL template library. With significant memory savings of up to 50% on the full ISO C++ implementation, widespread acceptance among leading compiler vendors such as Greenhills, plus an excellent testing solution to support it, ETC++ looks to be the perfect choice for embedded developers.

Cantata++ fully supports EC++ and ETC++. Users considering testing these C++ variants should contact Neil Langmead ([neil.langmead@iplbath.com](mailto:neil.langmead@iplbath.com)) for more information.

The full transcript of this paper can be found at <http://www.iplbath.com/pdf/p0835.pdf>.

## Monthly News

Don't forget that a monthly news update appears on our website, at [www.iplbath.com/tools/news](http://www.iplbath.com/tools/news).

## Testing Ted



Gilchrist & Downing

## New Customers

In the last few months we have been grateful to receive the custom of the following new companies (in alphabetical order): African Defence Systems, C&C Electronics, Ceprei Software Test Centre, Cognizant Technology, Denel Aviation, EastCOM, Hamilton Medical, Medical Intelligence, Nanjing Institute of Electronics, Samsung, and Shanghai Institute of Control Engineering.

## Customer Quotes

*"There's a lot of complicated dynamic data structure / link list stuff in my current work and Cantata has made testing this a breeze" TTP Comms*

*"Glad to get such a prompt reply from you. It is seldom that we have such prompt support." Infosys*

*"I believe I'm the one in debt here. Without AdaTEST I would have had a miserable time ... Having worked with a few other test tools since ending my contract AdaTEST is still my favourite." A consultant, Norway*

*"I am pleased to recommend IPL as an approved supplier of Cantata and the high integrity package to ... The development and subsequent support of the tool has been to a high standard in accordance with a mature Quality System which more than satisfies the requirements for tool validation as defined by RTCA DO 178B." Recent Cantata audit report.*

*"I used AdaTEST (with MUCH success) in the F22 project... I am now working on Ada code to support the JSF/F35 program. I IMMEDIATELY suggested AdaTEST." A Lockheed Martin engineer.*

## New Article

For an excellent description of the use of AdaTEST 95 in a Linux/GNAT environment please see [www.linuxjournal.com/article.php?sid=5965](http://www.linuxjournal.com/article.php?sid=5965). Our thanks to the author, Thomas Osterlie of ConsultIT.

## Meet Us

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

**Safety Systems Symposium (SSS'03)**, February 5-6, Bristol

**ICS Test**, April 2-4, Cologne, Germany

**Embedded Systems Club**, April 9-10, Swindon

**AdaEurope**, June 17-19, Toulouse, France

Joint seminars with **GreenHills** and **i-Logix**, provisionally April 29 and May 1.

## Indian Agent

IPL is pleased to announce that AK Aerotek will act as IPL's local agents in India. For contact details of all IPL distributors and sales agents see our website at [www.iplbath.com/tools/partners](http://www.iplbath.com/tools/partners).

## Training

We have introduced some new training courses to accommodate the newly revised products. The introductory courses are now:

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

All courses are of one-day duration. We expect to be introducing several half-day specialist training modules over the next few months. For further details see: [www.iplbath.com/tools/training](http://www.iplbath.com/tools/training).

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