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Transforming Organizations through Open Source Software

Walt Scacchi
Institute for Software Research
University of California, Irvine
Irvine, CA 92697-3425 USA
wscacchi@ics.uci.edu
http://www.ics.uci.edu/~wscacchi

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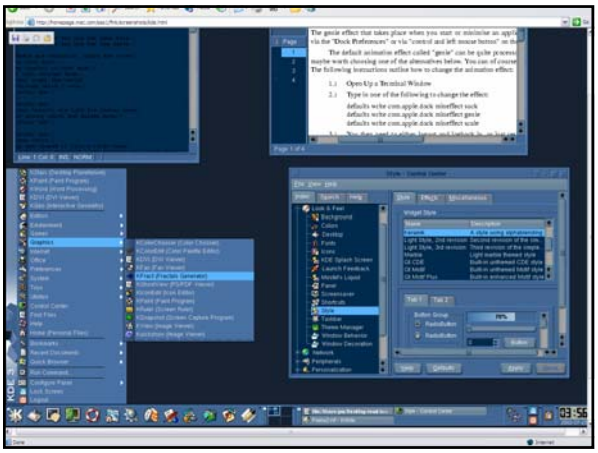

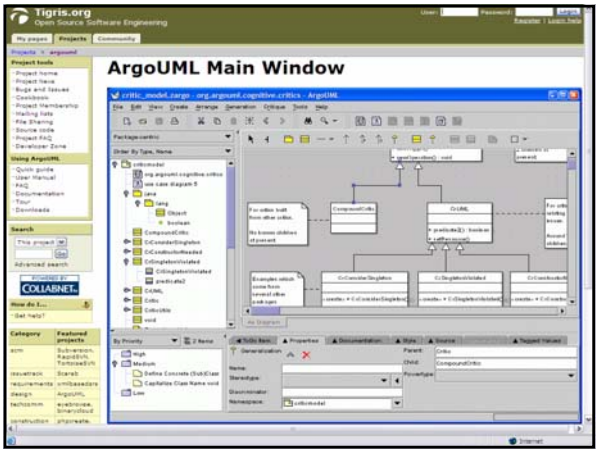

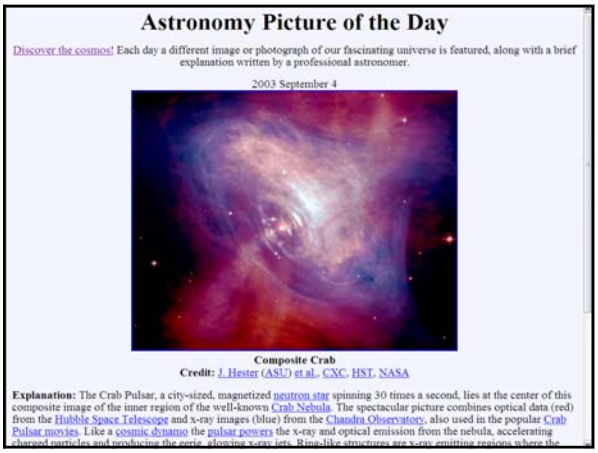

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Overview

- Open source software development
- OSSD business models
- Organizational forms for OSSD
- Governance structures for OSSD
- Transforming organizations via OSS

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Open Source Software Development

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What do we know so far about OSSD?

- What is it, what is it not
- Who is participating or investing?
- Recent research results

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What is OSSD, what is it not?

- Free (as in "freedom") vs. open source software
  - Freedom to access, browse/view, study, modify and redistribute the source code
  - Free is always open, but open is not always free
- F/OSSD is not "software engineering"
  - *Different*: F/OSSD can be faster, better, and cheaper than SE
  - SE "-ilities" may not apply in the same way to OSSD
- F/OSSD involves *more* software development tools, Web resources, and personal computing resources

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Who is investing in OSS?

- Large corporations/enterprises:
  - IBM-*Eclipse*, Sun-*NetBeans* and *OpenOffice*, HP-*Gelato*, Apple-*Darwin*, Microsoft Research-*Rotor*, etc.
  - Barclays Global Investors, DKW, Merrill Lynch, etc.
  - DoD, DoE, NSF, NIH, NASA, etc.
  - MIT, Stanford, CMU, UC, UMichigan, etc.
- Mid-size corporations:
  - RedHat, Novell, Borland
- Small (start-up) companies:
  - ActiveState (now part of Sophos), Collab.Net, Jabber, Ximian (now part of Novell), JBoss, Compiere, etc.

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Recent research results

- OSS project demographics
- OSSD processes and practices
  - Software requirements and design
  - Architectural practices
  - Configuration management and work practices
  - Evolution dynamics
  - Project management and career contingencies
  - Software technology transfer

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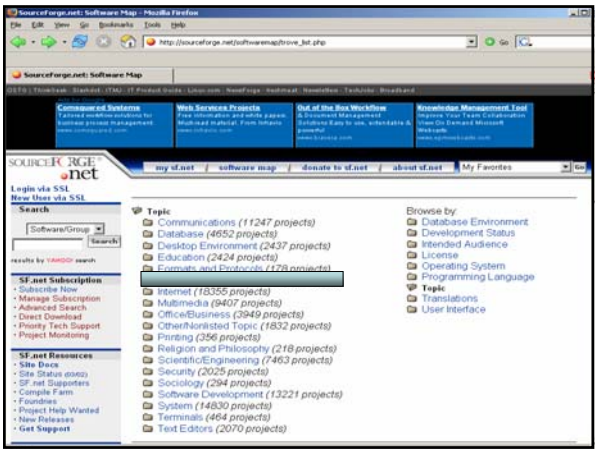

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Findings from F/OSS Studies

- *CIO* Executive Survey--2002-2003:
  - OSS primarily for new system deployments
  - OSS benefits
    - enable lower Total Cost of Ownership
    - lower capital investment
    - greater reliability
  - OSS weaknesses:
    - lack of in-house skills or skills in labor market,
    - lack of vendor support or vendor viability
    - switching costs
- *Observation*: We lack a detailed and predictable understanding of the costs of developing, deploying, and sustaining OSS.

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Findings from F/OSSD Studies

- Hars and Ou 2002:
  - >60% of F/OSS developers work on 2-10 F/OSS projects (i.e., socio-technical networking widespread)
- Madey, et al. 2003:
  - <5% of OSS projects on SourceForge.net sustained; >90% unsustained, and with less than 2 contributors (i.e., Power Law)
- Nichols and Twidale 2003:
  - Usability of F/OSS systems generally neglected
- Scacchi 2002-2004:
  - Largest F/OSSD projects sustain exponential growth; but most F/OSSD projects fail to grow to any sustainable effort

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F/OSS Processes for Software Requirements or Design

- F/OSS Requirements/Designs
  - not explicit
  - not formal
- F/OSS Requirements/Designs are embedded within "informalisms"
  - Example OSS informalisms to follow (as screenshot displays)
- F/OSS Requirements/Design processes are different from their SE counterparts.

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SE vs. F/OSS processes for Requirements

- Elicitation
- Analysis
- Specification and modeling
- Validation
- Communicating and managing
- *Post-hoc* assertion
- Reading, sense-making, accountability
- Continually emerging webs of discourse
- Condensing and hardening discourse
- Global access to discourse

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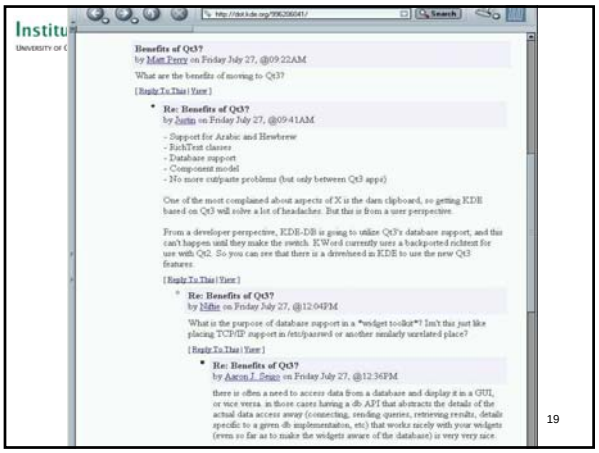

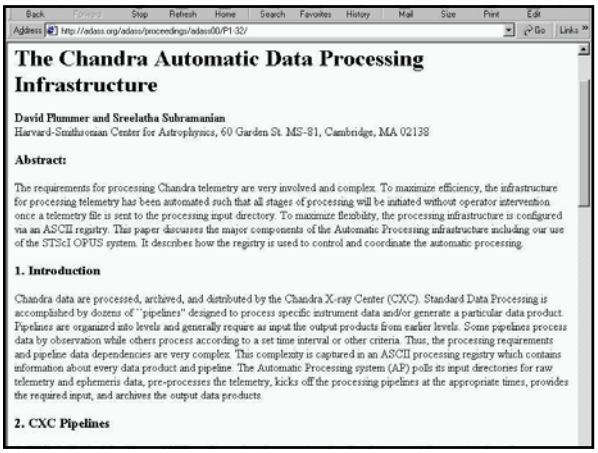

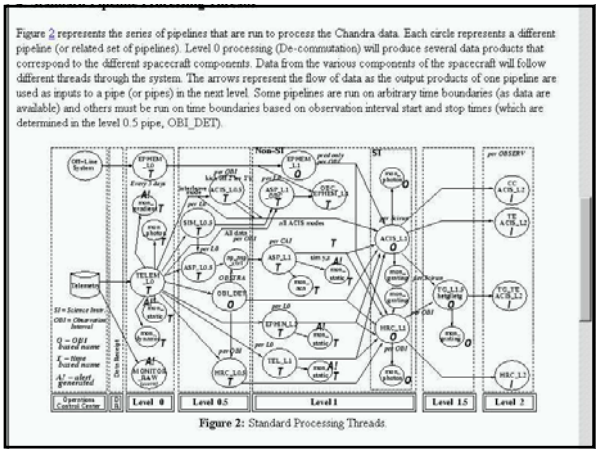
Figure 2 represents the series of pipelines that are run to process the Chandra data. Each circle represents a different pipeline (or related set of pipelines). Level 0 processing (De-commutation) will produce several data products that correspond to the different spacecraft components. Data from the various components of the spacecraft will follow different threads through the system. The arrows represent the flow of data as the output products of one pipeline are used as inputs to a pipe (or pipes) in the next level. Some pipelines are run on arbitrary time boundaries (as data are available) and others must be run on time boundaries based on observation interval start and stop times (which are determined in the level 0.5 pipe, OBI_DET).

Figure 2: Standard Processing Threads.

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OSS architectural issues

- Source code as API
  - Unpredictable evolution of product line
- *Bricolage*
  - Unanticipated composition of heterogeneous software components
- Social networks and software configurations: Conway's law revisited
  - OSS are socio-technical systems

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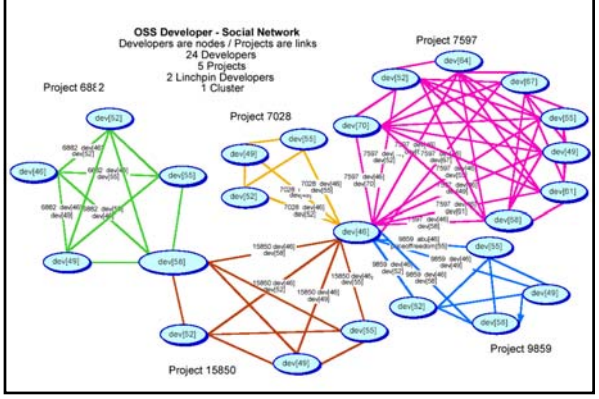

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Configuration management and work coordination

- Use CM to coordinate and control who gets to update what part of the system/online artifacts
  - Many F/OSSD projects use **CVS** (single centralized code repository with update locks) and frequent releases (*daily releases* on active projects)
  - Collab.Net and Tigris.org: **Subversion** (CVS++)
  - Apache: Single major release, with frequent "*patch*" releases (e.g., "A patchy server")
  - Linux Kernel: **BitKeeper** (multiple parallel builds and release repositories)—*being replaced by Git*
  - GNU **arch** seeks to develop Free CM unification

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Evolutionary redevelopment, reinvention, and redistribution

- Overall evolutionary dynamic of F/OSSD is *reinvention*
  - Reinvention enables continuous improvement
- F/OSS evolve through minor mutations
  - Expressed, recombined, redistributed via incremental releases
- F/OSS systems *co-evolve* with their development community
  - Success of one depends on the success of the other
- Closed legacy systems may be *revitalized* via opening and redistribution of their source
  - When enthusiastic user-developers want their cultural experience with such systems to be maintained.

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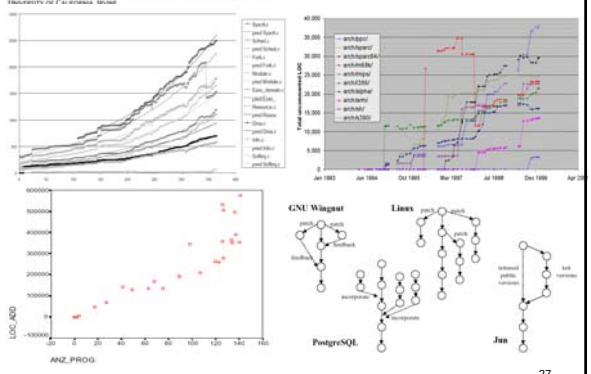

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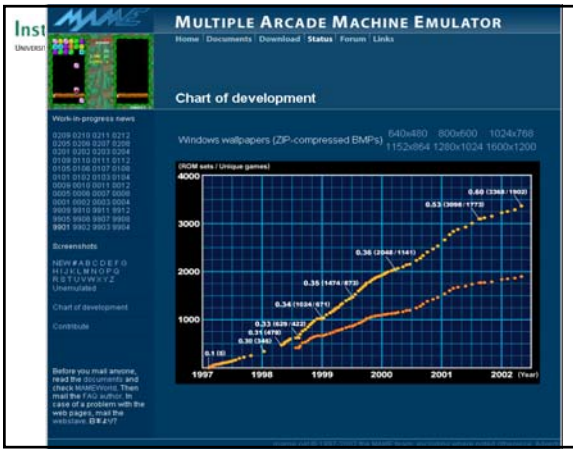

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Project management and career development

- F/OSSD projects self-organize as a *pyramid meritocracy* via *virtual project management*
  - Meritocracies embrace incremental mutations over radical innovations
  - VPM requires people to act in leadership roles based on skill, availability, and belief in project community
- F/OSS developers want to learn about new stuff (tools, techniques, skills, etc.), have fun building software, exercise their technical skill, try out new kinds of systems to develop, and/or interconnect multiple F/OSSD projects.

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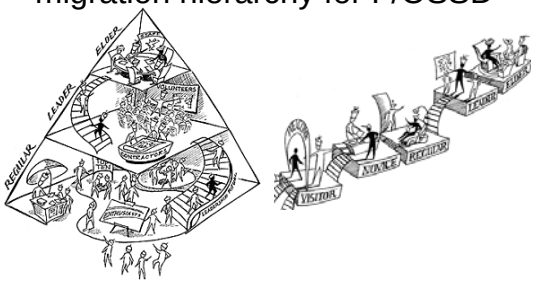
A pyramid meritocracy and role migration hierarchy for F/OSSD



(images from A.J. Kim, *Community Building on the Web*, 2000)

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Software technology transfer and licensing

- F/OSS technology transfer from existing Web sites is a *community and team building process*
  - Not (yet) an engineering process
  - Enables unanticipated applications and uses
  - Enables F/OSSD to persist *without* centrally planned and managed corporate software development centers

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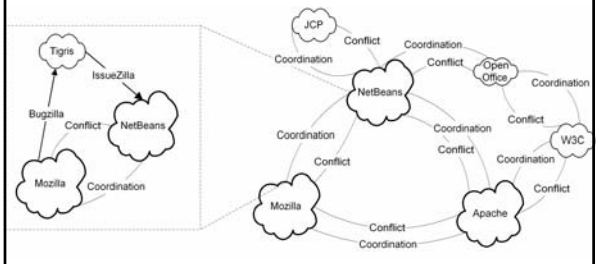

An *OSS Ecosystem*: a socio-technical community and infrastructure for tech transfer and inter-project governance

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Implications

- F/OSSD is a *community building process*
  - not just a technical development process
  - F/OSS peer review creates a *community of peers*
- F/OSSD processes often iterate *daily* versus infrequent singular (milestone) Software Life Cycle Engineering events
  - F/OSSD: frequent, rapid cycle time (easier to improve) *vs*.
  - SLC: infrequent, slow cycle time (harder to improve)

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Conclusions regarding OSSD

- Developing F/OSS is *different* than software engineering
  - not better, not worse, but different and new
  - more social, more accessible, more convivial
- F/OSS developers may not seek the goals and benefits from classic software engineering

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OSSD Business Models

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Traditional software production business models

- Custom software product engineering
- Cost reduction
- Agile production
- Revenue maximization
- Profit maximization
- Market dominance

M. Cusumano, *The Business of Software : What Every Manager, Programmer, and Entrepreneur Must Know to Thrive and Survive in Good Times and Bad* , Free Press, 2004.

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OSSD Business Models

- Free software (General Public License)
- Open source (BSD/MIT license)
- Dual license
  - F/OSS and proprietary licenses
- Corporate sponsored (SUN, IBM, Apple, HP)
- Corporate Source (Hewlett-Packard in-house)
- Shared Source (Microsoft Research)
- Community Source (SAKAI, Westwood, etc. in Higher Education)

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Organizational Forms for OSSD

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Common OSS organizational forms

- **One-off project** (>90%)
- **Replicated project** (Virtual product line?)
  - 500+ Linux distributions, 200+ OSS content management system projects, 400+ system build/make projects, etc.
- **Meta project**
  - Apache.org
- **Non-profit foundation**
  - Free Software Foundation, GNOME Foundation
- **Corporate sponsored**
  - Sun NetBeans, HP Gelato, IBM Eclipse, Apple Darwin, etc.
- **Consortium** and **Alliance**
  - Open Source Development Lab, Avalanche Cooperative
  - Asterisk VoIP PBX, SugarCRM, OpenAdaptor

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Governance Structures for OSSD

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Governance structures

- Collaboration
  - Guidelines, policies, separate concerns
- Leadership and Control
  - Transparency in decision-making
  - Consent in decision-making
  - Conflict Resolution

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Transforming Organizations via OSS

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Transforming organizations

- Concepts
- Methods
- Tools
- Case studies

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Concept

- Transforming organization target from *as-is* condition to *to-be* form via *here-to-there* transformations
- Transformation goal: Aligning organizational form, processes, strategy, and information technology
  - Organizational forms
  - Open source processes
  - Business model strategy
  - Web-centric OSS infrastructure

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Methods

- Change management
  - Empowering organizational participants to embrace, lead, and affect organizational transformation
- Process engineering
  - Proving participants with the concepts, techniques, tools, and authority to transform their organization in a process-centric manner

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Tools (1)

- Organizational process modeling, analysis, simulation, visualization, re-enactment, and redesign
  - Supports capture, description, and application of causal and interrelated knowledge about what can affect software development (from empirical studies).
  - Requires an underlying computational model of process states, actions, plans, schedules, expectations, histories, etc. in order to answer dynamic "what-if" questions.

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Tools (2)

Organizational transformation *collaboratory*

- An immersive environment where participants can take a first-person view of simulated organizational processes, before, during, and after transformation
- Using either an organizational process simulator, or a game-based computer supported collaborative organizational learning environment (CSCOLE)

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Case Studies

- Core process transformation at ONR
  - Process engineering using organizational transformation laboratory
- Supporting long-term, large-scale transformation
  - MMORPG-based computer supported collaborative organizational learning environment
    - Massively, multi-player online role playing game
- Transforming a software productivity crisis at "BigSysCo"
  - Process engineering and process simulator

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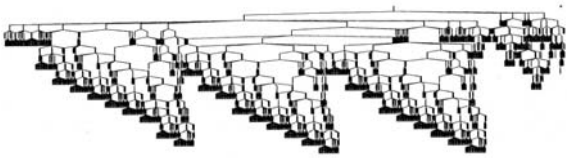
A complex software production process:

a *decomposition-precedence* relationship view
(19 levels of decomposition, 400+ tasks)



W. Scacchi, Experience with Software Process Simulation and Modeling, *J. Systems and Software*, 46(2/3):183-192,1999.

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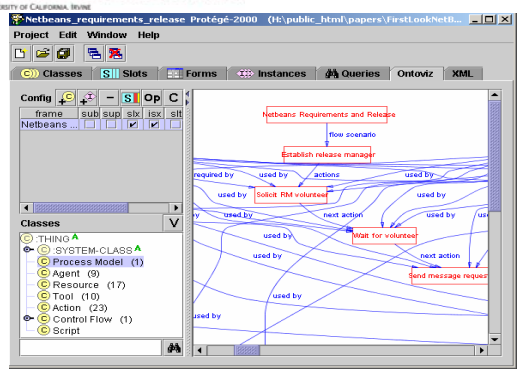

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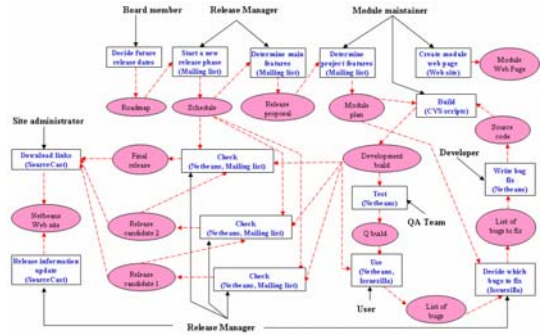

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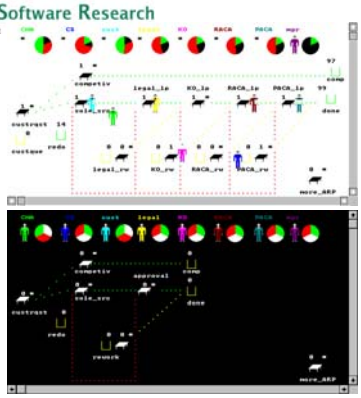

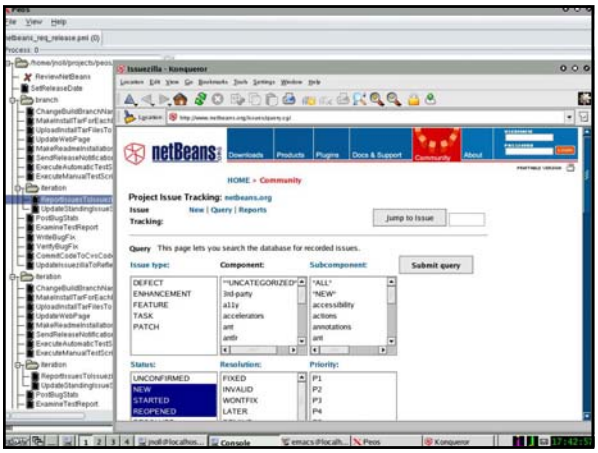

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Identify and cultivate software productivity drivers

- Why are software developers so productive in the presence of technical and organizational constraints?
- Software developers must realize the potential for productivity improvement.
  - The potential for productivity improvement is not an inherent property of new software development technology.
  - Technological impediments and organizational constraints can nullify this potential.
- Thus, a basic concern must be to identify and cultivate *software productivity drivers.*
  - Examples include workplace incentives and alternative software business models

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Open source *processes*

- Free/open source software *does not* embody the processes for how to develop, deploy, use or sustain them
  - Deploying free/open source software is low-cost, but often inefficient and sub-optimal
- Closed source software development, deployment, use, and support is also inefficient and sub-optimal
  - Explicit open source processes could also help closed source systems.

- Example of an open source process model of a *proposal submission* process, specified in a Process Markup Language, PML
- J. Noll and W. Scacchi, Specifying Process-Oriented Hypertext for Organizational Computing, *Journal of Network and Computer Applications*, 4(1):39-61, 2001.

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Questions?

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