

Evolutionary Design of Complex Systems

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

Third Annual Technical Report

Richard N. Taylor, David Redmiles
Department of Information and Computer Science
University of California
Irvine, California 92697-3425

{taylor, redmiles}@ics.uci.edu
<http://www.ics.uci.edu/pub/edcs/edcs.html>

Voice: 949-824-6429 FAX: 949-824-1715

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1. Progress and Accomplishments

Our work continues to focus on several technologies to aid in the effective evolution of complex software. In particular our research foci are:

- open, broad-based hyperprogram and active rationale support
- component-based architecture evolution technology, and
- multi-stakeholder process support

Open hyperware, software architecture, and workflow/process technologies are key enablers for supporting evolution of complex software systems. We are developing techniques, standards, and tools in each these areas and are distributing the results via the World-Wide Web (WWW). The technologies are being developed cooperatively, so that results in one area leverage the other two. The hyperware focus is on developing infrastructure to integrate open link server hypermedia systems with the WWW, while adding support for hyperweb configuration management, semantically-rich link generation, cooperation agents, and automatic rationale capture. The architecture research is directed at reducing the cost of application development by providing domain-informed, style-based design guidance, architecture design environments with analysis capabilities, implementation technologies, and support for dynamic change. The process work is designed to improve coordination and managerial control of teams by allowing flexible definition, modeling, and execution of typical workflow and process applications over the Internet.

Highlights of our progress and accomplishments for this reporting period include:

- The Internet Engineering Task Force (IETF) approved the HTTP/1.1 protocol specification (RFC 2616) as a proposed standard. This indicates that the standard is stable, of high technical quality, and has undergone significant community review. Roy Fielding of UC Irvine is the lead author [FG+99].
- We have seen wide scale adoption of the UC Irvine led WebDAV protocol (RFC 2518) for collaborative authoring of Web content. Adopters include Microsoft (Office 2000, IE5, IIS 5), IBM (DAV4J), and open source projects (Apache mod_dav, DAV Explorer). This has resulted in 10 client applications, 2 publicly available client API libraries, 17 WebDAV servers (12 class-2, 5 class-1), and 2 WebDAV-enabled Web storage sites. These applications run on a range of platforms, with client support for Windows, Unix, and MacOS, and server support for Windows and Unix.
- An Internet start-up company, ETI, has licensed Endeavors web-based process/workflow technology for use as a commercial software system. Endeavors, created by EDCS researchers at UC Irvine, enables customizable definition and execution of distributed workflow models involving multiple activities and resources. ETI is actively developing this technology and is supplying workflow solutions to commercial customers.
- UC Irvine licensed the JavaBrain technology to Sun Microsystems, Inc. Sun is using the JavaBrain technology for the development and deployment of Computer Based Training (CBT) materials. JavaBrain is built on top of the Endeavors technology.
- Argo/UML, a open source architecture design environment utilizing the industry standard Unified Modeling Language (UML), has been widely used by over 19,000 registered users and by over 150 developers at sites such as Aonix, ISX, IBM, Motorola, and Oracle.
- Researchers at UC Irvine have constructed ArchStudio 2.0, an extensible, integrated software architecture development environment. ArchStudio 2.0 integrates several existing EDCS technologies including Argo/C2, ArchShell, DRADEL, and Chimera. ArchStudio 2.0 uses an XML-based abstract model of the system architecture as a basis for integration. The defined XML DTD, called xADL, is designed to support a range of architectural models, including C2.

- Our researchers and staff organized the 1999 Workshop on Internet-scale Software Technologies (TWIST 99) - a follow-on to the first Workshop on Internet-Scale Event Notification (WISSEN). The workshop was held August 19-20 at UC Irvine. Participants included The Aerospace Corporation, Lotus Development, Intel Labs, MIT, Network Solutions, Xerox Palo Alto Research Center, Information Sciences Institute/USC, and CNRI.
- Research this period has resulted in 4 technical journal publications and 13 conference/workshop publications.

1.1. Hyperware

In June, 1999, the IESG published our specification of the Hypertext Transfer Protocol (HTTP/1.1) as a Draft Standard (RFC 2616) [FG+99]. HTTP/1.1 is an application-level protocol for distributed, collaborative, hypermedia information systems and is the primary transfer protocol for the World Wide Web. It is a generic, stateless protocol that can be used for many tasks beyond its use in hypertext, such as name servers, distributed object management systems, and global software engineering environments, through extension of its request methods, error codes and header fields. A feature of HTTP is the typing and negotiation of data representation, allowing systems to be built independently of the data being transferred.

We have seen wide scale adoption of the UC Irvine led WebDAV protocol (RFC 2518) [GW+99] for collaborative authoring of Web content. Adopters include Microsoft (Office 2000, IE5, IIS 5), IBM (DAV4J), and open source projects (Apache mod_dav, DAV Explorer). This has resulted in 10 client applications, 2 publicly available client API libraries, 17 WebDAV servers (12 class-2, 5 class-1), and 2 WebDAV-enabled Web storage sites. These applications run on a range of platforms, with client support for Windows, Unix, and MacOS, and server support for Windows and Unix.

The WebDAV project at UC Irvine released the first WebDAV client, DAVExplorer. DAVExplorer was released open source allowing for a wide pool of developers to study the WebDAV protocol and to improve the design of DAVExplorer. DAVExplorer has successfully been used as a test bed for WebDAV servers from Apache, Microsoft, and IBM. We have continued developing WebDAV Explorer to make it fully compliant with the final WebDAV specification, RFC 2518, and to upgrade it to use the Java JDK 1.2 libraries.

Wide industry support for WebDAV has included client support of WebDAV on Microsoft's Office 2000 release, and server support on Microsoft's Windows 2000 operating system. Microsoft's Internet Explorer web browser, version 5, also shipped with WebDAV support.

IBM has likewise supported WebDAV through DAV4J, a freely available WebDAV server, and Java client API for WebDAV, available on IBM's AlphaWorks site.

A WebDAV module for the Apache Web server (the module is called "mod_dav") was released in beta form, as part of ongoing development. Red Hat announced that they are bundling the mod_dav WebDAV support module for Apache in with their Apache Commerce Server product.

Zope, the "Z Object Publishing Environment" (<http://www.zope.org>), a product of Digital Creations, also announced their support for WebDAV during the reporting period.

Sharemation <<http://www.sharemation.com/>> announced the availability of a WebDAV-compliant storage site, where it is possible for anyone to sign up for free 20 Meg of storage in under 5 minutes. This was a big step forward for WebDAV, since it means that anyone can quickly get access to a WebDAV server to try out the protocol.

The first Macintosh WebDAV client, called Goliath, was announced on September 11th. It provides a Finder-like interface to a remote WebDAV server.

On February 2, the WebDAV Resources web site (<http://www.webdav.org>) went live. This Web site is maintained by Greg Stein, an independent software developer, and is indicative of the growing support for this standard.

Our work on WebDAV has continued with progress on the Advanced Collections, Versioning and Configuration Management (Delta-V), and Searching (DASL) protocols.

Our work on the Chimera open hypertext project has involved porting Chimera to other platforms as well as supporting users experimenting with ports to other systems. Our work included refining our Linux port and tests of Chimera 2.0 on Windows 95, Windows 98, and Windows NT. From these tests, it was discovered that both Windows 95 and Windows 98 have incomplete Java Virtual Machine implementation available which limited the ability of Chimera 2.0 to be ported successfully onto these platforms. The tests have lead to further refinement of Chimera's servers and client applications on Linux and Windows NT.

In support of cross platform activities, a new client integration was completed and tested in-house. for the Adobe's Acrobat Reader for Unix based systems. The integration was completed using the plug-in capability of the software.

Further Chimera research was undertaken at the University of Colorado at Boulder. The focus of work at CU was on the refinement of the servers and data models for Chimera. This has resulted in an new publicly available Chimera version, Chimera 3.0. Current work has focused on implementing first-class typing of anchors and links within the Chimera hypermedia model.

1.2. Software Architecture

Argo/UML, a open source architecture design environment utilizing the industry standard Unified Modeling Language (UML), has been widely used by over 19,000 registered users and by over 150 developers at sites such as Aonix, ISX, IBM, Motorola, and Oracle.

A new version of Argo/UML was released with significant new functionality. New features include non-modal wizards that help designers correct the design problems identified by design critics and selection-action buttons that bring the appropriate toolbar buttons down into the main diagram editing area for faster and more convenient use. The Argo/UML web site was updated with new documentation and new example design documents. We also explored the requirements for generating a web site to document a design modeled in Argo/UML and the requirements for managing programmatic extensions to Argo/UML. Jason Robbins also investigated the relationship of usage-centered design to our group's UML and user interface prototyping efforts.

We conducted a user study of the "broom alignment tool" feature of Argo/UML. The study consisted of ten subjects who performed sample diagramming tasks using the broom alignment tool or standard alignment commands. The results of this study showed that the broom alignment tool

required much less mouse movement and dragging, that users enjoyed using the broom tool, and that the short-term memory load required to use the broom was not significantly different from that of standard tools.

Jaya Vaidyanathan and Jason Robbins explored the use of HTML as a user interface prototyping medium. HTML is an attractive prototyping medium because many, high quality HTML editors are available and because the resulting prototypes emphasize elements of the design that is hard to express with paper prototypes, also HTML prototypes can be evaluated by remote subjects. An example user interface was prototyped and a prototyping method was outlined.

We have built ArchStudio 2.0, an extensible, integrated software architecture development environment. ArchStudio 2.0 incorporates a number of UCI's software architecture technologies, including: (a) ArchShell, an tool that enables runtime modification of software architectures; (b) Argo/C2, the graphical design environment that uses critics to continuously analyze software designs; (c) DRADEL's parser and topological constraint checker, a toolset that imports and statically analyzes C2 SADEL ADL descriptions; (d) Chimera integration, which allows hypertext linking between our design environment and other software artifacts such as source code and requirements documents; (e) a Web browser for downloading additional software components; and (f) off-the-shelf XML tools for viewing and manipulating the common architectural model. All of these tools use an extensible XML-based architectural model. This permits the addition of new attributes and properties as new tools are added to the environment. The defined XML DTD, called xADL, is designed to support a range of architectural models, including C2.

Peyman Oreizy continued research on decentralized software evolution. As an evaluation exercise, he componentized a small portion of the Mozilla Web browser -- the open-source version of Netscape's Communicator Web browser -- by adding several software connectors to its architecture. Exposing Mozilla's software architecture to third-party developers allows them to change its functionality in ways that were not previously possible.

Arabica's goal is to enable composition of JavaBeans components in the C2 architectural style. The JavaBeans developer expects an interface that enables easy, visual composition of individual JavaBeans into applications that are usable. Arabica not only allows this kind of visual JavaBeans composition, but also enforces C2 stylistic rules and provides customization mechanisms that allow an architect to compose JavaBeans according to the requirements of his or her particular specification of a C2 architecture. This is achieved with a wrapping mechanism that wraps every bean and customizes it into a C2 component. The wrapper also takes care of queuing outgoing events from the component after converting them into C2 messages and queuing incoming messages and converting them into JavaBeans events. Standard C2 connectors are provided, and an additional mechanism is provided to allow an architect to specify his or her own filtering or monitoring mechanisms and embed them into a C2 connector. The visual composition environment allows the architect to then link the wrapped components and connectors into the C2 architecture. C2 style rules guide this composition task. These features were implemented by taking Sun's Bean Development Kit (BDK 1.0) and extending it to implement the features of our tool.

Siena is an advanced middleware infrastructure that implements content-based routing to support event-based applications on a wide-area network. The components of a loosely-coupled system are typically designed to operate by generating and responding to asynchronous events. An event notification service is an application-independent infrastructure that supports the construction of

event-based systems. The two primary services that should be provided to components by the infrastructure are notification selection and notification delivery. Numerous event notification services have been developed for local-area networks, generally based on a centralized server to select and deliver event notifications. Therefore, they suffer from an inherent inability to scale to wide-area networks, such as the Internet, where the number and physical distribution of the service's clients can quickly overwhelm a centralized solution. The critical challenge in the setting of a wide-area network is to maximize the expressiveness in the selection mechanism without sacrificing scalability in the delivery mechanism.

Siena is an event notification service that we have designed to maximize both expressiveness and scalability. It has a formally defined application interface, which is an extension of the familiar publish/subscribe protocol. Its selection and delivery mechanisms are designed for networks of peer-to-peer event servers and adopt strategies for optimizing the performance of the notification matching process as well as the network resources used to propagate and store subscriptions and notifications. The first version of Siena has been publicly released. The package includes a peer-to-peer server (implemented in C++), a hierarchical server (implemented in Java), and a client-side API for both the C++ and the Java language. Both servers implement the subscription-forwarding algorithm.

1.3. Process

Several reusable process components were created to support rapid development and reuse of workflow processes. A library of components, called e-lib (Endeavors libraries), was developed for the domain of document routing and approval, and web-based workflows. The web-based workflow components allow end users to easily assign web pages as work activities. By using these web-based workflow components and WebNavigator, an interface that lies between an HTTP server and Endeavors, end users can initiate, continue complete and change a workflow process from a URL or HTML form.

Two workflow analysis tools are being developed. The first tool converts control flow based workflows into a Petri-net. The conversion requires that the control flow and all of its artifacts are converted into a data-flow model. By feeding the data-flow model into the Petri-net tool we can analyze five important attributes for workflow: Soundness of workflow, syntax, time analysis, simulations, and axiomatic verification. Soundness of workflow checks for reachability and completion, deadlock and livelock. Deadlock detection algorithms assure that one or more processes will not reach starvation due to conflicting or unavailable resources. Reachability analysis will ensure that the workflow will always start and end properly. Time analysis can be used to calculate minimum, average and maximum time for completion of a workflow. Simulations can provide cognitive walkthroughs to users before a system is deployed. Axiomatic verification can verify properties pertaining to a workflow.

The second tool called RealityCheck, supports analysis and filtering of data generated from adaptive workflow management tools. RealityCheck compares the history of completed workflow processes against the initially prescribed workflow. After the comparative analysis, RealityCheck constructs a new generalized process using a smoothing algorithm. The process manager can then interactively customize the new process by manipulating different aspects of the process.

The University of California, Irvine licensed the Endeavors technology to Endeavors Technology

Incorporated (ETI). ETI is a small, highly responsive technology company that will provide Web-based workflow, wireless workflow, Web-based information systems, and E-Business solutions. ETI will use Endeavors to build several products: a lightweight, HTTP-based workflow server that easily integrates with existing tools and technologies at use in a business; a full featured graphical environment for non-technical users to visualize, describe, and share executable descriptions of their work; a lightweight, HTTP-based document management repository; and a scaled down, small footprint version of the Endeavors desktop for use on PDAs, palmtops, and handheld computing devices.

The University also licensed the JavaBrain technology to Sun Microsystems, Inc. Sun is using the JavaBrain technology for the development and deployment of Computer Based Training (CBT) materials. JavaBrain is build on top of the Endeavors technology.

The Course Syllabus Process (CSP) has been deployed at UCI. The CSP lets end users systematically design a course syllabus by following a prescribed process using the Endeavors process engine. If necessary, any task of the CSP can be assigned and routed to different people. Professors and lectures at the Irvine campus now use the CSP for their courses.

The Endeavors group has been researching integration strategies with the latest event based architectures and tools. Recent CSCW tools (used to support the end users for work) provide rich event based communications and can be used as the integration mechanism for workflow systems. Endeavors is continuing to leverage and study the semantics of these event mechanisms for discovering and integrating process into everyday tools. This approach, consistent with the Endeavors design philosophy, lowers the cost of adoption and through Endeavors allows for better automation and analysis of work. New web-based reusable components as well as refinements to existing components have been made to the Endeavors web-based process library called e-lib (Endeavors library). These tools allow process managers to easily assign web pages as work activities and provide seamless integration of the WWW activities and resources with process.

The process group is surveying the technologies and approaches that support adapting changes to workflow for changing work environments and process requirements. This also suggests approaches that assist in discovering problems and avoiding conflicts between the system and environment before they occur. The approaches are drawn from the literature of the respective communities as well as insights based on the development of the Endeavors workflow support system.

Endeavors has designed and implemented a set of new and reusable process components for the field of scheduling and reservation systems. This process enables end users to add, modify, and remove their schedules from a database and uses the Endeavors process system to manage the user interactions and transactions as a high level processes. Typically, these systems interact with database systems which model these as transactions and enforce them through a database transaction manager to ensure their consistency. However, as the resource reaches capacity, the point at which exceptions occur, transaction systems are often too rigid to deal with these problems gracefully. By using the high level and interactive process components, dynamic flexibility and exception handling capabilities of Endeavors, Endeavors better resolves these complex scheduling issues, especially those that require coordination such as group calendaring systems.

Knowledge Depot has gained a new web based interface that has resulted in significant gains in usability over previous interfaces. It has also gained noticeably in speed. These two factors will

make the system far more approachable to users, allowing us to better study the impact of the system on users.

The scalability of Knowledge Depot was enhanced to support greater numbers and types of users. The new design will also allow greater flexibility in specifying relevant information, as well as in clustering the information together within a single notification. This will enable studies within the Open Source community and with user groups on the University campus in determining the exact benefits and potential of this system.

2. Professional Personnel

Faculty:

David Redmiles
David S. Rosenblum
Richard N. Taylor

Research Assistants:

Roy Fielding
David Hilbert
Arthur Hitomi
Peter Kammer
Michael Kantor
Rohit Khare
Neno Medvidovic
Rema Natarajan
Peyman Oreizy
Jason Robbins
Shilpa Shukla
James Whitehead

Research Programmers:

Clay Cover
Adam Gauthier
Yuzo Kanomata
Edwin Kraemer
Kari Nies

Degrees Awarded:

David Hilbert, Ph.D. Computer Science
Awarded June 1999

Dissertation: “*Large-Scale Collection of Application Usage Data and User Feedback to Inform Interactive Software Development*” [Hil99]

Jason Robbins, Ph.D. Computer Science
Awarded September 1999

Dissertation: “*Cognitive Support Features for Software Development Tools*” [Rob99]

3. Publications in Technical Journals

Peter Kammer, Greg Bolcer, Richard N. Taylor, and Mark Bergman. *Techniques for Supporting Dynamic and Adaptive Workflow*. To appear in the Journal of Computer Supported Cooperative Work. [KBTB99]

Nenad Medvidovic and Richard N. Taylor. A *Classification and Comparison Framework for Software Architecture Description Languages*. IEEE Transactions on Software Engineering, vol. 26, no. 1, January 2000. [MT99]

Peyman Oreizy, Michael M. Gorlick, Richard N. Taylor, Dennis Heimbigner, Gregory Johnson, Nenad Medvidovic, Alex Quilici, David S. Rosenblum, and Alexander L. Wolf. *An Architecture-Based Approach to Self-Adaptive Software*. IEEE Intelligent Systems, vol. 14, no. 3, May/June 1999, pp. 54-62. [OG+99]

Jason Robbins and David Redmiles. *Cognitive support, UML Adherence, and XMI Interchange in Argo/UML*. To appear in the Journal of Information and Software Technology special issue on the best of CoSET'99. [RR99-2]

4. Interactions (Related Activities/Conferences)

4.1. Hyperware

At the Hypertext'99 conference, held February 21-25, in Darmstadt, Germany, Jim Whitehead presented a tutorial on WebDAV titled "The Web as a Writable Collaborative Medium: An Introduction to the IETF WebDAV Standard," and also presented a talk on his paper, "Control Choices and Network Effects in Hypertext Systems"[Whi99]. At this conference, Ken Anderson also presented his paper entitled, "Data Scalability in Open Hypermedia Systems" [And99].

The WebDAV versioning and configuration management design team held a two-day meeting February 10-11, in Orem, Utah, hosted by Novell. The WebDAV Working Group held a meeting at 44th meeting of the Internet Engineering Task Force (IETF), March 17, Minneapolis, MN. The WebDAV versioning and configuration management design team also met in Minneapolis.

Roy Fielding was invited to the Open Source and Community Licensing Summit in San Jose, California, on March 5th and gave a talk on the techniques for globally-distributed, collaborative software development used by the Apache project. The summit meeting was attended by the leaders of approximately twenty open source projects, six commercial Linux distributors, IBM, Hewlett Packard, Netscape, Sun Microsystems, SGI, Intel, Oracle, Informix, and a representative from the White House.

A presentation introducing WebDAV was given at the 1999 Software Technology Conference in Salt Lake City, UT, May 2-6.

Ken Anderson presented a paper entitled "Supporting Industrial Hyperwebs: Lessons in Scalability" at the International Conference on Software Engineering [And99-2].

Chimera, the DAVExplorer client, the Apache ModDAV server, the Office 2000 client, and the Windows 2000 server were demonstrated at the Third Annual EDCS Demo Days in Arlington, VA, June 28-29th.

On July 16, Jim Whitehead presented a full day tutorial on WebDAV at DataChannel's xDev Developer Days which was attended by approximately 30 participants representing a range of development organizations including Xerox, Documentum, Xythos, and many others.

The paper "WebDAV: A network protocol for remote collaborative authoring on the Web" was presented at the 1999 European Conference on Computer Supported Cooperative Work (ECSCW'99), September 12-16 [WG99], and "Goals for a Configuration Management Network Protocol" was presented at the Ninth Int'l Symposium on System Configuration Management, September 5-7 [Whi99-2]. Jim also presented an update on WebDAV at the Open Hypermedia Workshop 5.5, September 17-19, and a presentation on Web collaboration systems at 3rd Nordic Interactive Multimedia Research School, September 8-11.

4.2. Software Architecture

Three software architecture papers were presented at the 1999 International Conference on Software Engineering: "Exploiting ADLs to Specify Architectural Styles Induced by Middleware Infrastructures" by Elisabetta Di Nitto and David Rosenblum [DR99]; "A Language and Environment for Architecture-Based Software Development and Evolution" by Nenad Medvidovic, David S. Rosenblum, and Richard N. Taylor [MRT99]; and "Using Off-The-Shelf Middleware to Implement Connectors in Distributed Software Architectures" by Eric M. Dashofy, Nenad Medvidovic, and Richard N. Taylor [DMT99].

A paper on Argo/UML entitled "Sweeping Away Disorder with the Broom Alignment Tool" by Jason Robbins, Michael Kantor, and David Redmiles was presented at the 1999 Conference on Human Factors in Computing Systems (CHI'99) [RKR99].

Also, the paper "Cognitive support, UML Adherence, and XMI Interchange in Argo/UML" by Jason Robbins and David Redmiles was presented at the 1999 Symposium on the Construction of Software Engineering Tools (CoSET'99) [RR99]. This paper was selected to appear in the Journal of Information and Software Technology in a special issue on the Best of CoSET'99 [RR99-2].

The paper "Using HTML to Create Early Prototypes" by Jaya Vaidyanathan, Jason Robbins, and David Redmiles was presented at the 1999 Conference on Human Factors in Computing Systems (CHI'99) [VRR99].

ArchStudio 2.0, Argo/UML, and Arabica were demonstrated at the 3rd EDCS Demo Days in Arlington, VA, June 28-29th.

A paper entitled, "Coping with Application Inconsistency in Decentralized Software Evolution" by Peyman Oreizy and Richard N. Taylor was accepted and presented to the International Workshop on the Principles of Software Evolution (IWPSE-2) on July 16 in Fukuoka, Japan [OT99].

4.3. Process

The University of California, Irvine licensed the Endeavors technology to Endeavors Technology Incorporated (ETI). ETI is a small, highly responsive technology company that will provide Web-based workflow, wireless workflow, Web-based information systems, and E-Business solutions. ETI will use Endeavors to build several products: a lightweight, HTTP-based workflow server that easily integrates with existing tools and technologies at use in a business; a full featured graphical

environment for non-technical users to visualize, describe, and share executable descriptions of their work; a lightweight, HTTP-based document management repository; and a scaled down, small footprint version of the Endeavors desktop for use on PDAs, palmtops, and handheld computing devices.

The University also licensed the JavaBrain technology to Sun Microsystems, Inc. Sun is using the JavaBrain technology for the development and deployment of Computer Based Training (CBT) materials. JavaBrain is built on top of the Endeavors technology.

The Endeavors process execution environment and EDEM 2.0, a system for performing large-scale collection of application usage data and user feedback, were demonstrated at the 3rd Annual EDCS Demo Days in Arlington, VA, June 28-29th.

The Course Syllabus Process (CSP) has been deployed at UCI for the start of the school year. The CSP lets end users systematically design a course syllabus by following a prescribed process using the Endeavors process engine. If necessary, any task of the CSP can be assigned and routed to different people. Professors and lectures at the Irvine campus now use the CSP for their courses.

Michael Kantor presented a talk entitled, "Enhancing Awareness and Coordination through Subscriptions" at the UC Irvine Institute for Software Research (ISR) sponsored Bay Area Roundtable on Organizational Memory and Project Awareness on September 10th.

References

- [And99] Kenneth M. Anderson. *Data Scalability in Open Hypermedia Systems*. In Proceedings of the ACM Hypertext'99 Conference, Darmstadt, Germany, February 21-25, 1999.
- [And99-2] Kenneth M. Anderson. *Supporting Industrial Hyperwebs: Lessons in Scalability*. In Proceedings of the 1999 International Conference on Software Engineering, Los Angeles, CA, May 16-22, 1999.
- [BK99] Gregory Alan Bolcer and Gail Kaiser. *SWAP: Leveraging the Web to Manage Workflow*. IEEE Internet Computing, vol. 3, no. 1, Jan-Feb, 1999.
- [DMT99] Eric M. Dashofy, Nenad Medvidovic, and Richard N. Taylor. *Using Off-The-Shelf Middleware to Implement Connectors in Distributed Software Architectures*. In Proceedings of the 1999 International Conference on Software Engineering, Los Angeles, CA, May 16-22, 1999.
- [DR99] Elisabetta Di Nitto and David Rosenblum. *Exploiting ADLs to Specify Architectural Styles Induced by Middleware Infrastructures*. In Proceedings of the 1999 International Conference on Software Engineering, Los Angeles, CA, May 16-22, 1999.
- [FG+99] R. Fielding, J. Gettys, J. Mogul, H. Frystyk, L. Masinter, P. Leach, T. Berners-Lee. *Hypertext Transfer Protocol -- HTTP/1.1*. Internet Draft Standard Request for Comments 2616. June 1999.
- [FT00] Roy T. Fielding and Richard N. Taylor. *Principled Design of the Modern Web Architecture*. To appear in Proceedings of the International Conference on Software Engineering (ICSE 2000), Limerick, Ireland, June 4-11, 2000.
- [GW+99] Y. Goland, E. Whitehead, A. Faizi, S. Carter, and D. Jensen. *HTTP Extensions for Distributed Authoring -- WEBDAV*. Internet Proposed Standard Request for Comments 2518. February, 1999.
- [Hil99] David M. Hilbert. *Large-Scale Collection of Application Usage Data and User Feedback to inform Interactive Software Development*. Ph.D. Dissertation, Department of Information and Computer Science, University of California, Irvine, June 8, 1999.
- [KBTB99] Peter Kammer, Greg Bolcer, Richard N. Taylor, and Mark Bergman. *Techniques for Supporting Dynamic and Adaptive Workflow*. To appear in the Journal of Computer Supported Cooperative Work.
- [MRT99] Nenad Medvidovic, David S. Rosenblum, and Richard N. Taylor. *A Language and Environment for Architecture-Based Software Development and Evolution*. In Proceedings of the 1999 International Conference on Software Engineering, Los Angeles, CA, May 16-22, 1999.
- [MT99] Nenad Medvidovic and Richard N. Taylor. *A Classification and Comparison Framework for Software Architecture Description Languages*. IEEE Transactions on Software Engineering, vol. 26, no. 1, January 2000. [MT99]

- [OG+99] Peyman Oreizy, Michael M. Gorlick, Richard N. Taylor, Dennis Heimbigner, Gregory Johnson, Nenad Medvidovic, Alex Quilici, David S. Rosenblum, and Alexander L. Wolf. *An Architecture-Based Approach to Self-Adaptive Software*. IEEE Intelligent Systems, vol. 14, no. 3, May/June 1999, pp. 54-62.
- [OT99] Peyman Oreizy and Richard N. Taylor. *Coping with Application Inconsistency in Decentralized Software Evolution*. In Proceedings of the International Workshop on the Principles of Software Evolution (IWPSE-2), Fukuoka, Japan, July 16, 1999.
- [RKR99] Jason Robbins, Michael Kantor, and David Redmiles. *Sweeping Away Disorder with the Broom Alignment Tool*. In Proceedings of the 1999 Conference on Human Factors in Computing Systems (CHI'99), Pittsburgh, PA, May 15-20, 1999.
- [Rob99] Jason Robbins. *Cognitive Support Features for Software Development Tools*. Ph.D. Dissertation. Technical Report UCI-ICS-99-39, Department of Information and Computer Science, University of California, Irvine, September 1999.
- [RR99] Jason Robbins and David Redmiles. *Cognitive support, UML Adherence, and XMI Interchange in Argo/UML*. In Proceedings of the 1999 Symposium on the Construction of Software Engineering Tools (CoSET'99), Los Angeles, CA, May 17-18, 1999.
- [RR99-2] Jason Robbins and David Redmiles. *Cognitive support, UML Adherence, and XMI Interchange in Argo/UML*. To appear in the Journal of Information and Software Technology special issue on the best of CoSET'99.
- [VRR99] Jaya Vaidyanathan, Jason Robbins, and David Redmiles. *Using HTML to Create Early Prototypes*. In Proceedings of the 1999 Conference on Human Factors in Computing Systems(CHI'99), Pittsburgh, PA, May 15-20, 1999.
- [WG99] E. James Whitehead, Jr. and Yaron Y. Goland. *WebDAV: A network protocol for remote collaborative authoring on the Web*. In Proceedings of the European Conference of Computer Supported Cooperative Work (ECSCW'99), Copenhagen, Denmark, September 12-16, 1999, pp. 291-310.
- [Whi99] E. James Whitehead, Jr. *Control Choices and Network Effects in Hypertext Systems*. In Proceedings of the ACM Hypertext'99 Conference, Darmstadt, Germany, February 21-25, 1999, pp. 75-82.
- [Whi99-2] E. James Whitehead, Jr. *Goals for a Configuration Management Network Protocol*. In Proceedings of the Ninth International Symposium on System Configuration Management (SCM-9), LNCS 1675, Toulouse, France on September 5-7, 1999, pp. 186-204.