

Evolutionary Design of Complex Systems

Open Technology for Software Evolution: Hyperware, Architecture, and Process

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Technical Status Report

1. Ongoing Research and Development

1.1. Hyperware

A significant amount of development has taken place on the Chimera open hypermedia system during this time frame.

- A wrapper which integrates Chimera 1.2 with Netscape 3.0 was completed on April 12th and shipped to Greg Johnson's group at Northrop for use in their EDCS demo.
- An upgrade to the Chimera 1.2 client chimera shell was completed on May 6. This client makes use of the new C API and provides a command line interface to the Chimera 2.0 client server.
- An upgrade to the Chimera 1.2 client XEmacs was completed on May 9. This new Chimera 2.0 client makes use of the upgraded chimera shell. This integration enables hypermedia information to be created over documents in XEmacs. It supports the creation of hypermedia anchors and links and fully supports complex link traversals.
- A FrameMaker 5.0 plug-in which integrates Chimera 1.2 with FrameMaker 5.0 was developed for use by Northrop in their July EDCS demo. This plug-in was converted to provide integration with Chimera 2.0 as well. It will be included as a standard client in future Chimera 2.0 releases.
- A C API to Chimera 2.0 was completed on May 2. This enables C-based clients to communicate with Chimera 2.0. Prior to this, Chimera 2.0 supported only Java-based clients.
- A new image viewer client for Chimera 2.0 written in Java was completed on May 14th. It supports the creation of hypermedia anchors and links over JPEG and GIF images. Plans are in place to make this Java application into a Java Applet as well.

Chimera versions 1.2 and 2.0 (alpha version) are available on the world-wide web at <http://www.ics.uci.edu/pub/chimera/1.0> and <http://www.ics.uci.edu/pub/chimera/> respectively.

1.2. Software Architecture

1.2.1. A Style Supporting Open, Dynamic Software Architectures

Many improvements have been made to ArchShell, a tool supporting dynamic modification and runtime evolution of software architectures. ArchShell was integrated with the Argo architecture design environment using a tool integration strategy based on the C2-style. The integrated environment, called *ArchStudio*, enables architects to design a system's architecture using Argo's graphical user interface and analysis facilities, and subsequently execute the system using ArchShell. While the system is executing, the architect may continue to modify the system's architectural model. The modifications are instantly reflected in the running system using ArchShell. An external tool has been added to ArchStudio that enables new components to be downloaded from a Web browser and automatically installed into a running system. The ArchShell command-line interface was enhanced to support event visualization using instrumented connectors.

An event monitoring and filtering facility was built on top of the Java-based C2 framework, a framework of abstract classes for modeling C2 architectures. This quarter the Klax video game

demonstration, originally built on the C++ C2 framework, was ported to the Java framework.

1.2.2. Software Architecture Design Environment

Version 5 of Argo, an interactive software architecture design environment, was released this quarter. It now provides better support for multiple views and persistency. New interfaces have been implemented for browsing design feedback and multiple design perspectives. Many new critics have also been implemented. New documentation for Argo includes a step-by-step cookbook that outlines how to specialize Argo's domain-independent infrastructure for design support to the particular needs of a given domain.

Versions 4 and 5 of GEF, a Java-based Graph Editing Framework, were released this quarter. GEF now has better performance, works under JDK 1.1, has an improved property sheet and substantially improved documentation. New features include grid snap, new FigImage to display GIFs and JPEGs, printing, better event handling, better FigText, new property organization, and better performance. Initial responses to a survey of GEF users indicate that developers find GEF understandable and easy to adapt to their particular needs.

Both Argo and GEF are freely available at <http://www.ics.uci.edu/pub/arch/argo/> and <http://www.ics.uci.edu/pub/arch/gef/> respectively.

1.3. Process

1.3.1. Process Support

This quarter the http server and client modules for Endeavors were completed. The server performs full Foundation level calls and enables communication between multiple Endeavors clients over the WWW. This implementation allows global visibility of Endeavors resources (via Internet) and adopts tight security protocols within currently available http servers. The Endeavors http server has successfully managed to function through several secure firewalls.

The Endeavors System level has been updated with new interfaces for Category, Specification, and Instance objects which provide stronger compile and runtime type checking of Endeavors objects. This new System level is used as the foundation for the new Project level interface.

The Project level is a new interface that runs between the Endeavors System level and User level. The Project level abstraction associates the Interpreter, Category object model and other System level objects with process design and runtime information. The encapsulation of these attributes provides stronger reuse capabilities for the process programmer.

To support some of the Project level functionality, the Foundation Proxy provides redirection of Foundation level calls to different Foundation instances and enhances data access capabilities of Applets over the WWW.

The Web level provides an interface for building Endeavors User process execution components over the WWW. To make Endeavors components more suitable for the WWW, these interfaces were designed to be specific yet lightweight. Notably, SunTeach and the Pacific Bell ADG uses this interface.

The User level's Artist and Artist manager can now communicate between each other. This ability

synchronizes and improves consistency of state between various end user views.

Endeavors has begun a port to the Java Developers Kit 1.1 to take advantage of new UI component, enhance performance and security, and to use its integrated protocols such as RMI.

We are completing the first phase of SunTeach, a Sun Microsystems sponsored project which uses Endeavors as a back end tool for administrating training.

An external communication tool for end users, Espresso, was integrated into Endeavors to provide a logged communication channel between participating process stakeholders.

1.3.2. Active Agents

Expectation-Driven Event Monitoring (EDEM) is currently being redesigned to allow generic monitoring of all software components conforming to the Java Beans Specification -- not just user interface components.

A survey of existing approaches/technologies/methodologies for collecting usage data is currently underway, and will provide future directions for the EDEM work.

2. Participants

Faculty:

David Redmiles
Richard N. Taylor

Research Programmers:

Clay Cover
Arthur Hitomi
Yuzo Kanomata
Kari Nies

Research Assistants:

Ken Anderson
Gregory Bolcer
Roy Fielding
David Hilbert
Peter Kammer
Michael Kantor
Tony Kutscher
Neno Medvidovic
Peyman Oreizy
Jason Robbins
Shilpa Shukla
James Whitehead

3. Notable Accomplishments and Technology Transition

3.1. Hyperware

Through two meetings of the WebDAV Design Team, consisting of working group members from Microsoft, Netscape, Novell, and U.C. Irvine, the design of the protocol extensions to HTTP for distributed authoring capability have been significantly refined. There is participation by a wide range of companies, including several vendors of document management systems and configuration management systems. The WebDAV discussion list currently contains over 200 email addresses.

A new draft of the WebDAV requirements document was issued <draft-ietf-webdav-requirements-00.txt>. This document lists the functional requirements for Web distributed authoring and versioning which are expected to be satisfied by the WebDAV extensions to HTTP [WebD97-3].

A new draft of the WebDAV scenarios document was released <draft-ietf-webdav-scenarios-00.txt>. This document lists scenarios of usage of distributed Web authoring tools [WebD97-4].

Work on the Apache implementation of the new Hypertext Transfer Protocol (HTTP/1.1) standard [FG+97] has completed and was publicly released as Apache 1.2 on June 4th.

The specification of Uniform Resource Locators [BFM97] is under revision and will eventually progress as an Internet standard.

Roy Fielding attended the Sixth International World Wide Web Conference (WWW6) April 7-11, Santa Clara, where he was a panelist on the “HTTP/1.x Developer’s Forum”. He also gave a presentation on “WebSoft: Building a Global Software Engineering Environment” at the ICSE 97 Workshop on Software Engineering and the World Wide Web [Fie97].

Ken Anderson and Jim Whitehead had papers presented at both Hypertext’97 and the co-located 3rd International Conference on Open Hypermedia Systems [And97, And97-2, Whi97-2, WW97].

A paper titled “A Critique of the Open Hypermedia Protocol.” was submitted to the Journal of Digital Information for the special issue on open hypermedia systems [ATW97].

Chimera 1.2 and 2.0 bindings to Netscape 3.0 and FrameMaker 5.0 were completed.

Chimera 2 was demonstrated at the 1997 International Conference on Software Engineering in Boston, Massachusetts, May 17-23 as part of the informal demonstrations track.

3.2. Software Architecture

Peyman Oreizy gave a presentation entitled “The WWW as an Enabling Technology for Software Engineering” at the ICSE 97 Workshop on Software Engineering and the World Wide Web [Ore97].

Nenad Medvidovic presented a paper titled “Reuse of Off-the-Shelf Components in C2-Style Architectures” at the 1997 Symposium on Software Reusability (SSR’97) in May [MOT97].

Peyman Oreizy gave a presentation entitled “Dynamic Architectures” at the 2nd EDCS Architec-

ture Cluster Workshop, Santa Fe, NM, April 16-18, 1997.

Nenad Medvidovic presented a paper titled “Classification and Comparison Framework for Software Architecture Description Languages” at the 2nd EDCS Architecture Cluster Workshop, Santa Fe, NM, April 16-18, 1997.

A paper titled “Exploiting Architectural Style to Develop a Family of Applications” was accepted to the IEE Proceedings Software Engineering journal [MT97-2].

A paper titled “A Framework for Classifying and Comparing Architecture Description Languages” was accepted to the Sixth European Software Engineering Conference together with Fifth ACM SIGSOFT Symposium on the Foundations of Software Engineering, [MT97-3].

Jason Robbins presented a formal demonstration paper on Argo at the 1997 International Conference on Software Engineering in Boston, Massachusetts, May 17-23 [RHR97]. Argo, ArchShell and the C2 Klax example were also demonstrated as part of the informal demo track at this conference.

June 6, 1996. Jason Robbins presented Argo to the AI group at NASA’s Jet Propulsion Laboratory, Section 395, in Pasadena, California. Dr. Daniel Dvorak expressed interest in evaluating Argo’s approach and toolset. Andre Stechert was the host.

Rob Deline of CMU started using GEF to implement a user interface to the Unicon system.

Version 5 of the Argo design environment was release this quarter. Also, versions 4 and 5 of the UCI Graph Editing Framework (GEF), a Java class library that supports construction of graphical editors, were released. Participants in the gef-users mailing list include members of Carnegie Mellon University, Northeastern University, Purdue University, University of Washington, The Naval Post-Graduate School, University of Cincinnati, UC Santa Barbara, National Chinese University of Taiwan, Gemstone, ObjectShare, Oracle, and Seimens.

An Argo demo paper was submitted to the 1998 conference on Intelligent User Interfaces (IUI98) [RR97].

3.3. Process

Sun Microsystems using Endeavors as a process execution environment for their internal Java education program. An Endeavors process was created for Tom Awkright to drive Sun’s web-based instruction delivery system. The Endeavors process provides Sun with an easily extensible means to coordinate multiple courses and collect metrics on the course takers. The system will be used on Sun’s new Java Stations. Endeavors is ideally suited for the Java Station due to it’s ease of use over the World Wide Web.

Jim Cunningham, head of the Netscape’s Enterprise Server group, is interested in experiments and integrations with Endeavors. Asad Faizi, the author of Netscape’s Enterprise Server Java bindings, was impressed with a demonstration of the Endeavors system at a WWW working group meeting held at UCI and is interested in exploring the design and architecture in further detail. The Endeavors group made two visits to Netscape at their corporate site in Mountain View, CA. The first visit was an in-depth presentation of Endeavors to their Enterprise Server group. The second visit, hosted by the same group, introduced Endeavors to other technology groups in the company.

An integration plan was discussed. Netscape has since requested several updates to the Endeavors software for evaluation and experimentation.

Ray Licon of Pacific Bell is investigating the use of Endeavors for the Application Development Group and the entire Pacific Bell organization.

Greg Bolcer presented a formal demonstration paper on Endeavors at the 1997 International Conference on Software Engineering in Boston, Massachusetts, May 17-23 [HBT97]. Endeavors was also included in the informal demonstration track at this conference.

EDEM version 1.0 (alpha) is now freely available for experimental purposes from the EDEM website: <<http://www.ics.uci.edu/~dhilbert/edem/>>.

EDEM was demonstrated at the 1997 International Conference on Software Engineering in Boston, Massachusetts, May 17-23 as part of the informal demonstrations track.

An EDEM technical report was completed in May [HRR97] and an EDEM demo paper was submitted to the 1998 Conference on Intelligent User Interfaces (IUI98) [HRR97-2].

4. Progress on Inter/Intra Cluster Collaborations

4.1. Hyperware

Northrop-Grumman's B-2 Division are using Chimera to record and browse heterogeneous collections of engineering information. UCI completed and shipped new client tool bindings to Netscape 3.0 and Frame Maker 5.0. Northrop-Grumman will use Chimera 1.2 for July demo; subsequent switch to Chimera 2.0 is planned.

Lockheed-Martin in Manassas, VA has installed Chiron 2.0 for evaluation.

Michael White of CoGenTex is evaluating the Chimera 2.0 alpha release. CoGenTex has offered to support the integration of Chimera with the Argo design environment for their subsequent use.

There have been some discussions of possible collaborations with Software Productivity Solutions (SPS). In particular, they believe that Chimera 2.0 can provide them hypermedia access to information not wrapped by CORBA objects, in their Catalyst environment.

Two technologies from Columbia University are being investigated for use in Chimera 2.0. The Rivendell Tool Server can be used to provide process invocation services which is required to provide delayed link traversals. The Pern Transaction Manager can be used to provide long-term transactions and locking to the concepts within a Chimera hyperweb.

4.2. Software Architecture

On May 16th, Peyman Oreizy and Nenad Medvidovic met with EDCS integrator, Greg Johnson, and his team at Northrop-Grumman to discuss how to model the interactions between their avionics software tools using the C2-architectural style as an integration framework.

Functionality has been added to ArchShell, our runtime architecture modification tool, to export architecture descriptions in the ACME language. This will enable us to leverage ACME-based

analysis tools from other architecture cluster members when they become available.

4.3. Process

We are working with Lockheed Martin C2 Integration Systems (contacts Teri Paton and Lyn Uzzle) to integrate EDEM into the Global Transportation Network (GTN) demo scenario.

A meeting was held with Computing Services Support Solutions (CS3), regarding integration of EDEM with their FLEA/SoMoS System (contact is K. Narayanaswamy).

Discussions with CoGenTex are underway regarding a possible integration of EDEM with work they have been doing on intelligent and adaptive user interfaces. Contact is Michael White.

5. Publications

Kenneth M. Anderson, Richard N. Taylor, and E. James Whitehead, Jr. *A Critique of the Open Hypermedia Protocol*. Submitted to the Journal of Digital Information for a special issue on open hypermedia systems. [ATW97]

Nenad Medvidovic, Richard N. Taylor. *Exploiting Architectural Style to Develop a Family of Application*. To appear in the IEE Proceedings Software Engineering journal. [MT97-2]

Nenad Medvidovic and David S. Rosenblum. *Architectural Domains: A Framework for Characterizing Architectural Description*. Submitted to the USENIX Conference on Domain-Specific Languages. [NR97]

David M. Hilbert, Jason E. Robbins, and David F. Redmiles. *EDEM: Intelligent Agents for Collecting Usage Data and Increasing User Involvement in Development*. Submitted to the 1998 conference on Intelligent User Interfaces. [HRR97-2]

Robbins, J. E., Hilbert, D. M., Redmiles, D. F. *Software Architecture Critics in Argo*. Submitted to the 1998 conference on Intelligent User Interfaces. [RR97]

6. Travel

Table 1: Project Meetings/Conferences and Attendance

Meeting	Location	Dates	Attendees
JavaOne	San Francisco, CA	Apr 1-6	CC
Hypertext 97	Southampton, UK	Apr 6-11	KA, JW
3rd Intl. Workshop on Open Hypermedia Systems	Southampton, UK	Apr 6-7	KA
6th Intl. WWW Conference (WWW6)	Santa Clara, CA	Apr 7-11	RF, GB

Table 1: Project Meetings/Conferences and Attendance

Meeting	Location	Dates	Attendees
EDCS Architecture Cluster Meeting	Santa Fe, NM	Apr 16-18	RT, NM, PO
WebDAV Design Team Meeting	Irvine, CA	Apr 1-4	JW
IETF WebDAV Working Group Meeting	Memphis, TN	Apr 7	JW
1997 Symposium on Software Reuse (SSR)	Boston, MA	May 17-19	NM, PO, JR
1997 Workshop on Software Engineering on the WWW	Boston, MA	May 19	RF, PO
1997 International Conference on Software Engineering	Boston, MA	May 17-23	DR, RT, AH, KN, KA,GB, RF, DH, NM, PO, JR
WebDAV Design Team Meeting	Netscape, MountainView, CA	Jun 23-24	JW

**Initials for attendees are based on the list of participants given on page 5.*

7. Near Term Plans

7.1. Hyperware

In the following quarter we anticipate several interesting developments with respect to the Chimera 2.0 open hypermedia system. First, a beta release is planned for the end of September. This beta release will provide new functionality such as the ability to import and export hyperwebs, create links between web-based clients and traditional clients, provide delayed link-traversal capabilities, and support the latest version of the Java Development Kit.

The WebDAV working group plans to hold working group meetings in Orem, Utah in July, and in conjunction with the Munich IETF meeting in August. There are expected to be several new releases of the requirements and protocol documents over the coming months, and the requirements document is expected to be sent to working group “last call” in September, a final step before sending the document off to the Internet Engineering Steering Group for final approval as a RFC (Request for Comments).

7.2. Process

Over the next quarter the Endeavors group plans to develop more processes and to complete the next phase of Pacific Bell’s ADG process and of Sun Microsystems’ SunTeach.

Enhancements and migration of the new System and Project level interfaces will take place as well as improvements in the Foundation Level for better performance and robustness.

An ICSE 98 submission on Supporting Distributed Workflow using HTTP is planned.

Endeavors will continue its JDK 1.1 migration.

In the following quarter, David Hilbert will continue his survey of existing approaches/technologies/methodologies for collecting usage data. Work will continue on the EDEM redesign to allow generic monitoring of all software components conforming to the Java Beans Specification.

An EDEM paper for submission to the Agents'98 Conference is planned.

Integration work with Lockheed Martin C2 Integration Systems, Computing Services Support Solutions (CS3), and CoGenTex will continue.

7.3. Software Architecture

We plan to incorporate technology into ArchShell to support external analysis tools as a means to support governed architectural change and runtime architectural analysis.

An ICSE 98 submission on dynamic architecture modification and ArchShell is planned

Jason Robbins is currently surveying object-oriented design methods and their relationship to software architectures. A submission to ICSE 98 is anticipated.

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