Find the Bug(s)!

BlockingQueue queue = ...

while (!queue.isEmpty() && ...) {
  CheaterFutureTask Task = queue.remove();
  incompleteTasks.add(Task);
  taskValues.add(
    Task.getRawCallable().call());
}

BatchCommitLogExecutorService.java using BlockingQueue in Cassandra, one bug injected
Foundations of Software Engineering

Part 15: Inspections and Reviews
Michael Hilton
Administrivia

• Midterm on Thursday
• 1 page of notes allowed
• Exam review in recitation tomorrow
Software Peer Reviews
What are Code Reviews?
Refactorings #28

joliebig merged 17 commits into liveness from CallGraph 9 months ago

ckaestne commented on Jan 29

@joliebig
Please have a look whether you agree with these refactorings in CRewrite

key changes: Moved ASTNavigation and related classes and turned EnforceTreeHelper into an object

ckaestne added some commits on Jan 29

- remove obsolete test cases
- refactoring: move AST helper classes to CRewrite package where it is ...
- improve readability of test code
- removed unused fields

https://help.github.com/articles/using-pull-requests/
Azure DevOps

Plan smarter, collaborate better, and ship faster with a set of modern dev services.

Start free
Fix daemon issues caused by Ubuntu's surprising intermediary shell  

**Author**: epriestley  
**Reviewers**: rm, aran, tuomaspelkonen, jungejason, terabyte, puneet  
**CCs**: aran, epriestley, rm, jcleveley, hugobarauna, feynman, biti, ramk, w31rd0, dleyanlin, taligahack, jiangzhongbo, tomlinsonryan, forestchu12, daviddeuler, abekkine, puneet, zakary, lasseespeholt, suwandi.cahyadi, lancelot.yao, ncu, rafatuita, jacob-zhoupeng, xiaoping, andreibelyaev, ganesanramkumar, thangtp, jamesjyu, googleyufei, demo, xiaobozi, alpha, jacobcly, michaelqvy, szwedyx, yoe.amram, paprotnik123  
**Lint**:  
**Unit**:  
**Commits**:  
**Branch**: master  
**Arcanist Project**: libphutil  
**Apply Patch**: arc patch D212  
**Tokens**:  

---  

epriestley summarized this revision.  
May 2, 2011, 4:56 PM  
*D212#summary*

On OSX and other Linuxii, `proc_open('/exec_daemon ...')` opens a PHP process; on Ubuntu it opens a "sh -c" process which opens a PHP process. The existence of this surprising shell made everything stop working.  

Use `exec` to replace the shell with the PHP process.  

---  

epriestley explained the test plan for this revision.  
May 2, 2011, 4:56 PM  
*D212#test-plan*

Ran daemons on OSX and Ubuntu, behavior seems okay in all cases.  

Keep in mind I have absolutely no idea how Lunix works so this probably breaks the world. (cc: simpkins)  

---  

epriestley commented on this revision.  
May 2, 2011, 5:13 PM  
*D212#1*

See [T128](#) for context.  

---  

rm accepted this revision.  
May 2, 2011, 5:13 PM  
*D212#2*

Nice sleuthing
Ideal MediaWiki Workflow

1) pushes his patch
2) review others patches

Developer

GERRIT

Local repo

WMF repo

Core Team

Validates / rejects changes

Merge to WMF repository

Reports verification status as a comment and +1/-1

JENKINS

Cherry pick patch then:
- lint check
- attempts MW install
- run tests suites

http://www.mediawiki.org/wiki/Gerrit/Advanced_usage
Date       Thu, 16 Oct 2014 14:47:41 +0200
From       Greg Kroah-Hartman <>
Subject    [PATCH] staging: android: binder: move to the "real" part of the kernel

From: Greg Kroah-Hartman <gregkh@linuxfoundation.org>

The Android binder code has been "stable" for many years now. No matter what comes in the future, we are going to have to support this API, so might as well move it to the "real" part of the kernel as there's no real work that needs to be done to the existing code.

Signed-off-by: Greg Kroah-Hartman <gregkh@linuxfoundation.org>

---
This was discussed in the Android miniconf at the Plumbers conference. If anyone has any objections to this, please let me know, otherwise I'm queueing this up for 3.19-rc1

```
drivers/Kconfig |  2 ++
drivers/Makefile |  1 +
drivers/android/Kconfig | 37 ++++++++++++++++++++
drivers/android/Makefile |  3 ++
drivers/{staging => }/android/binder.c |  0
drivers/{staging => }/android/binder.h |  2 -
drivers/{staging => }/android/binder_trace.h |  0
drivers/staging/android/Kconfig |  30 ------------------
drivers/staging/android/Makefile |  1 -
include/uapi/linux/Kbuild |  1 +
include/uapi/linux/android/Kbuild/ |  2 ++
.../uapi => include/uapi/linux/android}/binder.h |  0
12 files changed, 47 insertions(+), 32 deletions(-)
create mode 100644 drivers/android/Kconfig
create mode 100644 drivers/android/Makefile
rename drivers/{staging => }/android/binder.c (100%)
rename drivers/{staging => }/android/binder.h (100%)
diff -git a/drivers/Kconfig b/drivers/Kconfig
```

https://www.kernel.org/doc/Documentation/SubmittingPatches
Refactorings #28

Merged joliebig merged 17 commits into liveness from CallGraph 9 months ago

Conversation 3  Commits 17  Files changed 97

ckaestne commented on Jan 29

@joliebig
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- remove obsolete test cases
- refactoring: move AST helper classes to CRewrite package where it is ...
- improve readability of test code
- removed unused fields

ckaestne commented on Jan 29

Can one of the admins verify this? A?

https://help.github.com/articles/using-pull-requests/
“Many eyes make all bugs shallow”
Standard Refrain in Open Source

“Have peers, rather than customers, find defects”
Karl Wiegers
Isn’t testing sufficient?

- Errors can mask other errors
- Only completed implementations can be tested (esp. scalability, performance)
- Design documents cannot be tested
- Tests don’t check code quality
- Many quality attributes (eg., security, compliance, scalability) are difficult to test
A second pair of eyes

• Different background, different experience
• No preconceived idea of correctness
• Not biased by “what was intended”
Checklists!

The Checklist: https://www.newyorker.com/magazine/2007/12/10/the-checklist
Activity

Develop checklist for Code Review
Expectations and Outcomes of Modern Code Reviews
Outcomes (Analyzing Reviews)

- Code Improvements
- Understanding
- Social Communication
- Defects
- External Impact
- Testing
- Review Tool
- Knowledge Transfer
- Misc

Mismatch of Expectations and Outcomes

• Low quality of code reviews
  – Reviewers look for easy errors, as formatting issues
  – Miss serious errors

• Understanding is the main challenge
  – Understanding the reason for a change
  – Understanding the code and its context
  – Feedback channels to ask questions often needed

• No quality assurance on the outcome

Code Review at Google

• Introduced to “force developers to write code that other developers could understand”

• 3 Found benefits:
  – checking the consistency of style and design
  – ensuring adequate tests
  – improving security by making sure no single developer can commit arbitrary code without oversight
Reviewing relationships

Project lead

- Education
  - Maintaining norms

Readability reviewers

- Maintaining norms

Developer

- Education
  - Maintaining norms

New team members

- Gatekeeping
  - Education
    - Accident prevention

Other team members

Other teams
Comments vs. tenure at Google

Files seen vs. tenure at Google

Tenure at Google (years)

Tenure at Google (months)
Formal Inspections
Formal Inspections

• Idea popularized in 70s at IBM
• Broadly adopted in 80s, much research
  – Sometimes replacing component testing
• Group of developers meets to formally review code or other artifacts
• Most effective approach to find bugs
  – Typically 60-90% of bugs found with inspections
• Expensive and labor-intensive

(see textbook Chapter 22.2)
Inspection Team and Roles

• Typically 4-5 people (min 3)
• Author
• Inspector(s)
  – Find faults and broader issues
• Reader
  – Presents the code or document at inspection meeting
• Scribe
  – Records results
• Moderator
  – Manages process, facilitates, reports
Inspection Process

- **Planning**
- **Overview**
- **Preparation**
- **Meeting**
- **Rework**
- **Followup**

**Moderator**

**Inspectors** (one scribe, one reader, one verifier)

**Author**
Checklists

- Reminder what to look for
- Include issues detected in the past
- Preferably focus on few important items
- Examples:
  - Are all variables initialized before use?
  - Are all variables used?
  - Is the condition of each if/while statement correct?
  - Does each loop terminate?
  - Do function parameters have the right types and appear in the right order?
  - Are linked lists efficiently traversed?
  - Is dynamically allocated memory released?
  - Can unexpected inputs cause corruption?
  - Have all possible error conditions been handled?
  - Are strings correctly sanitized?
Perspective-based Inspections

• Have inspectors with different specialties or different focuses/checklists
  – Encourages alternative thinking patterns
• Have reviewers start in different places in the document
  – Avoid loosing focus at the same location
• Especially in preparation phase
• Little published data, but considered an effective practice
Process details

• Authors do not explain or defend the code – not objective
  – Author != moderator, != scribe, != reader
  – Author should still join the meeting to observe questions and misunderstandings and clarify issues if necessary

• Reader (optional) walks through the code line by line, explaining it
  – Reading the code aloud requires deeper understanding
  – Verbalizes interpretations, thus observing differences in interpretation
Social issues: Egos in Inspections

• Author’s self-worth in artifacts
• Identify defects, not alternatives; do not criticize authors
  – “you didn’t initialize variable a” -> “I don’t see where variable a is initialized”
• Avoid defending code; avoid discussions of solutions/alternatives
• Reviewers should not “show off” that they are better/smarter
• Avoid style discussions if there are no guidelines
• Author decides how to resolve fault
Social issues 2

• Moderator must move discussion along, resolve conflicts
• Meetings should not include management
• Do not use for HR evaluation
  – “finding more than 5 bugs during inspection counts against the author”
  – Leads to avoidance, fragmented submission, not pointing out defects, holding pre-reviews
• Responsibility for quality with authors, not reviewers
  – “why fix this, reviewers will find it”
Root Cause Analysis

• Beyond the immediate puzzle
• How to improve the development process to avoid this problem
  – Restructure development process
  – New policies
  – New development tools, new languages, new analysis tools
Review Checkpoints during Lifecycle

- Requirements specification
  - Review specs
  - Review architecture

- Architectural design

- Models / design
  - Review design

- Coding
  - Review code

- Testing
  - Review test documentation/protocol

- Delivery

Also reviewable:
- Business plan
- Marketing documents
- Project plans
- Documentation
When to inspect

• Before milestones
• Incremental inspections during development
  – Earlier often better than later: smaller fragments, chance to influence further development
  – Large code bases can be expensive and frustrating to review
    • Break down, divide and conquer
    • Focus on critical components
    • Identify defect density in first sessions to guide further need of inspections
Reviews as part of a Milestone

Task X

Task Y

Review

Suitable milestone?

Milestone
Reviews as part of a Milestone

Task X

Task Y

Review

Rework

Milestone
Guidelines for Inspections

• Collected over many companies in many projects and experiments
• Several metrics easily measureable (effort, issues found, lines of code inspected) ...

Focus Fatigue

Recommendation: Do not exceed 60 minute session
Inspection speed

Above 400 LOC/h reviews get shallow
Recommendation: Schedule less than 400 LOC for a 1h review session
Importance of Context

• Code with fewer context dependencies is easier to review
• Reviewers need to look at related files
• -> Modularity (small interfaces, high cohesion, low coupling, ...)

Software Engineering
Are meetings required?

Most issues found during preparation, not in meeting. Suggested synergy seems to have only low impact. Claim: Defects found in meetings often more subtle.
False positives

• About 25% of found issues are false positives
• Avoid discussing during meeting
• Confusion during meeting is indicator that document could be clearer
Self-checks can find half the issues

Effect of Author Preparation on Defect Density

Average Defect Density (Defects/kLOC)

Without Preparation: 85
With Preparation: 48

Authors have self-checked their document before inspection.
Arguments against Reviews?
Cost Discussion in Context

• Formal inspections vs modern code reviews
  – Formal inspections very expensive (about one developer-day per session)
  – Passaround distributed, asynchronous

• Code reviews vs testing
  – Code reviews claimed more cost effective

• Code reviews vs not finding the bug
Types of Code Reviews by Formality

- Ad hoc review
- Passaround ("modern code reviews")
- Pair programming
- Walkthrough
- Inspection

More formal

Types of Code Reviews by Formality

- Ad hoc review
- Passaround (“modern code reviews”)
- Pair programming
- Walkthrough
- Inspection

When to use reviews? Which formality?

More formal

## Differences among peer review types

<table>
<thead>
<tr>
<th>Review Type</th>
<th>Planning</th>
<th>Preparation</th>
<th>Meeting</th>
<th>Correction</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formal Inspection</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Walkthrough</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Pair Programming</td>
<td>Yes</td>
<td>No</td>
<td>Continuous</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Passaround</td>
<td>No</td>
<td>Yes</td>
<td>Rarely</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ad Hoc Review</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Experience (studies/claims)

- Raytheon
  - Reduced “rework” from 41% of costs to 20%
  - Reduced integration effort by 80%
- Paulk et al.: costs to fix a space shuttle software
  - 1$ if found in inspection
  - 13$ during system test
  - 92$ after delivery
- IBM
  - 1h of inspection saves 20h of testing
- R. Grady, efficiency data from HP
  - System use: 0.21 defects/h
  - Black box testing: 0.28 defects/h
  - White box testing: 0.32 defects/h
  - Reading/inspection: 1.06 defects/h
Security Audits
IsTrueCryptAuditedYet?

Yes!

Update Apr 2, 2015: Phase II complete. TrueCrypt has been audited.

Update Feb 18, 2015: Matthew posted an update on the Phase II cryptanalysis today. The Phase I audit report is available on the Open Crypto Audit Project site, and a verified source and download archive for TrueCrypt v. 7.1a can be found on our GitHub mirror. We’ll be posting further news @opencryptoaudit on Twitter in the months ahead.

TrueCrypt (TC) is an open source file and disk encryption software package used by people all over the world, but a complete cryptanalysis has not been performed on the software, and questions remain about differences between Windows, Linux and Mac OS X versions. In addition, there has been no legal review on the current TrueCrypt v. 3.0 open source license - preventing inclusion in most of the free operating systems, including Ubuntu, Debian, RedHat, CentOS and Fedora. We want to be able to trust it, but a fully audited, independently verified repository and software distribution would make us feel better about our security to this software. We’re pledging this money to sponsor a comprehensive public audit of TrueCrypt.

Support the Project

You can help support the Project on our FundFill site, or our new IndieGoGo site (note: both funds accept credit cards, FundFill also accepts Bitcoin, while IndieGoGo also takes PayPal & eChecks).

Goals

- Resolve license status on the current (v. 7.1a) TrueCrypt source code (license v. 3.0) copyright & distribution, in order to create a verified, independent version control history repository (signed source and binary).
- Perform and document repeatable, deterministic builds of TC 7.1a from source code for current major operating systems:
  - Windows 7
  - Mac OS X (Lion 10.7 and Mountain Lion 10.6)
  - Ubuntu 12.04 LTS and 13.04, RedHat 6.4, CentOS 6.4, Debian 7.1, Fedora 19
- Conduct a public cryptanalysis and security audit of the TC 7.1a

Rules

- Fully audited, independently verified source and software distribution
- Contributions are 100% tax-deductible at the federal level
- We’re cool with state and local taxes, but your mileage may vary
- Contributions are not exchangeable for products or services
- Contributions are not refundable
“Many eyes make all bugs shallow”

Standard Refrain in Open Source
Fix a 37 year old bug introduced by Bill Joy on August 24, 1977 that was already present in the 1BSD release on March 9, 1978 by merging Keith Bostic's 22 year old fix from 4.4BSD (not kidding).

Original CSRG SCCS commit message:

```
^As 00009/00006/00145
^Ad D 5.7 92/03/04 14:35:42 bostic 9 8
^Ac can't use freopen; example is "date | head file1 /dev/stdin"
```

ok deraadt@ tedu@, also checked by Martin <Natano dot net>
The Shellshock vulnerabilities affect **Bash**, a program that various Unix-based systems use to execute command lines and command scripts. Bash is free software, developed collaboratively and overseen since 1992 on a volunteer basis by Chet Ramey, a professional software architect.

Analysis of the source code history of Bash shows the vulnerabilities **had existed undiscovered since version 1.03 in 1989**.
Further Reading

  - Overview of formal inspections
- Wiegers. Peer Reviews in Software. Addison-Wesley 2002
  - Entire book on formal inspections, how to formalise and how to introduce them
  - Detailed studies of modern code reviews at Microsoft
  - Overview of empirical research on formal inspections