

Multi-Modal Modeling, Analysis, and Validation of Open Source Software Development Processes

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www.isr.uci.edu/research-open-source.html

Motivation

- Goal: Discover hidden processes within large-scale, global, loosely-coordinated open source software development (OSSD) projects.
 - Thousands of project participants
 - Developing, managing, and evolving over one million knowledge artifacts
 - Weakly coordinated by centralized authorities
 - All data are open source

Motivation

- Discover, model, re-enact, and repair OSSD processes
- Recognize process context, participant roles, tools, resources, interdependencies within and across projects over the Web
- Why?
 - Software development organizations and OSSD projects don't know their processes
 - Companies and new OSSD projects want to adopt “OSSD best practices”
 - Process improvement, optimization, redesign, or transformation requires knowledge of processes

Overview

- Process discovery
- Process modeling
- Process re-enactment
- Discussion
- Conclusions

Process discovery

- Participant observation (online, Web-based ethnography)
- Collection and annotation of participant created/modified artifacts
 - Objects of interaction
 - How objects are situated in facilitating collaboration, conflict, or conflict mitigation
- Tracking artifacts added or modified in response to intra-community or inter-community dynamics
- Automated process data mining, categorization, and composition

Annotated chat transcript

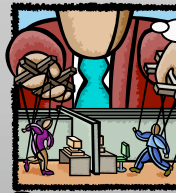
- <CB> Hello (**Outsider Critique-1**)
- <CB> Several images on the website seem to be made with non_free Adobe software, I hope I'm wrong: it is quite shocking. Does anybody know more on the subject ?
- <CB> We should avoid using non_free software at all cost, am I wrong ? (**Extreme belief in free software (BIFS)-1**)
- <CB> Anyone awake in here ? **Outsider Critique-1**)

Modeling OSSD Processes

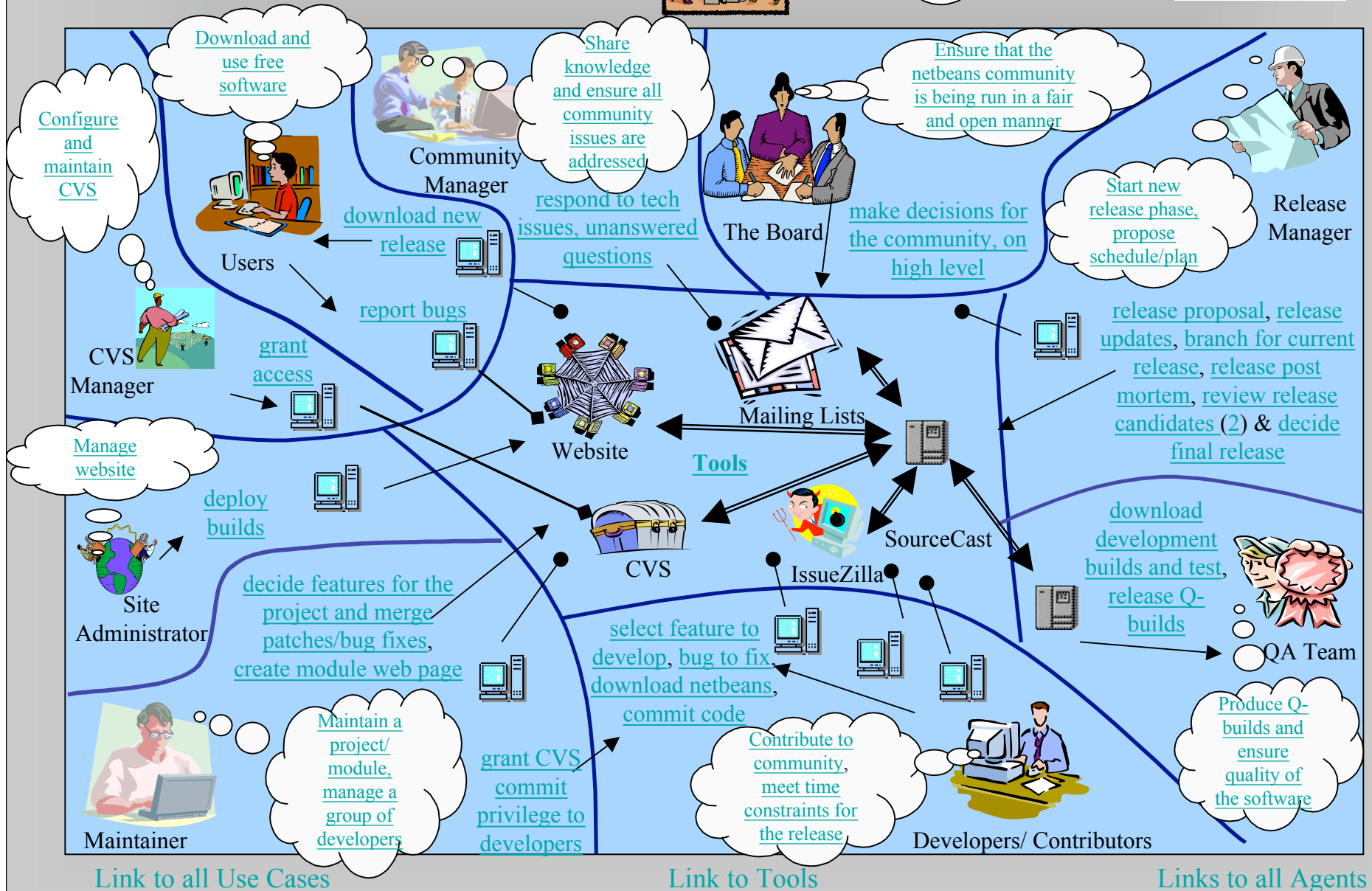
- “*Rich Pictures*” -- overall scenarios and stakeholders
- *Use cases* -- hyperlinked from Rich Pictures
- *Attributed flow graphs* -- process control flow, data flow, role and tool bindings
- *Process meta-model* -- provides formal reference model and ontology
- *Computational process models* -- formal representations that can be executed or re-enacted
- *Ethnographic hypermedia* -- Web-based documents that include above representations, links to source data, and analytical narrative.

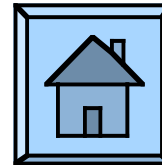
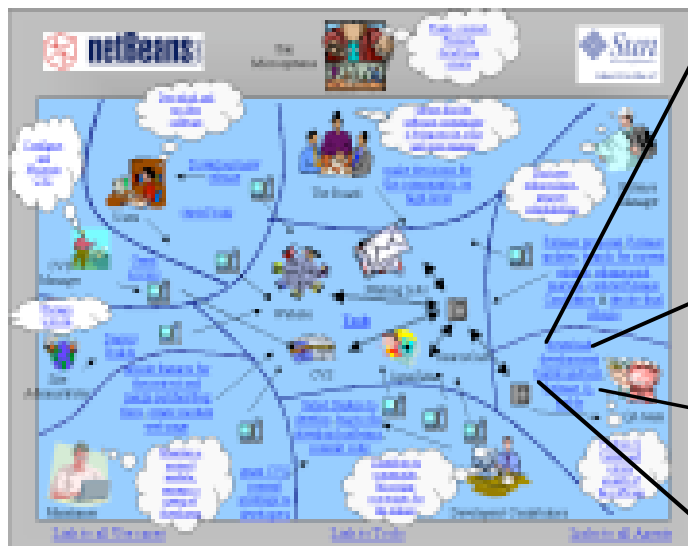


Sun
Microsystems



Funds, support,
Promote
Java/Open
source

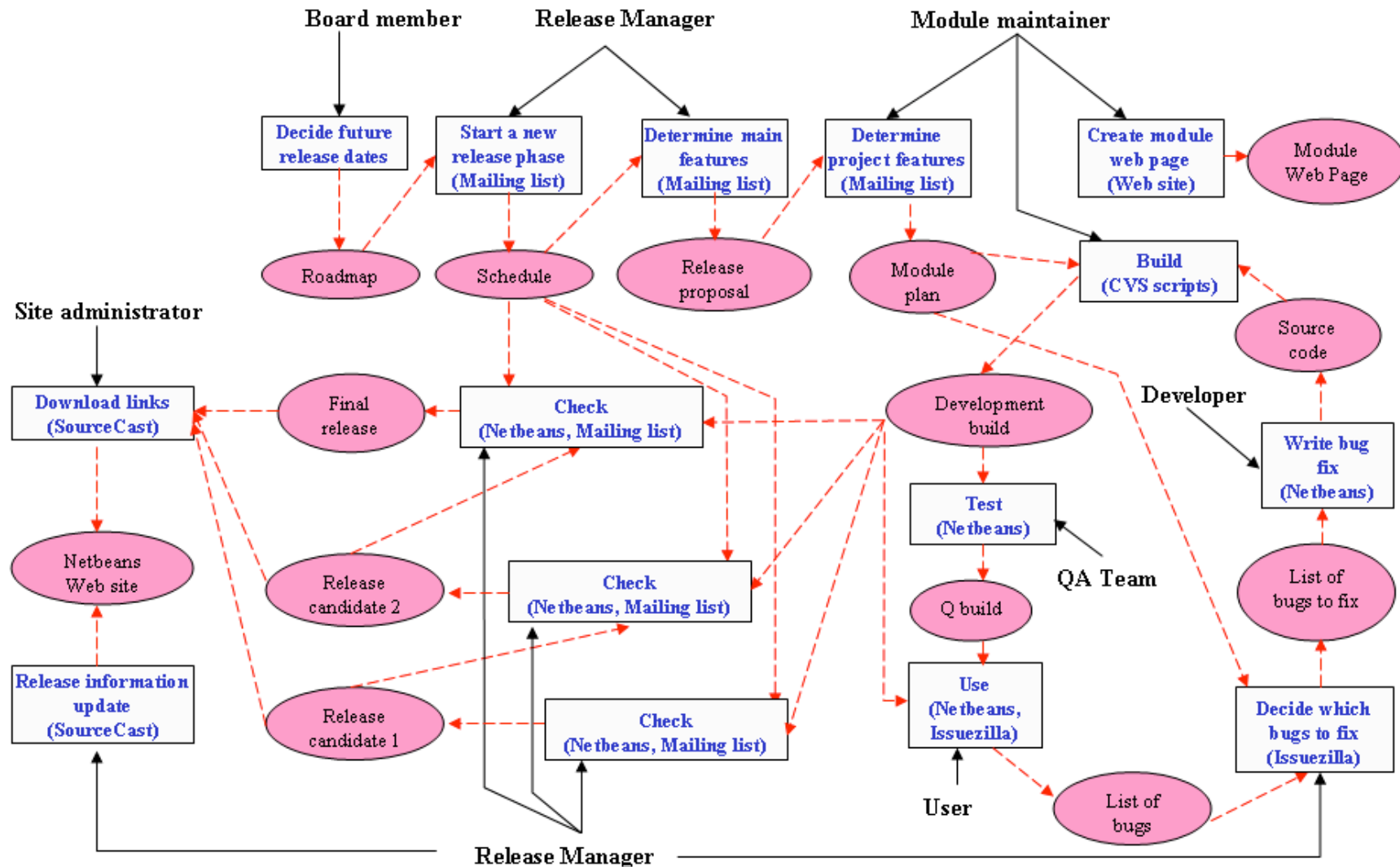




Test Builds

- The QA team tests the latest nightly builds every Friday
 - QA team executes a set of manual tests on the builds as well as some sanity checks
- Test results are categorized as
 - [Bug Types](#)
- *User Constraint:*
 - The tests depend on the manual tests specification
- *System Constraint:*
 - Not all bugs may be identified

Figure 2. A hyperlink selection within a rich hypermedia presentation that reveals a corresponding use case.



Netbeans_requirements_release Protégé-2000 (H:\public_html\papers\FirstLookNetB...

Project Edit Window Help

Classes Slots Forms Instances Queries Ontoviz XML

Config +C +I - S Op C

frame	sub	sup	slx	isx	slt
Netbeans ...	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Classes

- :THING A
- :SYSTEM-CLASS A
 - Process Model (1)
 - Agent (9)
 - Resource (17)
 - Tool (10)
 - Action (23)
 - Control Flow (1)
 - Script

The diagram illustrates a semantic network with the following nodes and relationships:

- Netbeans Requirements and Release** (top node) is connected to **Establish release manager** via a **flow scenario** relationship.
- Establish release manager** is connected to **Solicit RM volunteer** via a **used by** relationship.
- Solicit RM volunteer** is connected to **Wait for volunteer** via a **next action** relationship.
- Wait for volunteer** is connected to **Send message request** via a **next action** relationship.
- There are numerous other **used by** relationships between various nodes, indicating a complex web of dependencies and actions.

Process re-enactment

- Generating executable or re-enactable process specifications derived from ontology
- “Low-fidelity” process re-enactment support
 - We don’t try to model everything
 - Focus on resource flow patterns
 - Accommodate gaps and detect inconsistencies in process enactment models
- Re-enactments are interactive, navigational, and grounded in artifacts, tools, roles, and resource dependencies resulting from discovery and modeling

Formal model of an OSSD process coded in PML (excerpt)

- ...
- sequence Test {
 - action Execute automatic test scripts {
 - requires { Test scripts, release binaries }
 - provides { Test results }
 - tool { Automated test suite (xtest, others) }
 - agent { Sun ONE Studio QA team }
 - script { /* Executed off-site */ } }
 - action Execute manual test scripts {
 - requires { Release binaries }
 - provides { Test results }
 - tool { NetBeans IDE }
 - agent { users, developers, Sun ONE Studio QA team, Sun ONE Studio developers }
 - script { /* Executed off-site */ } }
- iteration Update Issuezilla {
 - action Report issues to Issuezilla {
 - requires { Test results }
 - provides { Issuezilla entry }
 - tool { Web browser }
 - agent { users, developers, Sun ONE Studio QA team, Sun ONE Studio developers }
 - script {
 -
Navigate to Issuezilla
 -
Query Issuezilla
 -
Enter issue } }
- ...

PML validation analysis

Summary of analysis for netbeans_req_release.pml

Model size (source lines): 307

Actions: 36

Resources: 72

Actions neither requiring nor providing resources: 1

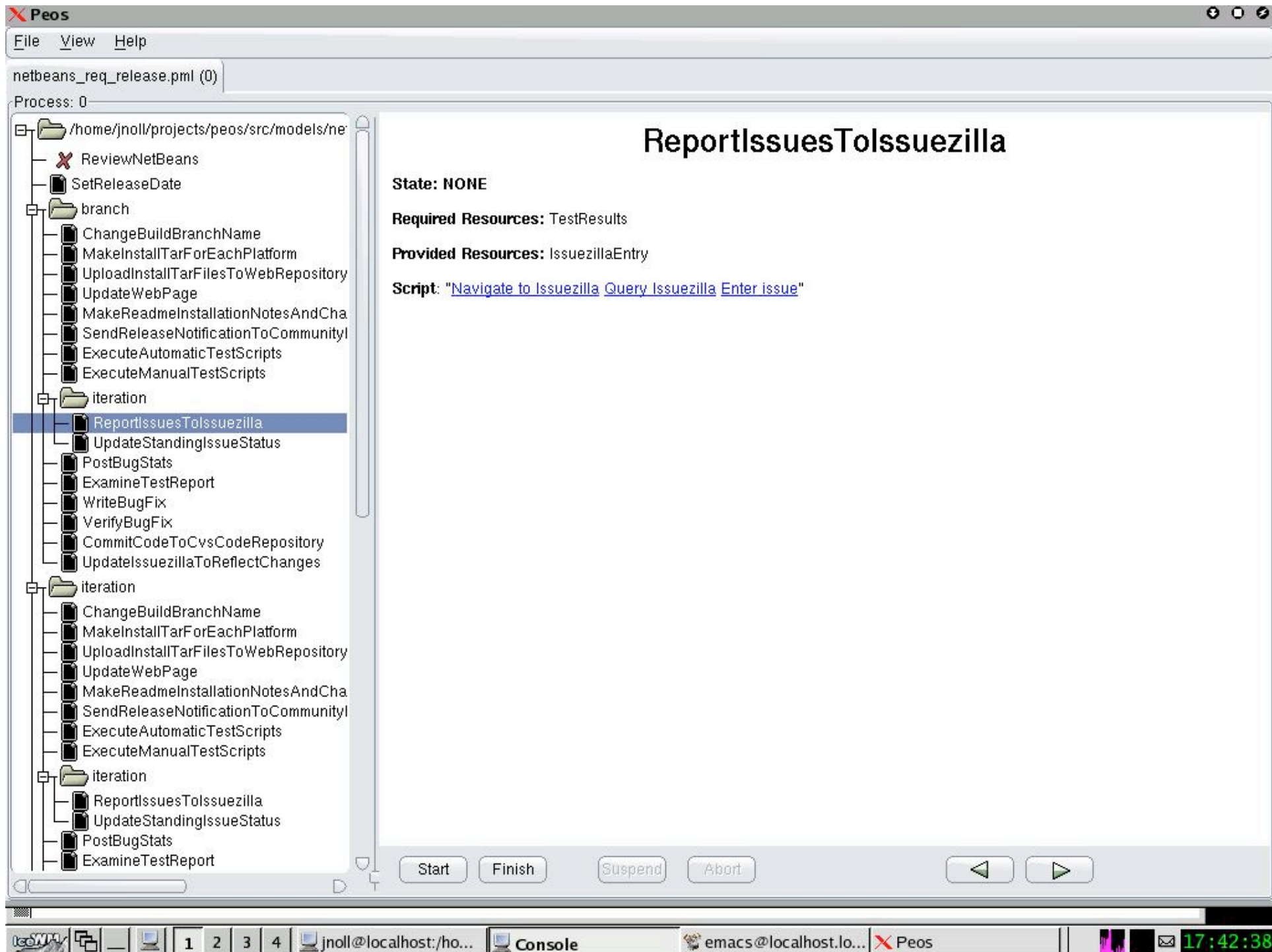
Resources required but not provided (potential inputs): 0

Resources provided but not required (potential outputs): 0

Miracles: 2

Black holes: 6

Transformations: 30



Peos

File View Help

netbeans_req_release.pml (0)

Process: 0

/home/jnoll/projects/peos.

- ReviewNetBeans
- SetReleaseDate
- branch
 - ChangeBuildBranchName
 - MakeInstallTarForEachI
 - UploadInstallTarFilesTo
 - UpdateWebPage
 - MakeReadmeInstallation
 - SendReleaseNotification
 - ExecuteAutomaticTestS
 - ExecuteManualTestScri
- iteration
 - ReportIssuesToIssuezi
 - UpdateStandingIssueS
 - PostBugStats
 - ExamineTestReport
 - WriteBugFix
 - VerifyBugFix
 - CommitCodeToCvsCode
 - UpdateIssuezillaToRefle
- iteration
 - ChangeBuildBranchName
 - MakeInstallTarForEachI
 - UploadInstallTarFilesTo
 - UpdateWebPage
 - MakeReadmeInstallation
 - SendReleaseNotification
 - ExecuteAutomaticTestS
 - ExecuteManualTestScri
- iteration
 - ReportIssuesToIssuezi
 - UpdateStandingIssueS
 - PostBugStats
 - ExamineTestReport

Issuezilla - Konqueror

Location Edit View Go Bookmarks Tools Settings Window Help

Location: http://www.netbeans.org/issues/query.cgi

netBeans.ORG

Downloads Products Plugins Docs & Support Community About

USERNAME
PASSWORD
LOGIN

PRINTABLE VERSION

HOME > Community

Project Issue Tracking: netbeans.org

Issue New | Query | Reports

Tracking: Jump to Issue

Query This page lets you search the database for recorded issues.

Issue type: Component: Subcomponent: Submit query

DEFECT	**UNCATEGORIZED**	*ALL*
ENHANCEMENT	3rd-party	*NEW*
FEATURE	all	accessibility
TASK	accelerators	actions
PATCH	ant	annotations
	antlr	ant

Status: Resolution: Priority:

UNCONFIRMED	FIXED	P1
NEW	INVALID	P2
STARTED	WONTFIX	P3
REOPENED	LATER	P4

1 2 3 4 jnoll@localhos... Console emacs@localh... Peos Konqueror 17:42:57

Discussion

- Socio-technical and cultural evolution processes
- Validation strategies and tactics
- Implications for discovering, modeling and re-enacting OSSD processes

Socio-technical and cultural evolution processes

- New processes under study
 - Joining and contributing to a project in progress
 - Role-task migration: from project periphery to center
 - Alliance formation and community development
- Independent and autonomous project communities can interlink via social networks that manipulate objects of interaction
 - Enables possible exponential growth of interacting and interdependent community as *socio-technical interaction network*

Validation strategies and tactics

- Multi-mode modeling
 - Collection and annotation of artifacts
 - Rich pictures with hyperlinked Use Case scenarios
 - Directed and attributed resource flow graph
 - Process domain ontology construction
- Simulated process re-enactment
 - Process model language generated from ontology
 - PML compiled into re-enactment environment
 - Automated PML source validation
 - Simulated walkthrough of process
- Integration via ethnographic hypermedia
- Open to independent validation and interactive traceability

Implications for discovering, modeling and re-enacting OSSD processes

- Discovering, modeling, and understanding “hidden” software processes in large OSSD projects
 - requires semi-automated process discovery techniques
 - must span multi-project ecosystem
- Discovered processes (still) need to be modeled as narrative, hypermedia, and formal computational models.
- Understanding large, aggregated Internet-based projects requires process discovery, modeling tools, re-enactment and validation techniques.

Conclusions

- We examine open source software development processes within and across multiple projects spanning multiple loosely-coupled communities.
- OSSD process patterns are continuously emerging, but can be detected, modeled, analyzed, simulated and re-enacted.
- Multi-modal modeling techniques are needed to study complex socio-technical processes found in OSSD.
- Discovering, modeling, validating, and re-enacting hidden processes within and across multiple inter-dependent projects is challenging and important.

Acknowledgements

- *Project collaborators:*
 - Darren Atkinson, Santa Clara University
 - Mark Ackerman, University of Michigan, Ann Arbor
 - Les Gasser, University Illinois, Urbana-Champaign
 - and others at UCI-ISR
- *Funding support* (no endorsement implied):
 - National Science Foundation #0083075, #0205679, #0205724, and #0350754.