Coordinating Distributed Software Development Projects with Integrated Process Modelling and Enactment Environments

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Abstract

Coordinating distributed software development projects becomes more difficult, as software becomes more complex, team sizes and organisational overheads increase, and software components are sourced from disparate places. We describe the development of a range of software tools to support coordination of such projects. Techniques we use include asynchronous and semi-synchronous editing, software process modelling and enactment, developer-specified coordination agents, and component-based tool integration.

Keywords : work coordination, distributed software development tools, process modelling, process-centred environments, computer-supported cooperative work

1. Introduction

Coordinating multiple developers working on a distributed software development project is very difficult, and gives rise to the following management problems:

- Developers need specific tasks assigned, which must be *coordinated* to ensure a working system results.
- Developers need to, at times, *communicate* and *collaborate* closely, while at other times can independently work on parts of a project.
- Software artefacts (code, designs, documentation etc.) need to be *shared* and kept *consistent*.
- Multiple tools must be used to modify artefacts, with some tools supporting close *collaborative editing* (e.g. via synchronous editing), while others supporting looser collaboration (e.g. via alternate version editing and subsequent merging).
- Progress towards specified goals needs to be tracked, developers need to remain *aware* of others' work, and complex software systems need to be configured from the constituent, distributively developed parts.
- Developers need to flexibly *configure* their environments' support for artefact management, communication, and work coordination.

Many systems have been developed which attempt to address these issues. Computer Supported Collaborative Work (CSCW) systems have been used to aid distributed software development. These include ConversationBuilder [16], wOrlds [6], Orbit [17], TeamRooms [24], Lotus Notes [19], and BSCW [5]. Programming environments, such as Mjølner [20], Mercury [15], and FIELD [23], may also provide basic collaborative software development facilities. However, while such systems may support shared editing and artefact management, they generally lack adequate coordination support.

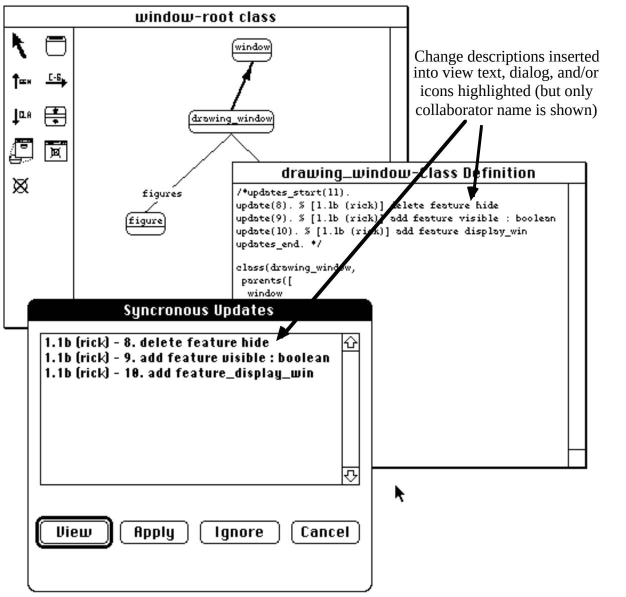
Process-centred Environments (PCEs), such as Oz [3], SPADE [1], ProcessWEAVER [7], and ADELE-TEMPO [2], more tightly integrate software development and software process support. Most such systems, however, provide complex mechanisms for specifying processes, have a limited range of work coordination strategies, and can be difficult to integrate with third-party tools. CSCW and process-centred environments can be usefully integrated. Examples include Oz [4], and SPADE-ImagineDesk [1], and some programming environments and process-centred environments, such as Multiview-Merlin [21]. Workflow systems, such as TeamFLOW [26], Regatta [25], and Action Workflow [22], provide more accessible facilities for modelling work processes but lack flexibility for specifying work coordination mechanisms and tool integration.

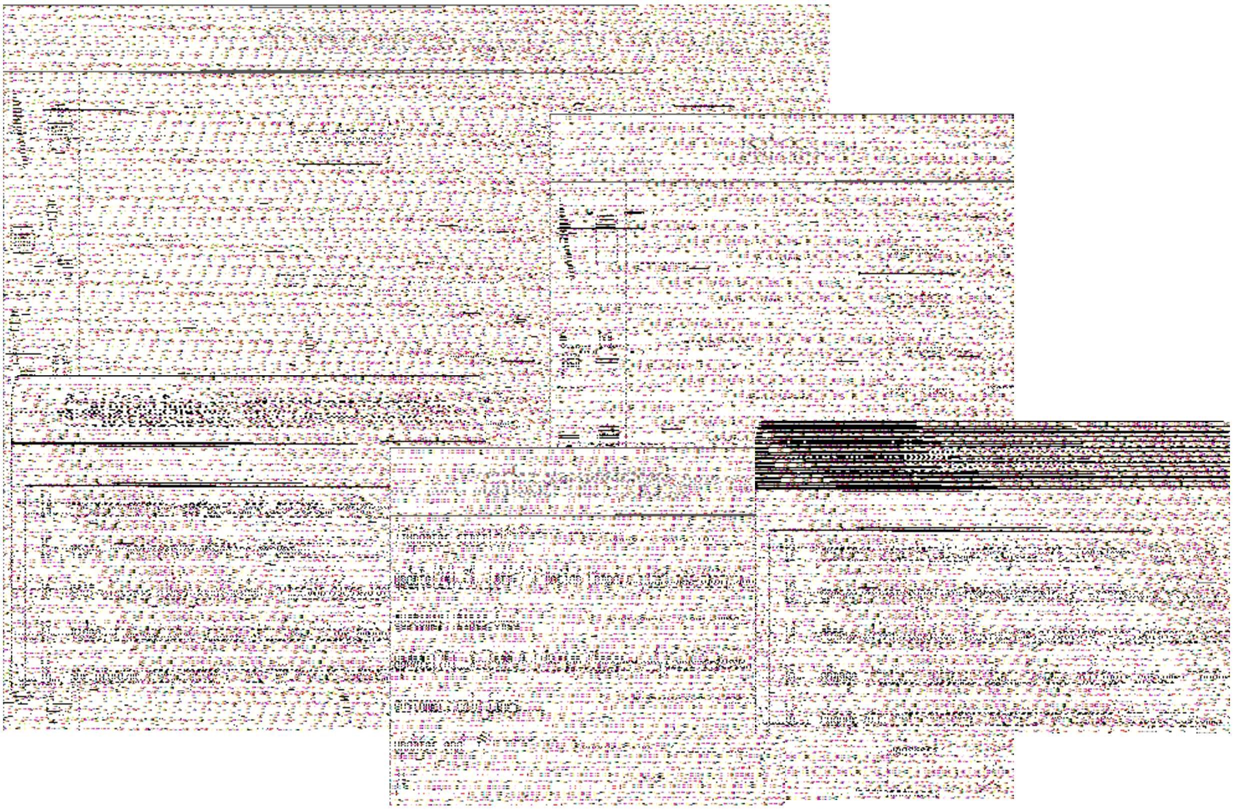
In the following sections we describe our recent work addressing these problems of distributed software development coordination. Our solutions include annotating changes made to software artefacts and distributed to multiple users, tightly integrated software development and process modelling and enactment tools, and component-based software development, process modelling, and collaborative editing tools.

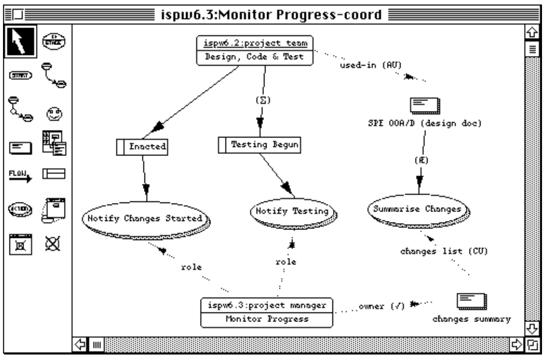
2. C-SPE

Our first attempt at supporting distributed software development was C-SPE [8]. SPE (Snart Programming Environment) is an integrated development environment for object-oriented software development using Snart, an Object-oriented Prolog [9]. SPE provides integrated OOA, OOD and Snart code views, along with debugging and documentation views. All are kept consistent under change by propagating representations of changes ("change descriptions") between views [9, 10].

C-SPE (Collaborative SPE) adds semi-synchronous and asynchronous editing to SPE. Distributed developers can simultaneously edit SPE views and be informed of changes other developers are making semi-synchronously. Developers distributed over time and space can edit different versions of software views asynchronously, and later merge the changes together. These modes of collaborative development are complementary; developers can move freely between them. A client-server architecture supports broadcast of editing changes to support semi-synchronous editing and provides a repository for storing versions to support asynchronous editing.



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Notify Testing
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changes list (CU)
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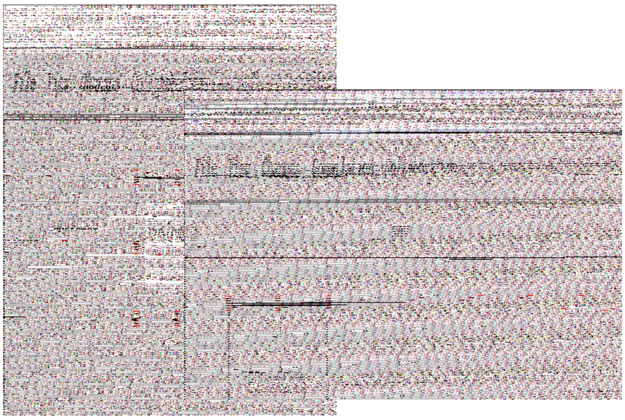
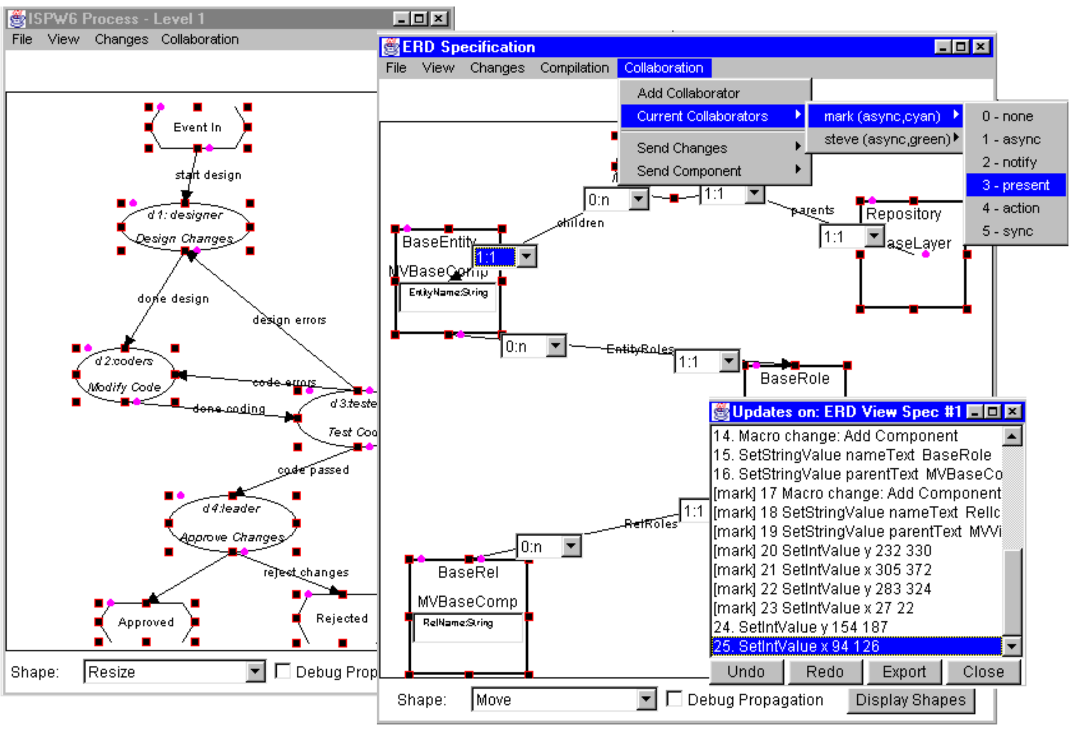
role
ispw6.3:project manager
Monitor Progress
owner (√)
changes summary

reimplemented MViews, using, to produce the JViews framework. JViews is more platform-independent, provides tools with better performance, and allows third-party tools to be more easily integrated with our systems through Java Beans component technology [12]. We have also developed the JComposer tool for visually specifying and generating JViews-based environments [12]. JComposer generates Java Beans-based components which implement software development tools, and provides reusable components with C-SPE style collaborative editing, tool repository management, multiple view consistency mechanisms, and user interface components.

JComposer includes a form of the Serendipity filter and action language to specify event handling models for JViews tools. These filters and actions can be specified at run-time for these tools. This enables any JViews-based tool to support the degree of flexible, developer-controlled work coordination and user configuration Serendipity's filter and action language affords.

Figure 4 shows a simple example of a JComposer-generated tool, a collaborative ER modeller. The right-hand view shows a JViews component which is being visualised (the "customer" entity), and a filter and action which have been added by the developer. Whenever the customer entity is renamed, the developer will be notified. The action component can be configured via a dialogue to notify the developer via an email message, broadcast message, highlighted icon in a view or via a dialogue box. Other work coordination schemes can be added at run-time by developers, for example constraining which artefacts and views can/can't be changed, automatically changing artefacts based on other events, or initiating a dialogue via chat with a developer when a process stage is enacted, tool used or artefact changed. [12].





JComposer has been used to specify and generate a new, component-based version of Serendipity, Serendipity-II. This can be used with JComposer-generated tools to coordinate their use as with SPE-Serendipity. It can also use Java Beans components, interfaced via filters and actions, to be informed of third party tool events and to send instructions to such tools. This provides a very open architecture for coordinating the use of JViews-based and third-party distributed software development tools.

Figure 5 shows JComposer in use, specifying the ER modeller repository from Figure 4. This development is being carried out collaboratively, with Serendipity-II being used to coordinate work with JComposer. The Serendipity-II model describes the process of developing this ER modeller specification, and uses it to coordinate the distributed software development work as in our original Serendipity environment.

JViews-based environments like JComposer and Serendipity-II also support a decentralised form of user-configurable collaborative editing, as illustrated in Figure 5. Here user "John" is configuring the "level" of collaborative editing with user "Rick" using a "collaboration menu". This is a component which has been plugged into the environment to provide a range of asynchronous to fully synchronous editing capabilities for JViews-based environments [14].

Serendipity-II utilises collaborative editing components to support cooperative process model specification and evolution. It also adopts a similar approach to decentralised software process enactment, using broadcasting of enactment events between users' environments. A history of enactment and work artefact-related events can be stored by each environment, or can be managed by a central server, as desired. JComposer filters and actions are used in Serendipity-II to specify various work coordination schemes and to handle the automatic processing of events. Component-based tools which have been integrated with Serendipity-II, including all other JViews-based tools, can be interfaced to using appropriate filters and actions. Other tools can be interfaced to using file translation-supporting actions, or by building custom filters and actions specific to the data and control requirements of these tools.

5. Summary

Distributed software development requires facilities to support collaboration, communication and coordination among software developers. We have developed a variety of solutions to these needs, including collaborative artefact editing mechanisms, and software process modelling tools to support coordination of this distributed work. Our approaches use component-based architectures, allowing our tools to have such facilities added to them rather than having to be built-in, and to be more readily observed and controlled by our process modelling environment.

We are currently enhancing the process modelling languages and software architecture of Serendipity-II to improve its performance for coordinating distributed software development. This includes the provision of integrated communication tools, such as annotation and messaging, the management of enactment and artefact change events via an object-oriented database, and the development of new filters and actions to integrate with diverse third-party tools.

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