Enhanced Techniques for CORBA Validation

CORVAL2

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Validating Multi-Vendor CORBA Conformance and Interoperability in Heterogeneous Environments

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1. Overview

This White Paper summarises the past and current activities and achievements in validating implementations of The Object Management Group™ (OMG™) Core Common Object Request Broker Architecture (CORBA®) specifications. Featured in the paper are the goals, plans and work in progress of the IST Enhanced Techniques for CORBA Validation (CORVAL2) project, which runs from January 2000 to December 2002.

2. Introduction

The formation of OMG in 1989 galvanised the global software industry to abandon the procedural programming approach and to embrace object oriented computing, pioneered by Dahl[1] and Nygaard[2] in Norway some twenty years before. OMG's goal has always been to enable interoperable applications from multiple vendors in heterogeneous environments. For this goal to be realised, a critical mass of developers have to agree on a set of standards and the industry has to set up mechanisms to ensure that the standards are being adhered to.

3. Enabling Customer Choice in IT

Customer choice is currently a very topical issue in the IT industry. Customers and legislators want an open market where the 'same' product or service can be obtained form a range of vendors. This encourages competitive pricing and there should be little or no degradation of function when switching from one vendor to another. In addition, end-users should be able to interoperate with other end-users - irrespective of the vendor who supplied them. This sort of market currently operates in mobile telephony in the UK, with four major vendors - BT Cellnet, Vodafone, Orange and One2One - all having a significant market share and all users of any one service being able to interoperate with all three other services. An ideal way to create and maintain open markets is by adopting an open process for consensus-based standard setting.

3.1 The Role of Standards

The most effective standards are, by definition, not proprietary. Ideally they are implementation independent and freely available in the public domain. These standard specifications need to be arrived at using a consensus-based process and the time between standards agreement and compliant product availability should be reasonably rapid.

3.2 Validation, Branding and "Marking"

In order for this multi-choice, multi-vendor market to be created and maintained, it is vital that vendors, integrators, re-sellers and end-users are confident that products do actually comply with the standards. Validation through testing is the only reliable way of checking that products comply with standards. The establishment of a branding programme can give confidence when acquiring and using those products. The use of a well publicised, registered and protected 'mark' on the packaging and/or on the product itself is an indicator that standards compliance has been shown.

4. CORBA and The OMG

For over a decade OMG, the world's largest software consortium (www.omg.org) with some 800 members, has been building a standard architecture for integration based on object and component technology. This architecture, called the Object Management Architecture (OMA) [3], is the OMG's roadmap for developing a standard integration language (OMG Interface Definition Language™ or IDL™) for describing IT services and applications in a language and implementation-independent manner; a set of service interfaces for delivering requests between applications and services; and a set of higher-level layered application services for building distributed applications or, more importantly, for integrating existing applications and data.

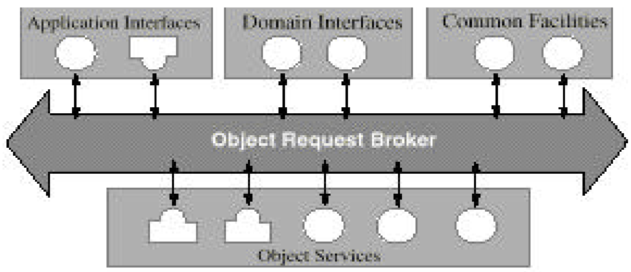

Figure 1: OMA Reference Model

4.1 OMG CORBA®

The Common Object Request Broker Architecture (CORBA) is at the heart of the OMA and is OMG's answer to the need for interoperability among the rapidly proliferating number of hardware and software products available today. Simply stated, CORBA allows software components to communicate with one another, no matter where they are located or who has designed them. CORBA Core 1.1 was introduced in 1991 by the OMG and defined the IDL and the Application

Programming Interfaces (API) that enable client/server object interaction within a specific implementation of an Object Request Broker™ (ORB™). OMG IDL is an ISO standard (DIS 14750).

The ORB is the basic infrastructure that establishes client/server relationships between objects. Using an ORB, a client can transparently invoke a method on a server object, which can be on the same machine or across a network. The ORB intercepts the call and is responsible for finding an object that can handle the request, pass it the parameters, invoke its method and return the results.

CORBA Core 2.0, adopted in December of 1994, defines true interoperability by specifying how ORBs from different vendors can interoperate. This interoperability was achieved by the adoption of the GIOP and IIOP protocols. In a CORBA 2.0 implementation, the client does not have to be aware of where the object is located, its programming language, its operating system or any other system aspects that are not part of an object's interface. In so doing, the ORB provides interoperability between applications in heterogeneous distributed environments by seamlessly interconnecting multiple object systems.

In the subsequent revisions 2.1[4] and 2.2[5] an interface for dynamic management of Any Values (DynAny) was introduced and the concept of Portable Object Adaptor (POA) was further improved in the 2.3[6] revision that was standardised in December 1998. New concepts included in this revision were Value Type and Abstract Interfaces, as well as COM/CORBA interworking. Language support has increased continuously and includes Ada, COBOL, C, C++, Java, Lisp and Smalltalk.

CORBA Core 2.4 was close to its final form at the time of writing (September 2000) and is likely to be adopted in Autumn 2000.

4.2 The OMG Process

The OMG technology adoption process is unique in many ways and has been refined over ten years, through the adoption of some 100 technologies. OMG is not a formal standards body, but neither is it a classical trade association. It consists of a wide variety of members, including IT developers/vendors, systems integrators, users, consultants, academics, government institutions and analyst organisations. It separates its technology adoptions into two categories - platform and domain. Platform technologies are those horizontal technologies which underpin all corporate software development and deployment activities - namely software lifecycle and interoperability technologies. Domain technologies are those specific to a particular line of business.

The technology adoption process begins with the formation of a group of members interested in a particular technology. Once OMG has given its blessing to the activities of the group, the group will discuss their "angle of attack" and then write, agree and have OMG issue a Request for Information (RFI). The voting process, which is universal within OMG, is that a 3 to 1 majority (excluding abstentions) is required to accept or reject a proposal. RFI's solicit ideas from the OMG membership and the world at large.

RFI responses are reviewed and synthesised into the issuance of a Request For Proposal (RFP). Only OMG members can respond to an RFP. RFP's solicit technology specifications to meet the requirements of the RFP. These specifications must reflect existing working code. The submitting vendor must also commit to build and market a product based upon the specification - should it be adopted.

OMG specifications - which all emanate from RFP responses - consist of compilable IDL statements. The specifications are implementation independent, language and platform independent. The implementation independence is key to the creation and maintenance of an open market-place. With multiple vendors implementing OMG specifications, users are given a choice of products. Because the same OMG IDL underpins each product implementation, users can also easily change from one product to another or have multiple products interoperating where necessary.

When vendors submit product specifications in response to RFP's they agree to relinquish their Intellectual Property Rights (IPR) should the specification be adopted by OMG. Once specifications become adopted they are published on OMG's Web site and can be accessed, downloaded and implemented by anyone.

4.3 OMG End User Vertical Domain Standards

Whilst infrastructure based on CORBA and UML has become the de facto standard for achieving integrated systems in the heterogeneous distributed enterprise, OMG has pushed "up the stack" to the heart of enterprise application integration; into "vertical market" or application-specific areas. Today OMG publishes specifications for medical and pharmaceutical systems; air traffic control and flight planning; manufacturing and inventory management; telecommunications; banking and other financial systems; human resources management; retail sales systems - a total so far of some 15 vertical market groups are working on OMG's second 100 specifications.

This work in end-user vertical domains began in 1994, and has led to an explosion in the growth of end-user members of OMG. Included in this group are such industry goliaths as AT&T, Boeing, BT, Citigroup, Ford, Fuji, Motorola, Nokia, NTT, Pfizer, SmithKline Beecham, UBS and Xerox. It is Global 500 companies such as these that will drive OMG to continue to populate what is already the world's most complete architecture for software integration.

5. CORBA Validation Initiatives

Since the initial core CORBA Core (1.1) specification was adopted in 1991, there have been various CORBA validation initiatives. One of the first of these was a famous CORBA 2.0 interoperability demonstration on the floor of the Object World '95 exhibition in San Francisco. Out of this effort grew the CORBAnet idea.

5.1 CORBAnet

The CORBAnet (www.corba.net) idea was to have an Internet-based CORBA interoperability demo permanently available and accessible on the World Wide Web. The CORBAnet Interoperability Showcase went live in 1996, demonstrating interoperability between seven CORBA ORBs from four vendors. The CORBAnet application is a minimal room booking system. The demonstration includes access of attributes, operation invocations, and passing and invoking object references. CORBAnet is still running, currently hosted by DSTC in Australia. It now features five CORBA ORBs from five vendors.

5.2 EURESCOM Project P715

EURESCOM is an institute for performing collaborative projects on research and strategic studies in telecommunications. Its 24 shareholders are major European network operators and service providers.

As part of EURESCOM Project P715 (www.eurescom.de/Public/projects/P700-series/P715/mainpr.htm), which ran from May 1997 to March 1999, an experimental environment was set up with six nodes across Europe, using commercially available products providing CORBA Common Services e.g. naming, persistence, trading, security and transactions. The objective was to create a middleware platform based on CORBA and TINA principles, running on top of various distributed hardware and software platforms. The participating companies were BT, Deutsche Telekom, Finnet Group, France Telecom, KPN and Eircom. Seven different CORBA ORBs were variously deployed at the six nodes in Finland, France, Germany, Ireland, The Netherlands and the UK. In all, 12 ORBs were installed.

The conclusion reached in September 1998 was that CORBA 2.x interoperability based on IIOP works, but that additional support is required for persistency, transactional behaviour, scalability, security and maintenance.

5.3 DOPG

The Distributed Object Promotion Group - DOPG (www.dopg.gr.jp) was established in October, 1997 in Japan to promote distributed object technology and to verify the inter-connectivity of member companies' products. Members of the group are BEA Systems, Fujitsu, Hitachi, IBM, Inprise, Mitsubishi, NEC, Nihon Unisys, Oki Electric

Industry, Oracle, Osaka Gas, Sun Microsystems, TIBCO and Toshiba. In December 1998, its Interoperability Working Group (chaired by NEC) succeeded in an IIOP level interoperability trial between CORBA products, which was the world's largest attempt to prove the interoperability of CORBA-based products in terms of the number of companies, the number of products verified and the number of combinations tested. Ten different CORBA ORBs were used in this interoperability trial.

The test worked by using simple client-server programs, consisting of invoking remote jobs (remote procedure call), passing and receiving data and handling exceptional status, which are all realistic tasks. The data types used in the test included primitive data types (integer, string etc.), any type (which can handle any type of data), object type and typecode type (which represents type itself). Since C++ and Java language mapping were both supported, the inter-language data passing and exceptional handling as well as remote job invocation, were also verified.

In March 1998, the Transaction Working Group (chaired by Fujitsu) succeeded in its first transaction level interoperability verification test among members' products based on the CORBA Transaction Service. In May 1999, DOPG announced that its Transaction Working Group had verified the transaction level interoperability of four members' products, which implement the CORBA Object Transaction Services (OTS). The transaction test verified interoperability using the Object Transaction Services 2-phase commit (2PC) protocol, including recovery cases. This was the first test to verify interoperability of products based on the CORBA Transaction Service.

5.4 The ESPRIT CORVAL Project

CORVAL (www.opengroup.org/corval) was the first European Commission (EC) sponsored CORBA validation project. It was part of the EC ESPRIT programme and was a 20 month project which ran from October 1996 to May 1998.

The objective of the CORVAL project was to facilitate and encourage multi-vendor deployment of CORBA ORBs. This was achieved by developing and bringing to market a programme to promote and differentiate conforming and interoperable CORBA ORBs that was distinctive, clear and valuable to buyers; and product quality test tools to help developers build conformance and interoperability into their CORBA ORBs, according to the CORBA 2.1 Specification.

The project built on the ADL automated test generation research already conducted by The Open Group, The Information Technology Promotion Agency (Japan) and Sun Microsystems Labs (USA), and to transfer skills in this technology into Europe. It also aimed at defining and validating the benefits and features users required of an ORB "marking" or "branding" programme, and developing and launching a continuing programme that best exploited the existing equity of The Open Group's X/Open brand.

The project partners were The Open Group, IONA Technologies and ICL. The test tools for the project were developed by Aptest Ireland. The CORVAL test suite achieved "General Availability" status, and has been on sale since December 1997.

6. The Open Brand Program for CORBA

The Open Brand was established by The Open Group™ (then called X/Open) over ten years ago. Products that conform to the standard specifications can receive the Open Brand. The Open Brand ensures that products fulfil all the criteria of open computing. Represented by the "X" mark, the Open Brand provides the purchaser with a binding supplier guarantee that each registered product not only conforms to open standards, but will continue so to conform. The Open Brand also guarantees that in the event of problems the fault will be corrected within a prescribed time-frame.

The Open Brand Program for CORBA, announced by OMG in June 1999, was developed by The Open Group. The program's goal is to ensure CORBA compliance among vendors and to guarantee out-of-the-box interoperability for vendors and end-users and portability to customers. The Open Brand Program for CORBA was developed in response to end-user and vendor demand for interoperability assurance between CORBA 2.1 products. As part of the certification process, software products are passed through rigorous test suites. Successfully tested products receive the Open Group CORBA trademarked logo. The attainment of the Open Brand is a guarantee by vendors that their products adhere to the specification both now and in the future. The Open Brand carries one of the strongest guarantees in the industry. The CORBA Brand was launched with an announcement that Fujitsu's ObjectDirector (now referred to as INTERSTAGE), ThinkOne's MICO 2.2.7 and AT&T National Laboratory's omniORB2 had been awarded The Open Brand for CORBA.

7. The IST Project CORVAL2 on Enhanced Techniques for CORBA Validation

7.1 Introduction

The IST Enhanced Techniques for CORBA Validation (CORVAL2) Project is a current project whose objective is to develop new concepts and tools for testing CORBA technology. CORVAL2 (www.opengroup.org/corval2) is a 2 year project which commenced in January 2000. The total project budget is EUR 1.7 million, with the EC Information Societies Technology (IST) Programme funding some 50% of this.

The CORVAL2 project partners are The Open Group, GMD FOKUS, Eric Leach Marketing, OMG, Fujitsu (ICL ITCentre) and Object Oriented Concepts.

The specific objectives of CORVAL2 are to specify and develop new test development tools and test suites for CORBA 2.3, and subsequently CORBA 2.4. The test suites will be used to verify the correctness of ORB implementations by vendors and other OMG members; to enhance The Open Group Brand Program in support of CORBA technology; and to promote the user acceptance of CORBA technology. The intention is to make this scheme further available to ORB vendors worldwide.

The tools and tests are being developed by GMD FOKUS in Berlin, Germany and they make use of The Open Group tests and tools created for validating CORBA 2.1 in the EC ESPRIT CORVAL project. The new functionality being specified in CORBA 2.3/ 2.4 for which the project will create tests, includes The Portable Object Adapter (POA), Value Type Semantics, Abstract Interface Semantics and CORBA interoperability.

The primary CORBA ORBs to be used in the development of the new tests are Fujitsu's INTERSTAGE and Object Oriented Concepts' ORBacus™ . Other ORBs to be used in the project include MICO™ and TAO. The project co-ordinator is The Open Group and Eric Leach Marketing provides the marketing resource for the project.

Major inputs to the project are VSOrb and Conformance Testing Methodology Framework (CTMF)[7]. VSOrb, The Open Group's test suite for C and C++ mapping of CORBA 2.1, has been applied to different ORB implementations. VSOrb makes use of the Assertion Definition Language (ADL) Translation System and Test Environment Toolkit (TET)[8] of The Open Group in order to automate the creation and execution of tests.

CTMF is an IUT-T/ISO standards initiative which is widely adopted for testing OSI systems and IT systems in general. A test management environment supporting CTMF-based test systems is also part of the input. It covers general purposes of test management, including setup and control of tests, as well as test reporting.

7.2 Conformance Requirements for CORBA

Following the terminology of the Reference Model of Open Distributed Processing (RM-ODP) defined by ITU-T/ISO-IEC[9], the term *conformance* is used to denote an implementation-specification relationship, while *compliance* refers to a specification-specification relationship.

Conformance testing is used to determine the conformance relationship. It is the process of testing the extent to which a system under test is conformant, i.e. adheres to the requirements put forward in the relevant standard or specification. It verifies the capabilities and behaviour of a system in order to assess the quality of the system and to find errors if existent. Conformance testing is black-box testing of functional properties. Testing cannot guarantee the absence of errors in an implementation - because exhaustive testing is not practical and too expensive in most cases.

A conformance *test suite* is an artifact to do so. It is a collection of *test cases* that represent test purposes and test activities to verify an implementation’s conformance with regard to the specification.

Further, the terms IUT (Implementation Under Test) and SUT (System Under Test) are used to denote a product or part of a product to be tested. For example, a SUT that VSOrb is applied to is an implementation of the CORBA specification.

CORBA does not make the distinction between conformance and compliance. It uses *Compliance Points* and *CORBA-compliance* to define conformance requirements on CORBA products. OMG, in section 0.5 of[10] defines that:

- "The minimum required for a CORBA-compliant system is adherence to the specifications to CORBA Core and one mapping. Each additional language mapping is a separate, optional compliance point."

- "Interoperability and Interworking are separate compliance points."

Nevertheless, the subsequent discussion will use the conformance terminology to refer to the implementation-specification relationship. The quoted statements above are considered to be insufficient. An important reason is that CORBA Interoperability is not part of the mandatory requirements on CORBA conformance. Following this definition, a CORBA conformant system would not ensure the interworking with other CORBA conformant systems. An essential goal of the OMG would not be fulfilled.

To solve this problem, on behalf of OMG, the Product Standard Definition Subcommittee (PSDS) defines a *Product Profile* for each CORBA reversion. According to the Product Profile, a conforming product must support the interoperability protocols GIOP and IIOP in addition to the Core functionality, whereas conformance to the Interworking specification is not mandatory. The Product Profile is adopted by the The Open Group's Product Standard[11], which is used to brand CORBA conformant products. In the context of the CORVAL2 project, CORBA conformance implies conformance with regard to the Product Profile and Product Standard.

According to the Product Profile, conformance requirements to an implementation of the CORBA ORB in a selected programming language (currently, either C++ or Java) can be separated into five major aspects:

1. Syntax of IDL constructs and their mappings to the selected programming language.
2. Semantics of IDL constructs and their mappings to the selected programming language.
3. Syntax of CORBA APIs and their mappings to the selected programming language.
4. Semantics of CORBA APIs and their mappings to the selected programming language.
5. Capability and behaviour of GIOP and IIOP.

While the realisation of the first four parts is constrained by language mappings, an implementation of aspect 5. may use any appropriate language as long as the defined functionality is provided.

For CORBA 2.3, all IDL constructs defined in Section 3 of[10], and their mappings defined in appropriate language mapping specifications are considered by the conformance tests.

All interfaces, including constants, types, operations, attributes and exceptions, that are defined by the Core API as mandatory will be covered by conformance tests. In comparison to V2.1, new API components introduced in V2.3 are interfaces of the Portable Object Adaptor (POA), Dynamic Management of Any Values (DynAny), Value Type Semantics and Abstract Interface Semantics. Extensions of the interfaces of the ORB, DII, DSI and Interface Repository are also considered.

7.3 Development of Conformance Tests

Below we will discuss different notations and methods for the development of conformance tests: TTCN and ADL are notations for abstract test cases (with the support of automated test implementation and execution) and TET is a test programming environment where the tests are defined directly on execution level.

7.3.1 The Tree and Tabular Combined Notation (TTCN)

TTCN (Tree and Tabular Combined Notation) has been defined as part of the Conformance Testing Methodology and Framework (CTMF)[7] for testing the conformance of OSI systems. It is a semi-formal test notation that supports specification of abstract test suites. The T for tabular refers to the use of tables (proformas) for the graphical representation of test suites. The T for tree refers to the hierarchical organisation of a test suite.

Concurrent TTCN allows the specification of multi-party testing provided by concurrent executed test components. Multi-party testing is applied especially for systems realised by decentralised or distributed components.

TTCN is the well-accepted, well-established and widely used test notation for the specification of abstract test cases and for automated execution. It is supported by various tool vendors (such as Telelogic or TTCNExperts) and test manufacturers (such as H-P, Tektronix or W&G). It is used by various industrial consortia and standardisation bodies for the definition of test suites (eg. by ETSI, Eurescom, ATM Forum or 3GPP).

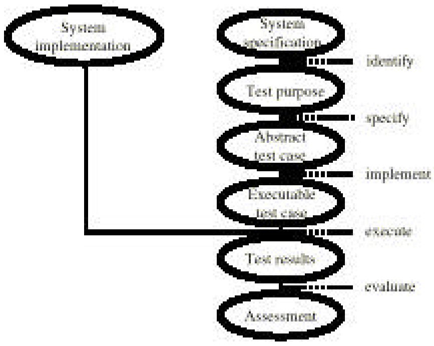

Figure 2: The Test Development Process

7.3.1.1 The Assertion Definition Language (ADL) and the Test Data Definition Language (TDD)

The Assertion Definition Language (ADL) provides formal syntax for the functional testing of software components. The earlier version of ADL[12] was developed under a collaboration of different partners, among them Sun Microsystems and X/Open. ADL was designed to test the behaviour of C routines. It specifies the semantics of the routines to be tested. ADL specifications are not embedded in the programs being tested, they are separate units. Data that is used in the tests is specified in the Test Data Description language (TDD). Both ADL and TDD specifications are required by the ADL Translator (ADLT) to generate test programs.

To use ADL for other languages, user-written wrapper code must be provided. The most recent version of ADL, 2.0[13], adds support for C++, Java and IDL. The Open Group was in charge of the development of ADL2.0. ADL provides formal syntax for semantics description in terms of annotated functions.

ADLT has its own test harness, but it supports also the test execution under the TET test harness. Options of ADLT test generation can be set to produce scenario files and test reports in TET format.

7.3.3. TCgate: The TTCN/CORBA Gateway

The TCCN/CORBA gateway (TCgate, for short), supports the "conversation" between a message-oriented TCCN test system and an object-oriented CORBA ORB. It provides a uniform operational interface to TTCN-based test systems for CORBA-based systems. TCgate is a generic request-level bridge using dynamic interfaces DII and DSI, and is thus independent from particular SUT types. It is also easily portable as it uses standard CORBA mechanisms. TCgate has been developed by GMD FOKUS and provides the means to test the conformance of CORBA systems.

TCgate consists mainly of two parts:

1. A set of mapping rules for IDL to TTCN transformation
2. A generic test execution support tool for CORBA-based systems.

CORBA-based applications use IDL to specify signatures of the functionality to be provided. The IDL to TTCN mappings facilitate the abstract description of conformance tests in TTCN. They determine how IDL constants and data types are translated to TTCN constant and type declarations. With TCgate and its generic CoDec, the development of conformance tests for CORBA-based system concentrates on the description of tests on the abstract level of TTCN. The generation of executable tests is completely automated.

TCgate is the key component for an automated execution of TTCN tests for CORBA-based applications, services and APIs. It is independent of the used CORBA ORB and of the system under test. It has been successfully used for different test campaigns of TINA and CORBA systems.

7.4 Test Management

Test management is tightly coupled with test development as it provides the infrastructure for the execution of tests. Typical test configurations for CORBA ORBs involve an ORB as the system under test, a test client and a test server, so that distributed test systems have to be handled with a test management tool.

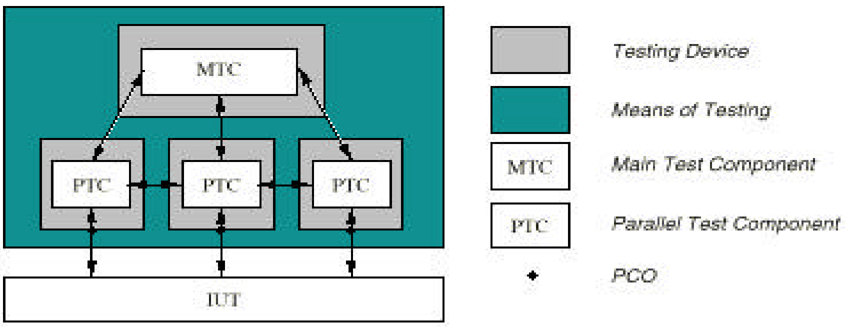

Figure 3: Generic Distributed Test Architecture

7.4.1 TET: The Test Environmental Toolkit

The Test Environment Toolkit (TET)[8] provides users and programmers with an uniform framework, in which test suites from different vendors can be incorporated through a common interface. It supports the development of portable test suites, which could easily be adapted to the user's needs regarding size and purpose of the tests. TET is provided by The Open Group and has been used with different test suites. It automates the execution of the current VSOrb test suite.

7.4.2 TTman: A Test Manager for Distributed Testing

TTman provides a GUI for the typical aspects of test selection, configuration, parameterisation, execution and test result logging with specific emphasis on the support for distributed tests. TTman is based on the Test Synchronisation Protocol 1 (TSP1) defined by ETSI Methods for Testing and Specification (MTS) for synchronisation issues in distributed test setups. The purpose of the TSP1 protocol is to achieve functional co-ordination and time synchronisation between two or more Test Synchronisation Architectural Elements. These are test components (for performing the test cases) front ends (for controlling test components on test devices) and the system supervisor (for setting up and configuring a test campaign and co-ordinating the test execution via a GUI).

TTman has been successfully used for conformance and interoperability test campaigns using TTCN test suites, as well as for measurement experiments in IP based networks.

7.5 The Conformance Tests

7.5.1 IDL Compiler Tests

These tests are based on the standard IDL to C++ mapping and concern the conformance testing of IDL compilers. They examine more the static aspects of the code produced by an IDL compiler. The tests use C++ compiler output to validate the capability of the IDL compiler under test.

7.5.2 IDL Stub and Skeleton Tests

IDL stub and skeleton tests are to verify whether requests are made through translated code for language mappings, and whether the runtime behaviour of the compiled IDL code works correctly. It is tested by passing typed values over operation invocations between client and server applications that reside on stubs and skeletons of an ORB. The TCgate approach is used for these tests (see 7.3.3).

7.5.3 API Syntax Tests

API syntax tests are to verify whether the language mappings for CORBA APIs are correctly reflected in the declarations which are contained in header files in the case of C++. They focus on the static aspects of CORBA APIs. The tests use similar techniques as for the IDL compiler tests.

7.5.4 API Behaviour Tests

API behaviour tests are to verify whether CORBA APIs operate as specified in the CORBA Core and language mappings - for example, an operation invocation under normal or exceptional conditions. The ADL-based test method is used for these tests.

7.5.5 GIOP/IIOP Tests

GIOP/IIOP tests are to verify whether GIOP messages are generated with correct syntax and the message exchange over IIOP works properly. In general, GIOP/IIOP is used when clients and servers located in different address spaces communicate via an ORB. Thus, the ORB can be separated into a client site part (client ORB) and a server site part (server ORB). GIOP/IIOP ensures that client ORBs and server ORBs from different vendors interoperate.

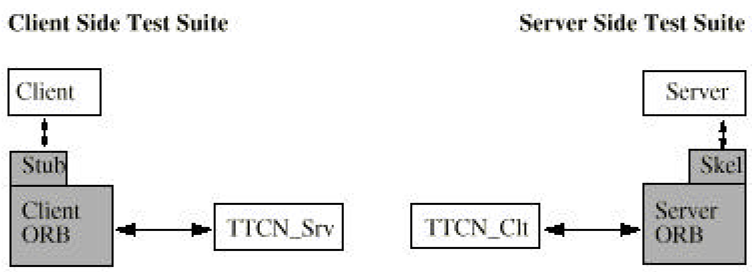

Figure 4: GIOP/IIOP Test Configuration

7.6 Development of a Testability Concept for CORBA Systems

Part of the project's remit is an investigation into a testability concept for CORBA from theoretical and practical viewpoints. In particular, the project will attempt to answer the following questions:

- What are the requirements on architecture and specification with regard to testability?
- Are the requirements fulfilled by CORBA specifications and implementations?

7.7 CORBA Interoperability Demonstration

The project has built, and is maintaining and extending a CORBA Interoperability Demonstration which made its public debut at the OMG Technical Meeting in Oslo on

14 June, 2000. INTERSTAGE™, ORBacus™, MICO™ and TAO ORBs were featured in this demonstration. There already exist CORBA ORBs that provide support for features of the new functionality defined in CORBA 2.3. In the demonstration they are able to interwork with ORBs from other ORB implementors via the IIOP protocol. The CORVAL2 demonstration shows how interoperability testing of ORBs works in principle, and will be a feature at all OMG Technical Meetings throughout 2000 and 2001.

The CORBA interoperability aspects covered by the demonstration include:

- Concepts of inter-ORB bridges to connect ORBs
- Format of Interoperable Object References (IORs)
- GIOP
- Common Data representation (CDR)
- GIOP Message Formats
- GIOP Message Transfer
- IIOP that maps GIOP message transfer to TCP/IP

7.8 CORVAL2 Benefits

The ORB market today is constrained by the perception held by application developers and system integrators that ORB implementations do not conform to the CORBA specification and do not interoperate. One very large software vendor consistently spreads fear, uncertainty and doubt around this issue.

The CORVAL2 Project is likely to represent the world's most complete exercise in "debugging" ORB implementors' interpretations of the OMG CORBA core 2.3/2.4 specifications. The branding programme within the project directly addresses the negative perceptions in the market. The test tools will "straighten out" discrepancies in ORB implementations and tackle the technical issues that underlie them.

By promoting the availability of conforming and interoperating ORBs, the project will benefit application software developers as they will be able to take advantage of the intrinsic benefits of distributed object and component technology and begin to unlock the significant commercial opportunities that this market offers them for the future. The availability of conformant and branded CORBA ORBs will simplify and reduce the cost of the middleware procurement procedures of end-users, especially those in the more conservative organisations.

8. Glossary

ADL	Assertion Definition Language
ADLT	ADL Translator
API	Application Programming Interface
CORBA	Common Object Request Broker Architecture
CTMF	Conformance Testing Methodology and Framework
DII	Dynamic Invocation Interface
DSI	Dynamic Skeleton Interface
GIOP	General Inter-ORB Protocol
IDL	Interface Definition Language
IIOP	Internet Inter-ORB Protocol
IOR	Interoperable Object Reference
IUT	Implementation Under Test
OMA	Object Management Architecture
OMG	Object Management Group
ORB	Object Request Broker
SUT	System Under Test
TCgate	TTCN/CORBA Gateway
TDD	Test Data Description Language
TET	Test Environment Toolkit
TSP1	Test Synchronisation Protocol 1
TTCN	Tree and Tabular Combined Notation
TTman	TSP1 Test Manager
UML	Unified Modeling Language
VSOrb	CORBA Verification Suite (C++)

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