Stop the Software Architecture Erosion

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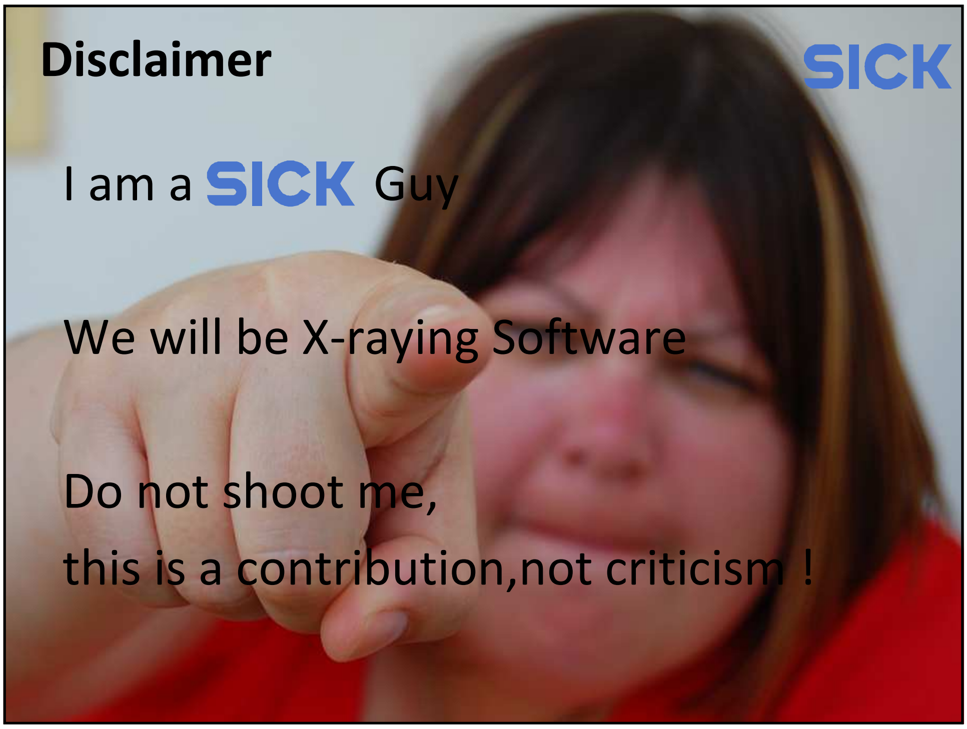


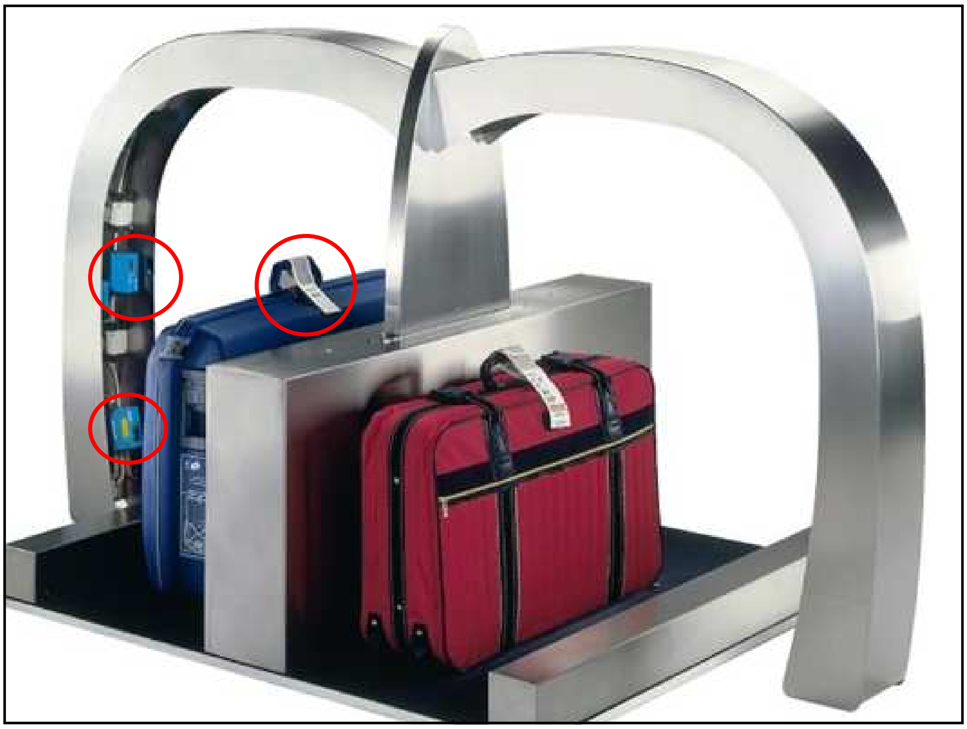
Disclaimer

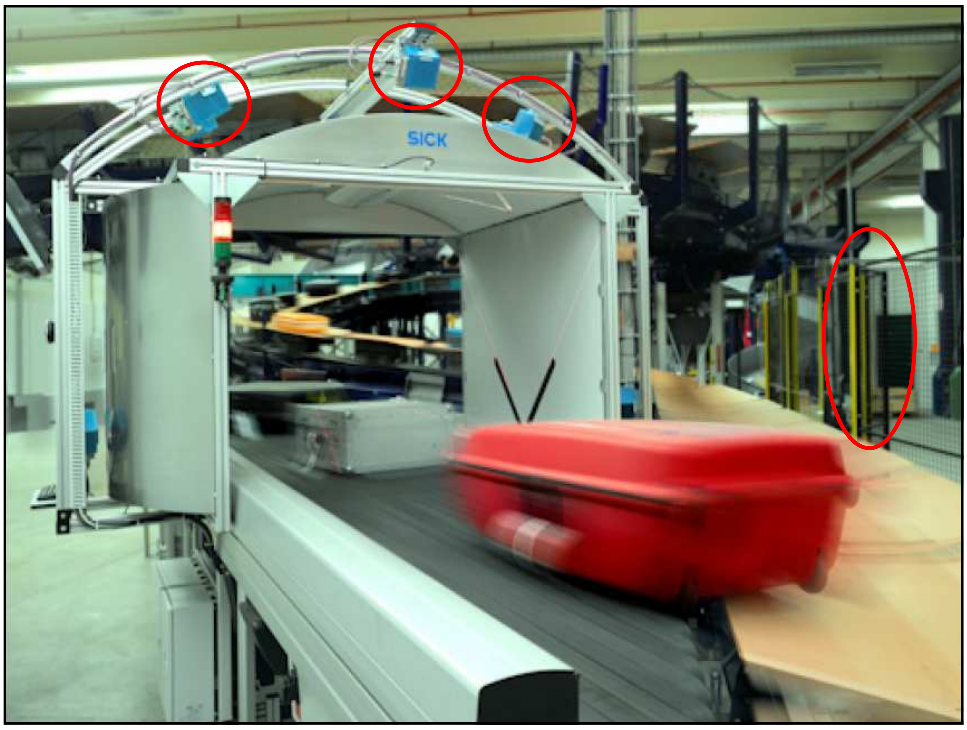
SICK

I am a SICK Guy

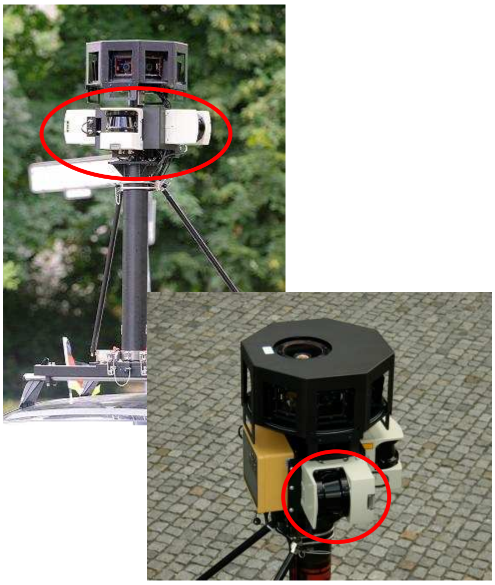
We will be X-raying Software

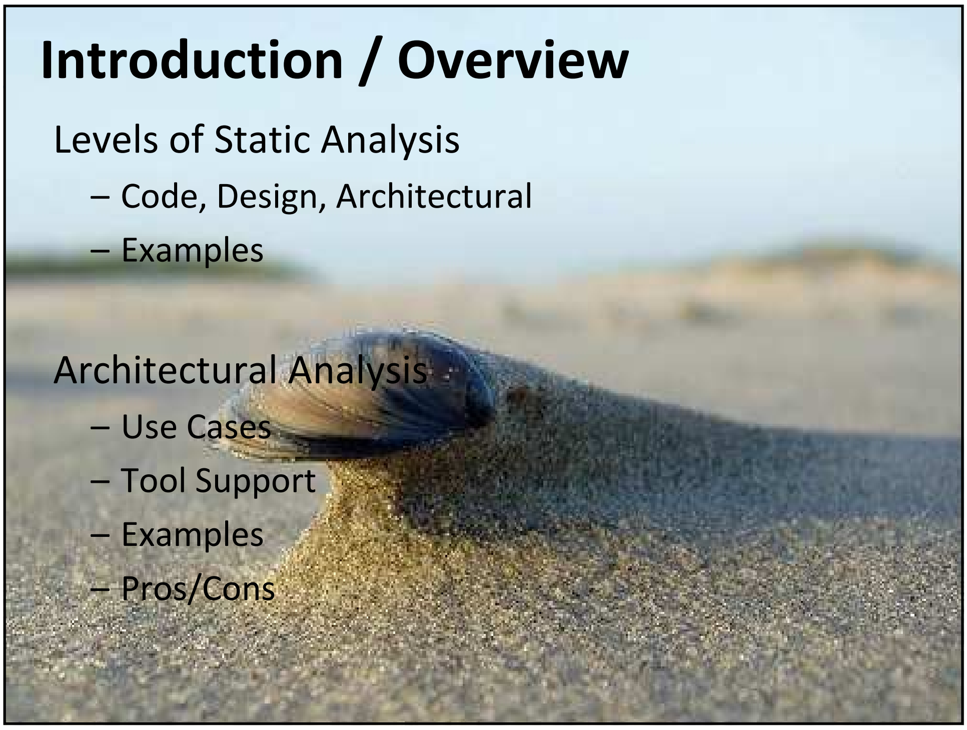
Do not shoot me,
this is a contribution,not criticism !




SICK

Google: Street View





Introduction / Overview

Levels of Static Analysis

- Code, Design, Architectural
- Examples

Architectural Analysis

- Use Cases
- Tool Support
- Examples
- Pros/Cons

Levels of Static Analysis:

Micro-Level

- Code
- =, ==, { }

Macro-Level

- Class-Design, API-Design
- by reference, Exception-Handling, equals/hashCode/op=

Architecture-Level:

- Layers, Subsystems, Compoments, Interfaces
- Coupling, Dependency, etc…

Micro-Level: MISRA-C 2004

```
#define MAX(a, b) ( ((a) > (b)) ? (a) : (b) )
/*  ...  */
z = MAX( i++, j );

x = b[i] + i++;

x = func( i++, i );
```

MISRA The Motor Industry Software Reliability Association

MISRA-C: 2004

Guidelines for the use of the C language in critical systems

October 2004

Macro-Level: Design+Coding Guidelines

Effective C++
Second Edition
50 Specific Ways to Improve Your Programs and Designs
Scott Meyers
ADDISON-WESLEY PRO
Effective Software Development Series
Scott Meyers, Consulting Editor
Effective C#
50 Specific Ways to Improve Your C#
Joshua Bloch
Effective Java
Second Edition
The Java Series
from the Source
C++ Coding Standards
101 Rules, Guidelines, and Best Practices
Herb Sutter
Andrei Alexandrescu
C++ In-Depth Series • Bjarne Stroustrup

Samples for Effective Rules

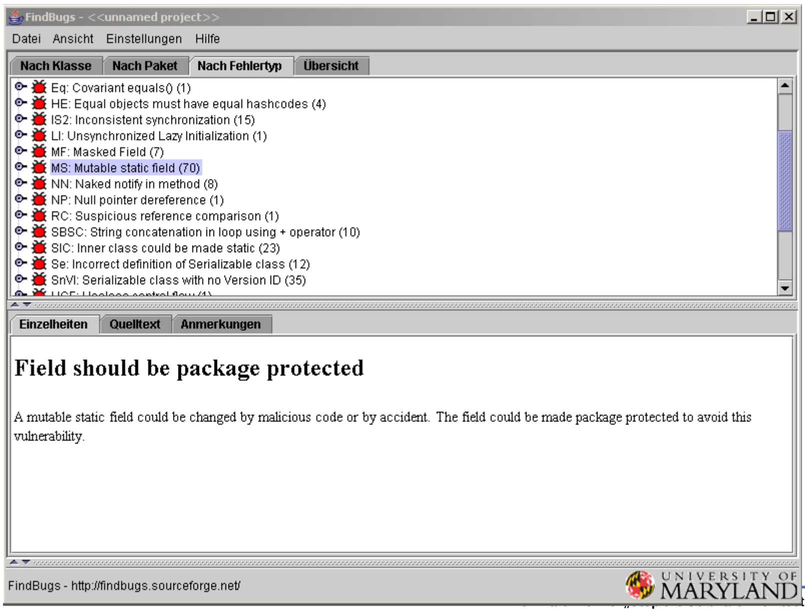
C++

- Prefer `const` and `inline` to `#define`
- Use same form in corresponding uses of new and delete
- Declare cctor and assignment op for classes with dyn memory
- Strive for class interfaces that a minimal and complete
- Choose carefully betw. fuction overloading / parameter default

Java

- Eliminate obsolete object references
- Always override `hashCode` when you override `equals`
- Minimize mutability
- Favor composistion over inheritance
- Do not use raw types in new code

Tool Example Java: findbugs



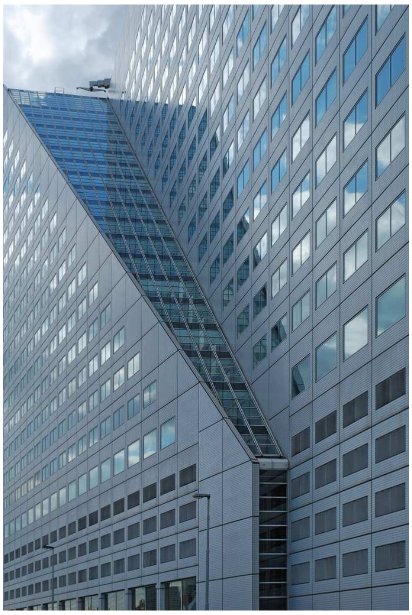
Eq: Covariant equals() (1)
HE: Equal objects must have equal hashcodes (4)
IS2: Inconsistent synchronization (15)
LI: Unsynchronized Lazy Initialization (1)
MF: Masked Field (7)
MS: Mutable static field (70)
NN: Naked notify in method (8)
NP: Null pointer dereference (1)
RC: Suspicious reference comparison (1)
SBSC: String concatenation in loop using + operator (10)
SIC: Inner class could be made static (23)
Se: Incorrect definition of Serializable class (12)
SnVI: Serializable class with no Version ID (35)
UCF: Useless control flow (1)

Field should be package protected

A mutable static field could be changed by malicious code or by accident. The field could be made package protected to avoid this vulnerability.

FindBugs - http://findbugs.sourceforge.net/

Software, Architecture, Erosion



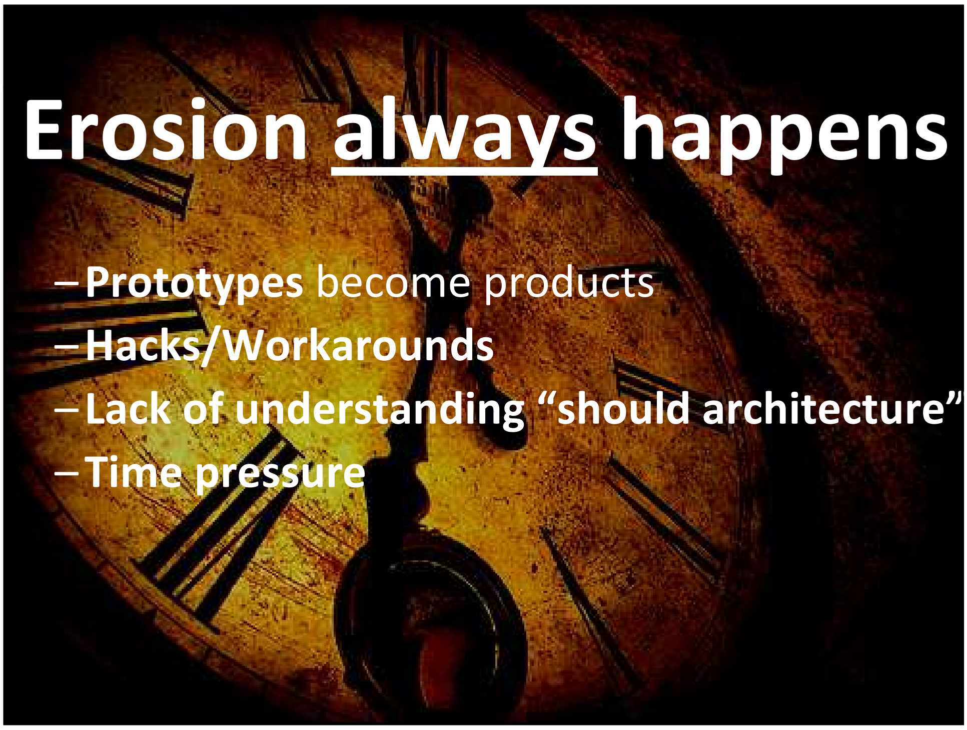
Software-Architecture: Definitions

IEEE 1471-2000:

The fundamental organization of a system,
embodied in its components,
their relationship to each other and the environment,
and the principles governing its design and evolution.

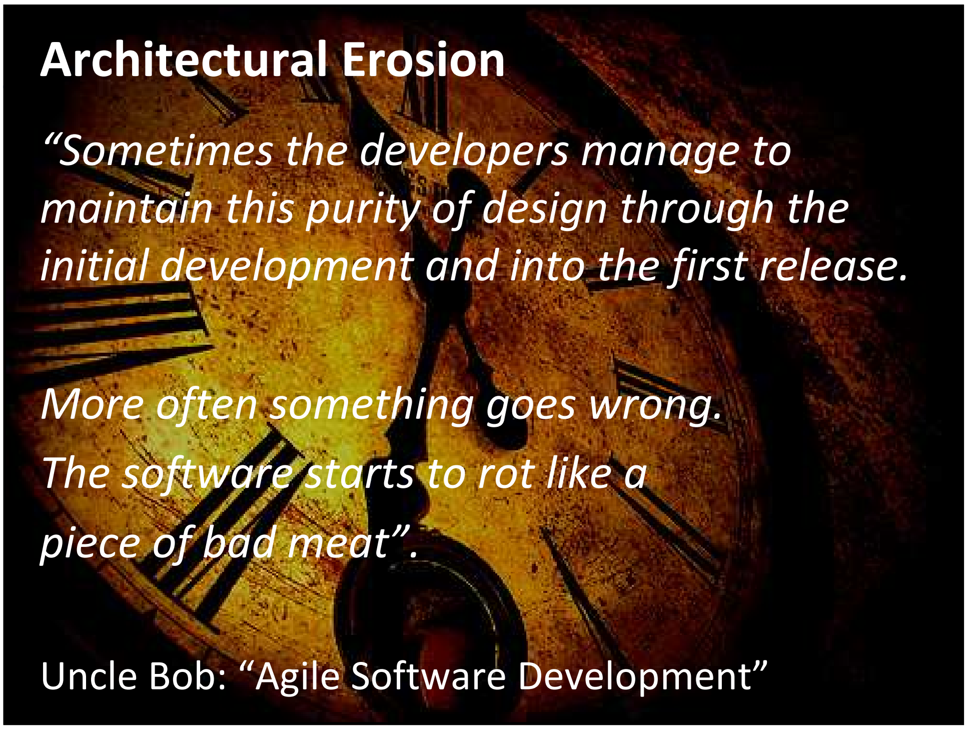
Kruchten: captured in

– *Software Architecture Document*
– *Software Design Guidelines*



Erosion always happens

– **Prototypes** become products
– **Hacks/Workarounds**
– **Lack of understanding “should architecture”**
– **Time pressure**



Architectural Erosion

"Sometimes the developers manage to maintain this purity of design through the initial development and into the first release.

More often something goes wrong.
The software starts to rot like a
piece of bad meat".

Uncle Bob: "Agile Software Development"

There is/was a plan

X-raying Software…

TM
SIEMENS
SOMATOM Definition
FindBugs - <<unnamed project>>
Datei Ansicht Einstellungen Hilfe
Nach Klasse Nach Paket Nach Fehlertyp Übersicht
Einzelheiten Quelltext Anmerkungen
UNIVERSITY OF MARYLAND

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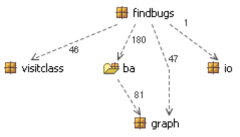
Is there a architecture ?

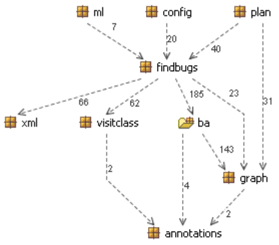
Is there a erosion ?

Do AA-Tool work well ?

Do codelevel lints care about architecture ?

Findbugs: the first years

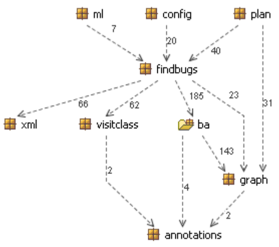


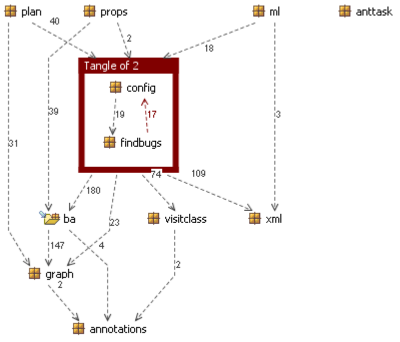


0.7.2
(03/2004)

0.8.6
(10/2004)

Findbugs: the first years

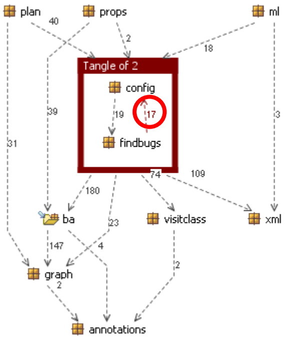


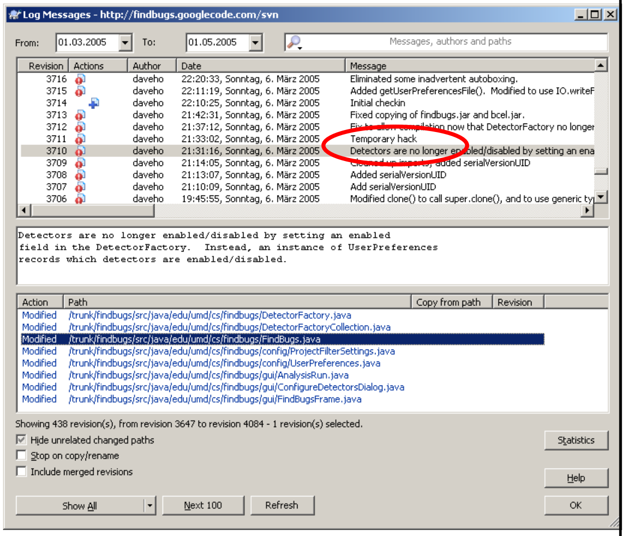


0.8.6
(10/2004)

0.8.7
(05/2005)

Findbugs 0.8.7: Architectural Analysis




Log Messages - http://findbugs.googlecode.com/svn
Messages, authors and paths

From: 01.03.2005 To: 01.05.2005

Revision	Actions	Author	Date	Message
3716		daveho	22:20:33, Sonntag, 6. März 2005	Eliminated some inadvertent autoboxing.
3715		daveho	22:11:19, Sonntag, 6. März 2005	Added getUserPreferencesFile(). Modified to use IO.writeF
3714		daveho	22:10:25, Sonntag, 6. März 2005	Initial checkin
3713		daveho	21:42:31, Sonntag, 6. März 2005	Fixed copying of findbugs.jar and bcel.jar.
3712		daveho	21:37:12, Sonntag, 6. März 2005	Fix to allow compilation now that DetectorFactory no longer
3711		daveho	21:33:02, Sonntag, 6. März 2005	Temporary hack
3710		daveho	21:31:16, Sonntag, 6. März 2005	Detectors are no longer enabled/disabled by setting an ena
3709		daveho	21:14:05, Sonntag, 6. März 2005	Cleaned up imports, added serialVersionUID
3708		daveho	21:13:07, Sonntag, 6. März 2005	Added serialVersionUID
3707		daveho	21:10:09, Sonntag, 6. März 2005	Add serialVersionUID
3706		daveho	19:45:55, Sonntag, 6. März 2005	Modified clone() to call super.clone(), and to use generic ty

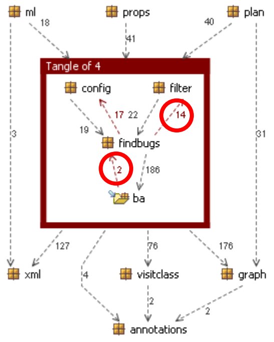
```
Detectors are no longer enabled/disabled by setting an enabled
field in the DetectorFactory.  Instead, an instance of UserPreferences
records which detectors are enabled/disabled.
```

Action	Path	Copy from path	Revision
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/DetectorFactory.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/DetectorFactoryCollection.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/FindBugs.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/config/ProjectFilterSettings.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/config/UserPreferences.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/gui/AnalysisRun.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/gui/ConfigureDetectorsDialog.java		
Modified	/trunk/findbugs/src/java/edu/umd/cs/findbugs/gui/FindBugsFrame.java		

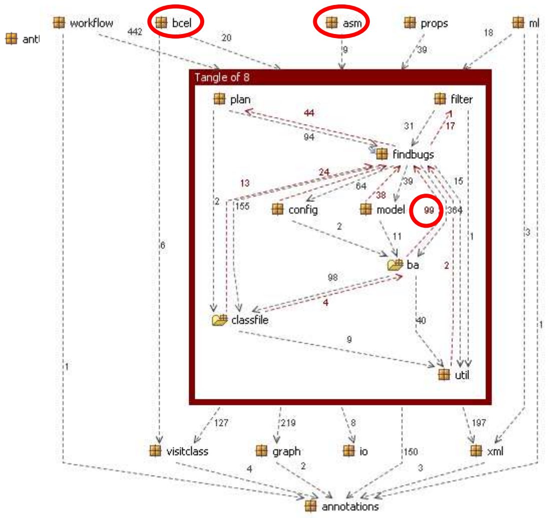
Showing 438 revision(s), from revision 3647 to revision 4084 - 1 revision(s) selected.

☑ Hide unrelated changed paths
☐ Stop on copy/rename
☐ Include merged revisions

Tangle increase…

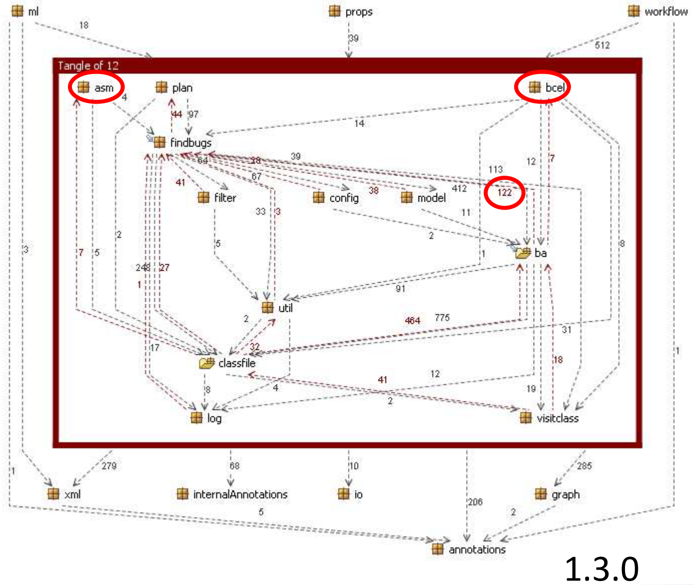


0.8.8
(05/2005)



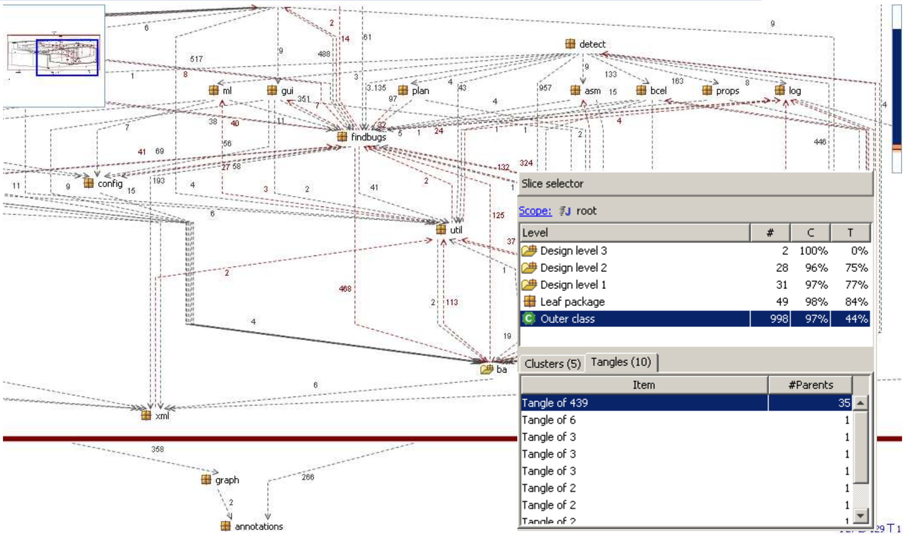
1.0.0
(06/2006)

Tangle increase…



1.3.0
(07/2007)

ONE BIG Tangle…



Slice selector

Scope: root

Level	#	C	T
Design level 3	2	100%	0%
Design level 2	28	96%	75%
Design level 1	31	97%	77%
Leaf package	49	98%	84%
Outer class	998	97%	44%

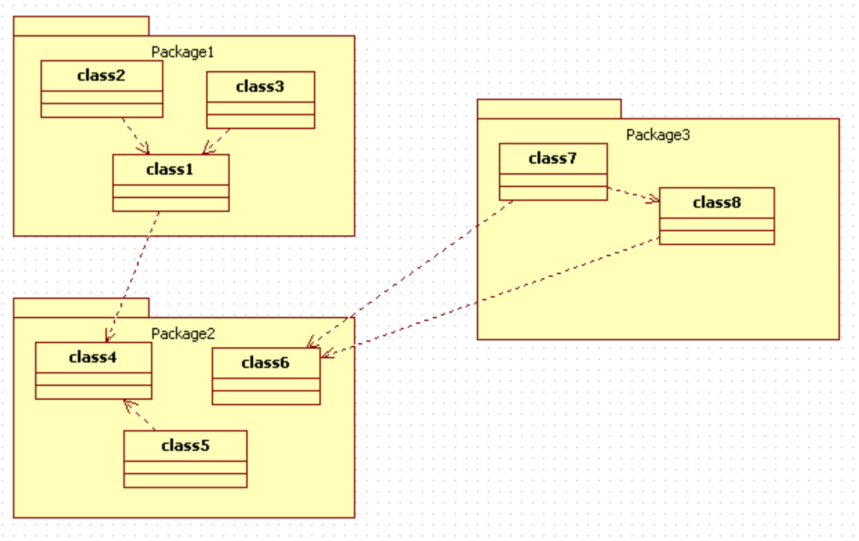
Clusters (5) Tangles (10)

Item	#Parents
Tangle of 439	35
Tangle of 6	1
Tangle of 3	1
Tangle of 3	1
Tangle of 3	1
Tangle of 2	1
Tangle of 2	1
Tangle of 2	1

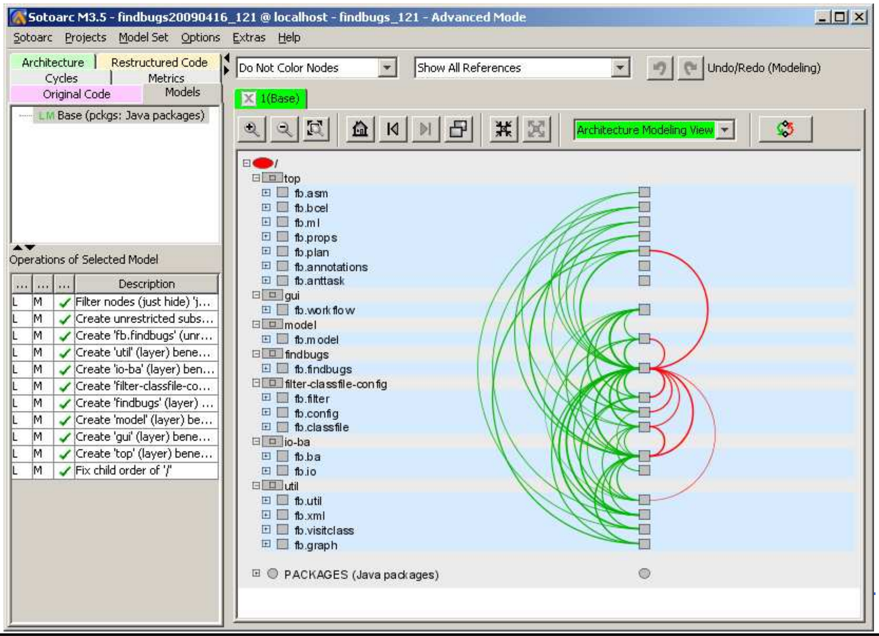
1.3.8 (03/2009)

Still managable ?

Anti-Pattern: Findelkind (foundling)



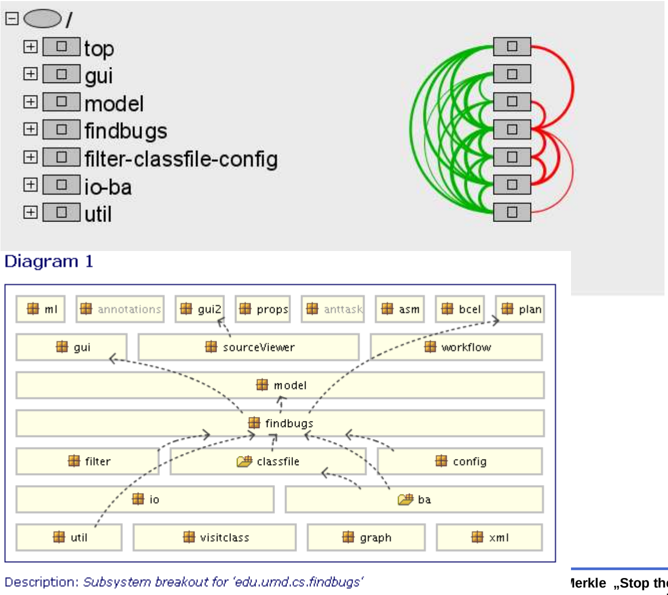
Modeling Subsystems:



Operations of Selected Model

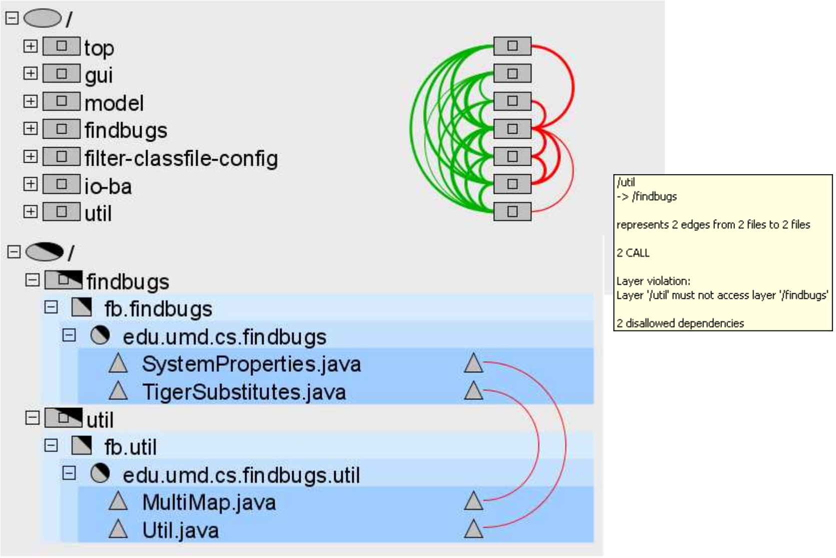
...	...	...	Description
L	M	✓	Filter nodes (just hide) 'j...
L	M	✓	Create unrestricted subs...
L	M	✓	Create 'fb.findbugs' (unr...
L	M	✓	Create 'util' (layer) bene...
L	M	✓	Create 'io-ba' (layer) ben...
L	M	✓	Create 'filter-classfile-co...
L	M	✓	Create 'findbugs' (layer) ...
L	M	✓	Create 'model' (layer) be...
L	M	✓	Create 'gui' (layer) bene...
L	M	✓	Create 'top' (layer) bene...
L	M	✓	Fix child order of '/'

Fixing Architectural Violations



Description: *Subsystem breakout for 'edu.umd.cs.findbugs'*

Fixing Architectural Violations



/util
-> /findbugs

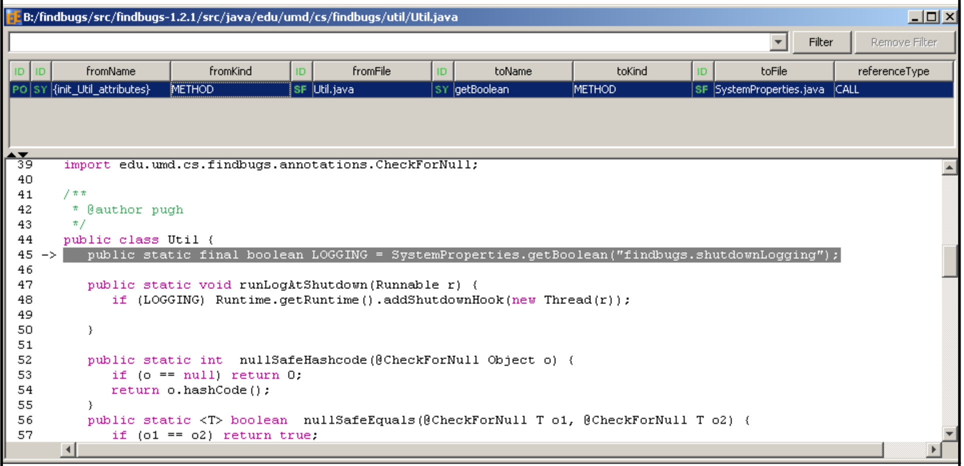
represents 2 edges from 2 files to 2 files

2 CALL

Layer violation:
Layer '/util' must not access layer '/findbugs'

2 disallowed dependencies

Fixing Architectural Violations

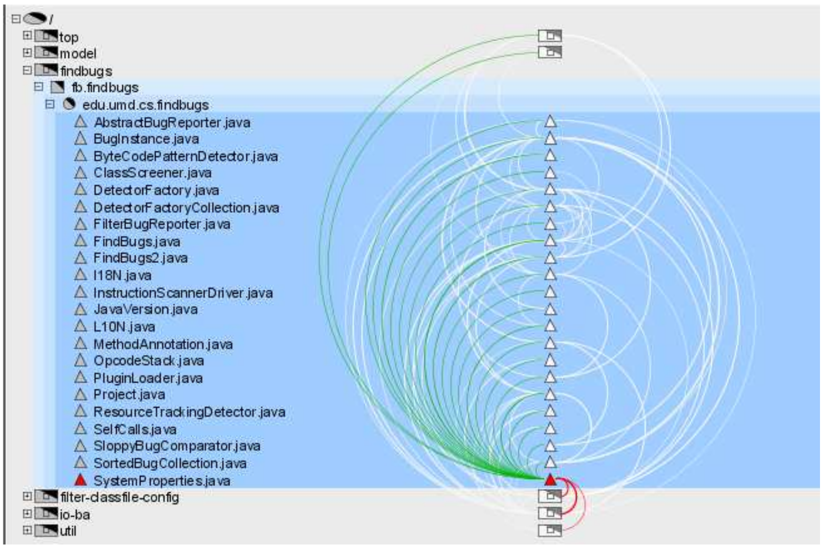


B:/findbugs/src/findbugs-1.2.1/src/java/edu/umd/cs/findbugs/util/Util.java

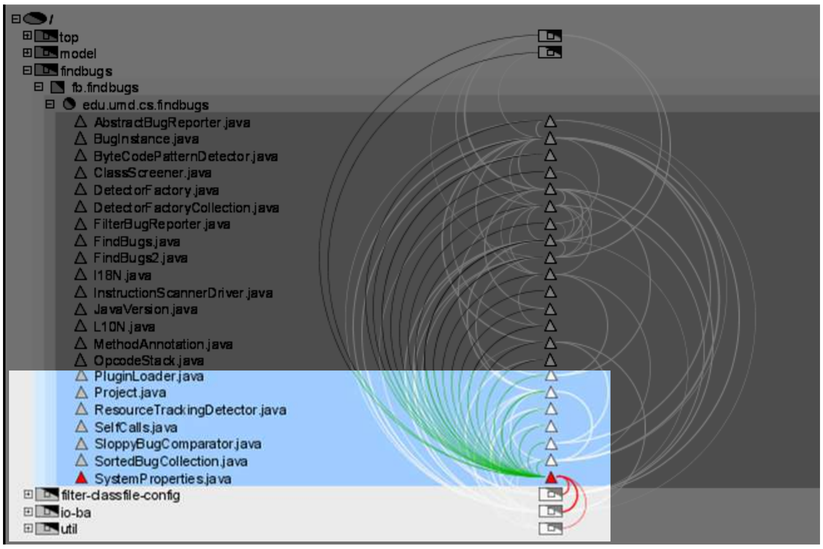
ID	ID	fromName	fromKind	ID	fromFile	ID	toName	toKind	ID	toFile	referenceType
PO	SY	{init_Util_attributes}	METHOD	SF	Util.java	SY	getBoolean	METHOD	SF	SystemProperties.java	CALL

```
import edu.umd.cs.findbugs.annotations.CheckForNull;

/**
 * @author pugh
 */
public class Util {
   public static final boolean LOGGING = SystemProperties.getBoolean("findbugs.shutdownLogging");

   public static void runLogAtShutdown(Runnable r) {
      if (LOGGING) Runtime.getRuntime().addShutdownHook(new Thread(r));

   }

   public static int  nullSafeHashcode(@CheckForNull Object o) {
      if (o == null) return 0;
      return o.hashCode();
   }
   public static <T> boolean  nullSafeEquals(@CheckForNull T o1, @CheckForNull T o2) {
      if (o1 == o2) return true;
```

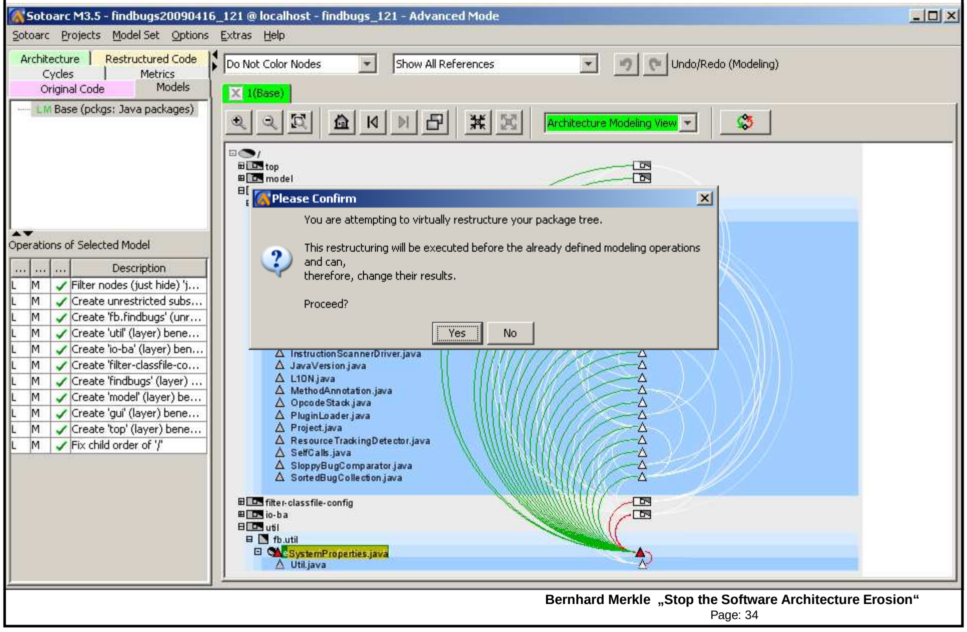
Fixing Architectural Violations



Fixing Architectural Violations



Fixing Architectural Violations



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L	M	✓	Filter nodes (just hide) 'j…
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L	M	✓	Create 'model' (layer) be…
L	M	✓	Create 'gui' (layer) bene…
L	M	✓	Create 'top' (layer) bene…
L	M	✓	Fix child order of '/'

Please Confirm

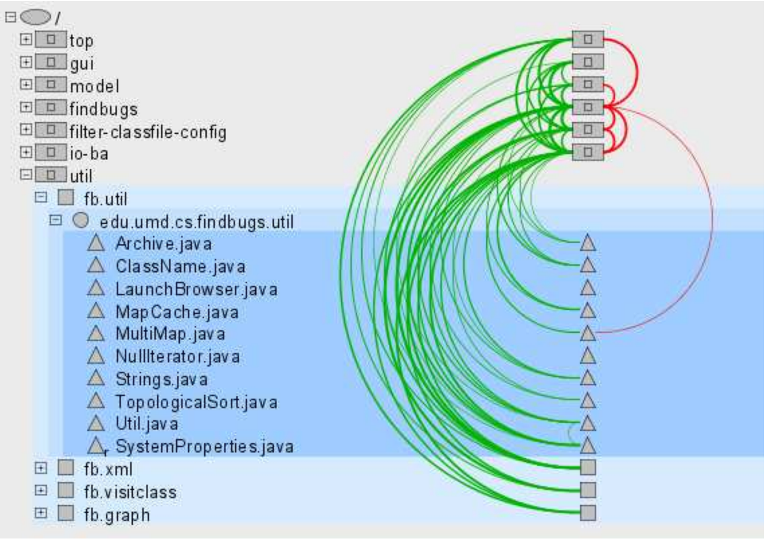
You are attempting to virtually restructure your package tree.

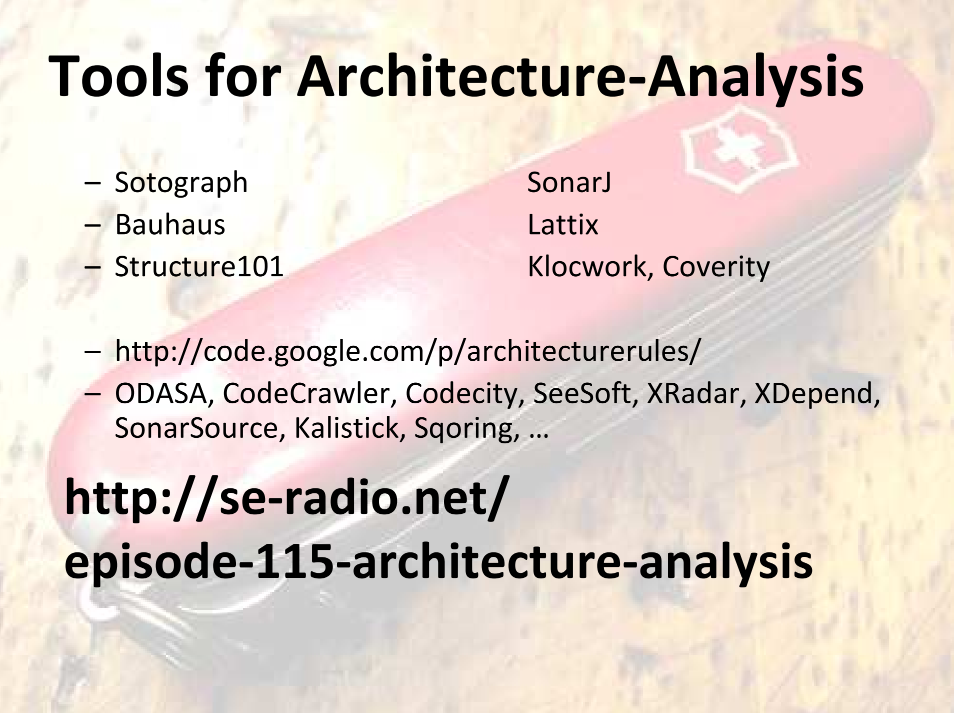
This restructuring will be executed before the already defined modeling operations and can,
therefore, change their results.

Proceed?

Yes No

Fixing Architectural Violations





Tools for Architecture-Analysis

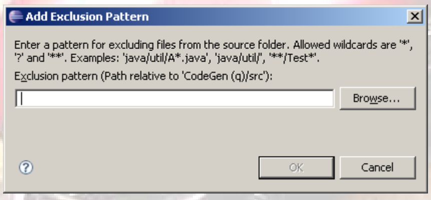
– Sotograph	SonarJ
– Bauhaus	Lattix
– Structure101	Klocwork, Coverity

- http://code.google.com/p/architecturerules/
- ODASA, CodeCrawler, Codecity, SeeSoft, XRadar, XDepend, SonarSource, Kalistick, Sqoring, …

http://se-radio.net/ episode-115-architecture-analysis

Basic Approaches

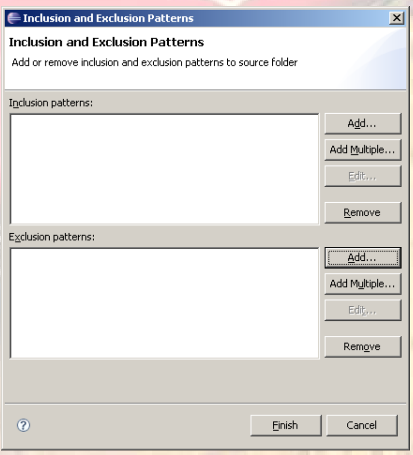
- Your makesystem…
- makedepend, jdepend
- Eclipse (Java Build Path)
- OSGI (Dependencies)



Add Exclusion Pattern

Enter a pattern for excluding files from the source folder. Allowed wildcards are '*', '?' and '**'. Examples: 'java/util/A*.java', 'java/util/', '**/Test*'.

Exclusion pattern (Path relative to 'CodeGen (q)/src'):



Inclusion and Exclusion Patterns

Inclusion and Exclusion Patterns

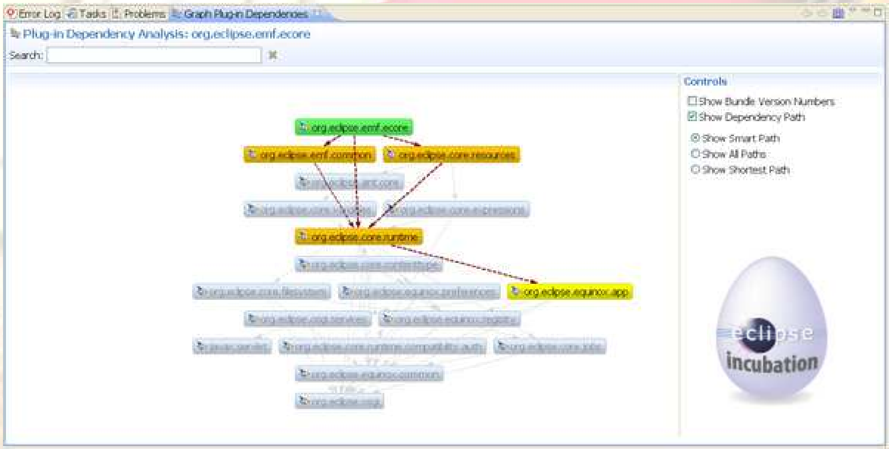
Add or remove inclusion and exclusion patterns to source folder

Inclusion patterns:

Exclusion patterns:

Basic Approaches

PDE Dependency Visualization



Plug-in Dependency Analysis: org.eclipse.emf.ecore

Search:

Controls

☐ Show Bundle Version Numbers
☑ Show Dependency Path

● Show Smart Path
○ Show All Paths
○ Show Shortest Path

Error Log
Tasks
Problems
Graph Plug-in Dependencies
org.eclipse.emf.ecore
org.eclipse.emf.common
org.eclipse.core.resources
org.eclipse.ant.core
org.eclipse.core.variables
org.eclipse.core.expressions
org.eclipse.core.runtime
org.eclipse.core.contenttype
org.eclipse.core.filesystem
org.eclipse.equinox.preferences
org.eclipse.equinox.app
org.eclipse.osgi.services
org.eclipse.equinox.registry
javax.servlet
org.eclipse.core.runtime.compatibility.auth
org.eclipse.core.jobs
org.eclipse.equinox.common
org.eclipse.osgi
eclipse
incubation

Missing in basic approaches:

Architecture Analysis (Deviation)

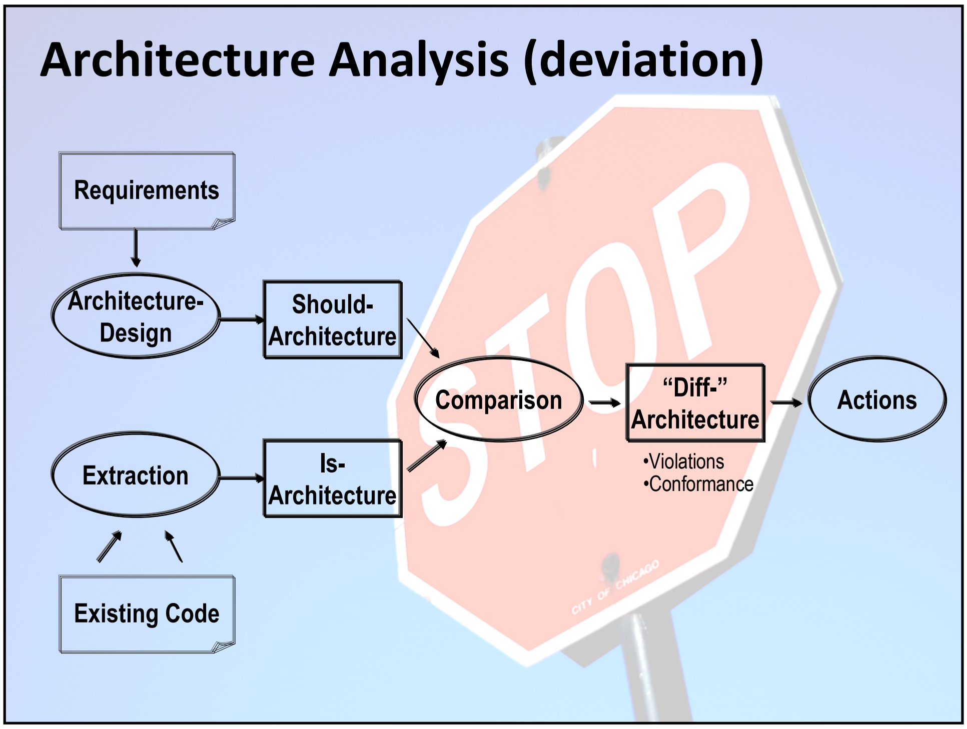
Drill-Down + Aggregation

Displaying results

Monitoring changes, trends

Rating of Architecture

→ Requirements for Architectural Analysis Tools



Architecture Analysis (deviation)

Requirements

Architecture-Design

Should-Architecture

Extraction

Is-Architecture

Existing Code

Comparison

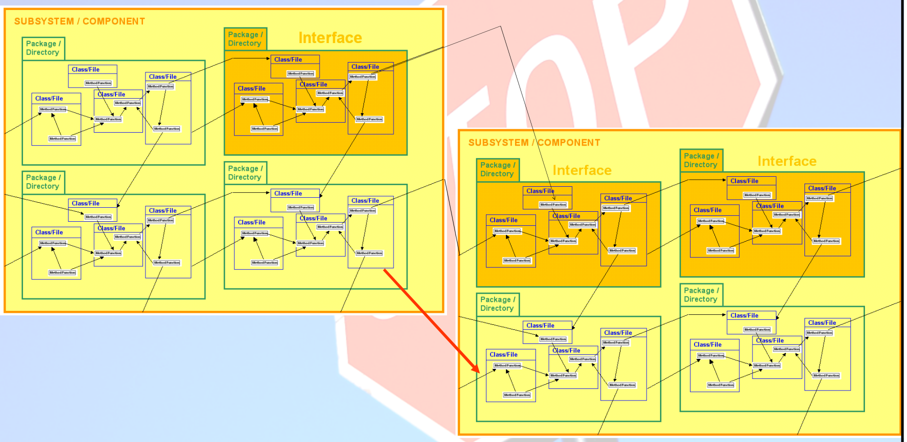
“Diff-” Architecture

- Violations
- Conformance

Actions

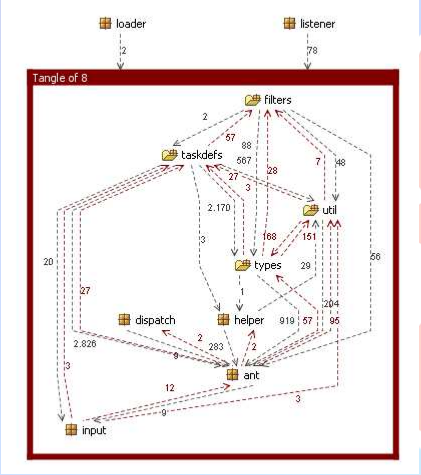
Drill-Down + Aggregation:

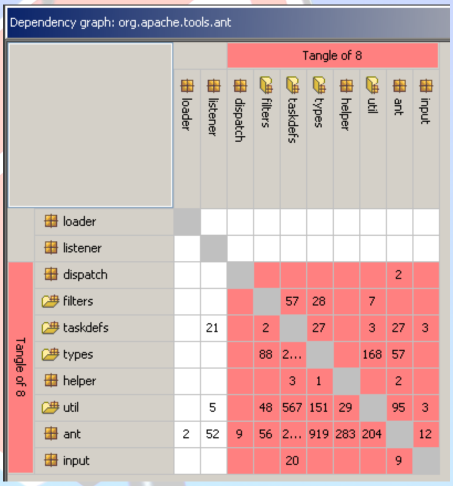
Component → System → Package → Class → Src-Line



Displaying results:

Graphical and/or numerical



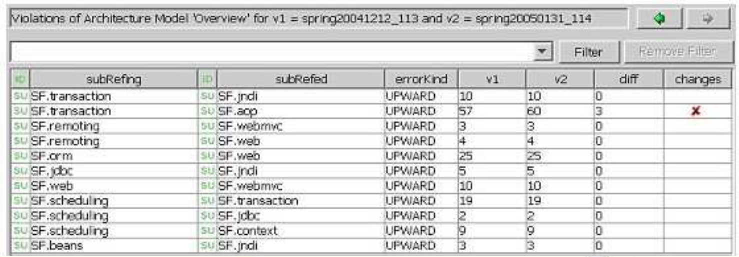


Dependency graph: org.apache.tools.ant

		loader	listener	dispatch	filters	taskdefs	types	helper	util	ant	input
	loader										
	listener										
Tangle of 8	dispatch									2	
	filters					57	28		7		
	taskdefs		21		2		27		3	27	3
	types				88	2…			168	57	
	helper					3	1			2	
	util		5		48	567	151	29		95	3
	ant	2	52	9	56	2…	919	283	204		12
	input					20				9	

Tangle of 8 spans the columns dispatch to input.

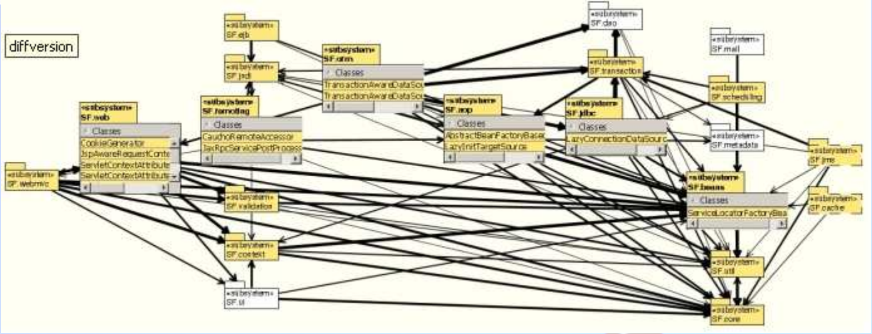
Monitoring changes, trends (QA)



Violations of Architecture Model 'Overview' for v1 = spring20041212_113 and v2 = spring20050131_114

ID	subRefing	ID	subRefed	errorKind	v1	v2	diff	changes
SU	SF.transaction	SU	SF.jndi	UPWARD	10	10	0	
SU	SF.transaction	SU	SF.aop	UPWARD	57	60	3	✗
SU	SF.remoting	SU	SF.webmvc	UPWARD	3	3	0	
SU	SF.remoting	SU	SF.web	UPWARD	4	4	0	
SU	SF.orm	SU	SF.web	UPWARD	25	25	0	
SU	SF.jdbc	SU	SF.jndi	UPWARD	5	5	0	
SU	SF.web	SU	SF.webmvc	UPWARD	10	10	0	
SU	SF.scheduling	SU	SF.transaction	UPWARD	19	19	0	
SU	SF.scheduling	SU	SF.jdbc	UPWARD	2	2	0	
SU	SF.scheduling	SU	SF.context	UPWARD	9	9	0	
SU	SF.beans	SU	SF.jndi	UPWARD	3	3	0	

ion etc.

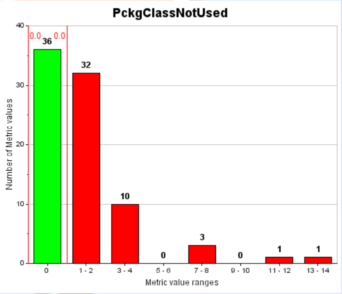


Rating of Architecture

NO Rating of external Requirements (Fullfillment)

Internal Quality:

- Cycles
- Coupling of Modules
- Stability of API
- Anti-Patterns, Bad Smells
- Reuse/Extract system parts

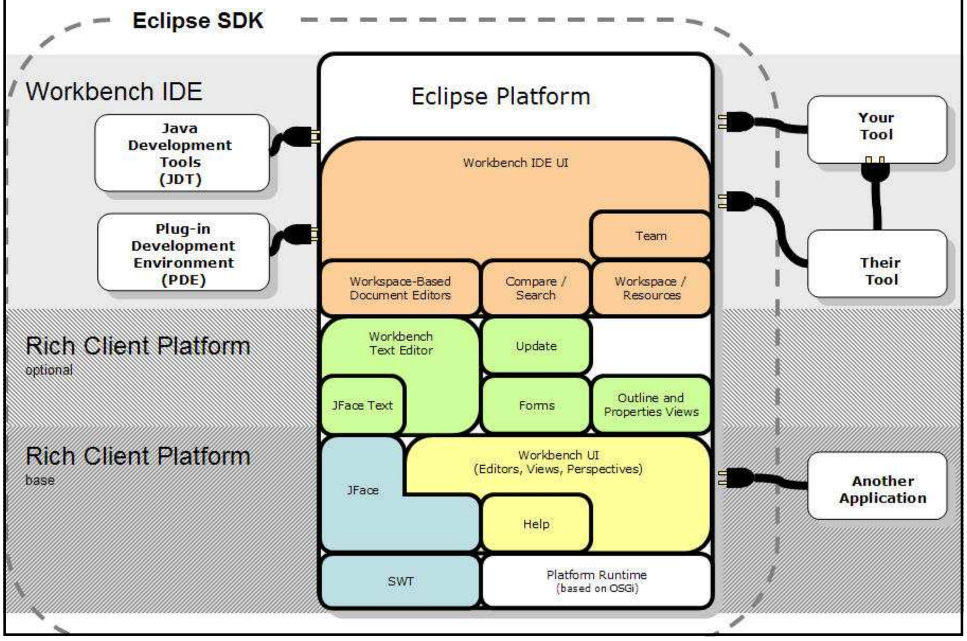


Eclipse: Architectural Analysis

– JDT

– CDT

Eclipse Architecture



Eclipse SDK

Workbench IDE

Java Development Tools (JDT)

Plug-in Development Environment (PDE)

Rich Client Platform

optional

Rich Client Platform

base

Eclipse Platform

Workbench IDE UI

Team

Workspace-Based Document Editors

Compare / Search

Workspace / Resources

Workbench Text Editor

Update

JFace Text

Forms

Outline and Properties Views

JFace

Workbench UI (Editors, Views, Perspectives)

Help

SWT

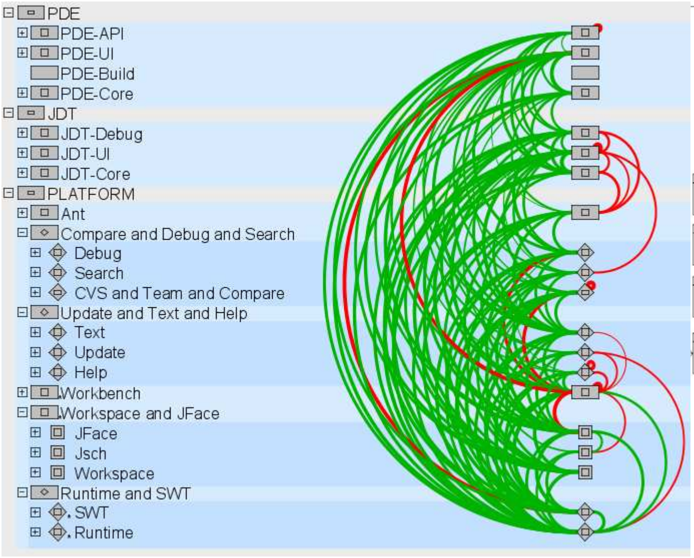
Platform Runtime (based on OSGi)

Your Tool

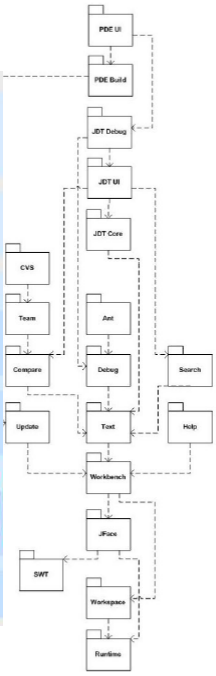
Their Tool

Another Application

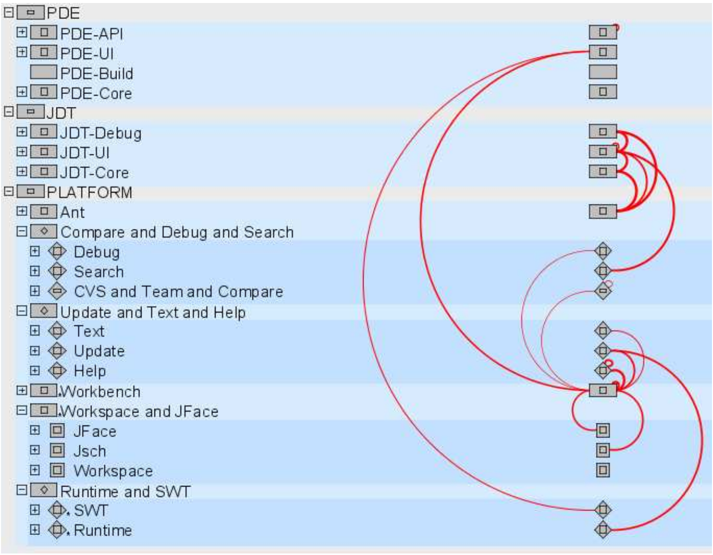
Eclipse Architecture



- PDE
  - PDE-API
  - PDE-UI
  - PDE-Build
  - PDE-Core
- JDT
  - JDT-Debug
  - JDT-UI
  - JDT-Core
- PLATFORM
  - Ant
  - Compare and Debug and Search
    - Debug
    - Search
    - CVS and Team and Compare
  - Update and Text and Help
    - Text
    - Update
    - Help
  - Workbench
  - Workspace and JFace
    - JFace
    - Jsch
    - Workspace
  - Runtime and SWT
    - SWT
    - Runtime



Eclipse Architecture



- PDE
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  - PDE-UI
  - PDE-Build
  - PDE-Core
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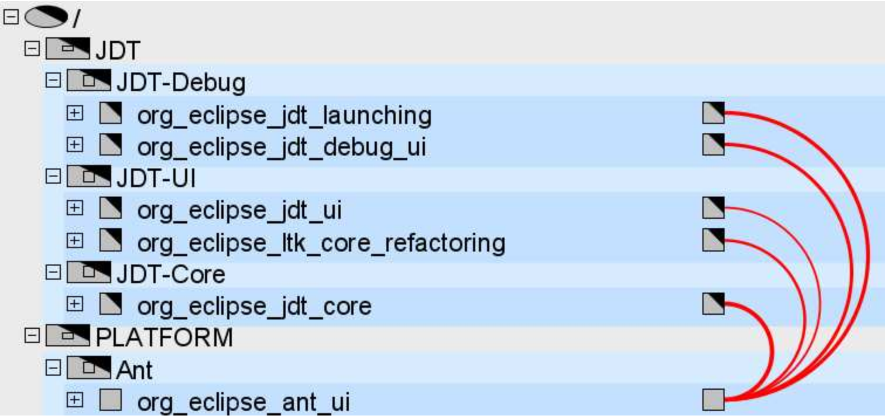
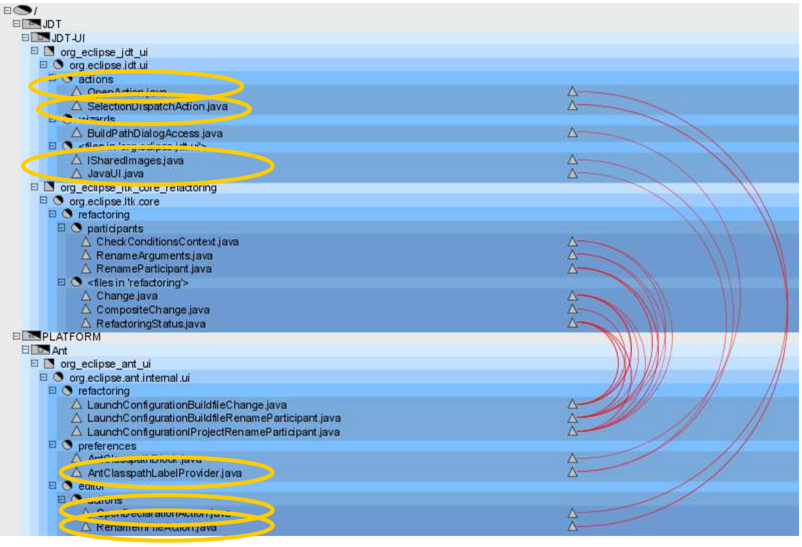
    - Workspace
  - Runtime and SWT
    - SWT
    - Runtime

E3.4: Plattf:Ant → JDT:*



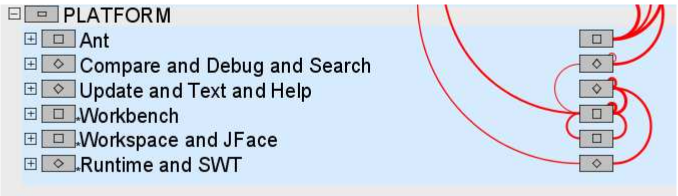
```
/
  JDT
    JDT-Debug
      org_eclipse_jdt_launching
      org_eclipse_jdt_debug_ui
    JDT-UI
      org_eclipse_jdt_ui
      org_eclipse_ltk_core_refactoring
    JDT-Core
      org_eclipse_jdt_core
  PLATFORM
    Ant
      org_eclipse_ant_ui
```

E3.4: Plattf:Ant → JDT:UI

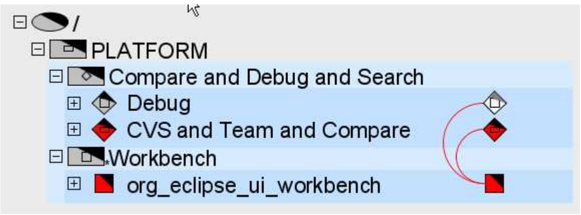


```
/
  JDT
    JDT-UI
      org_eclipse_jdt_ui
        org.eclipse.jdt.ui
          actions
            OpenAction.java
            SelectionDispatchAction.java
          wizards
            BuildPathDialogAccess.java
          <files in 'org.eclipse.jdt.ui'>
            ISharedImages.java
            JavaUI.java
      org_eclipse_ltk_core_refactoring
        org.eclipse.ltk.core
          refactoring
            participants
              CheckConditionsContext.java
              RenameArguments.java
              RenameParticipant.java
            <files in 'refactoring'>
              Change.java
              CompositeChange.java
              RefactoringStatus.java
  PLATFORM
    Ant
      org_eclipse_ant_ui
        org.eclipse.ant.internal.ui
          refactoring
            LaunchConfigurationBuildfileChange.java
            LaunchConfigurationBuildfileRenameParticipant.java
            LaunchConfigurationIProjectRenameParticipant.java
          preferences
            AntClasspathBlock.java
            AntClasspathLabelProvider.java
          editor
            actions
              OpenDeclarationAction.java
              RenameInFileAction.java
```

Plattform: CVS → Workb (internal)

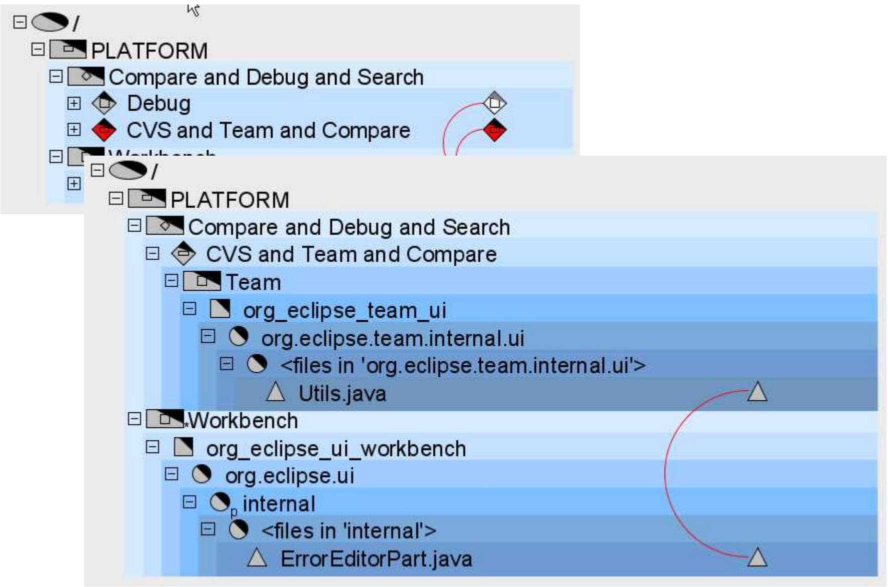


- PLATFORM
  - Ant
  - Compare and Debug and Search
  - Update and Text and Help
  - Workbench
  - Workspace and JFace
  - Runtime and SWT



- /
  - PLATFORM
    - Compare and Debug and Search
      - Debug
      - CVS and Team and Compare
    - Workbench
      - org_eclipse_ui_workbench

Plattform: CVS → Workb (internal)

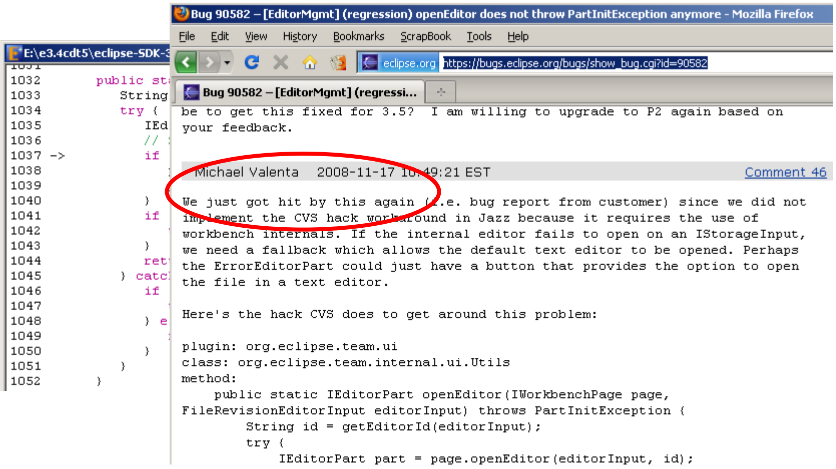


- /
  - PLATFORM
    - Compare and Debug and Search
      - Debug
      - CVS and Team and Compare

- /
  - PLATFORM
    - Compare and Debug and Search
      - CVS and Team and Compare
        - Team
          - org_eclipse_team_ui
            - org.eclipse.team.internal.ui
              - <files in 'org.eclipse.team.internal.ui'>
                - Utils.java
    - Workbench
      - org_eclipse_ui_workbench
        - org.eclipse.ui
          - internal
            - <files in 'internal'>
              - ErrorEditorPart.java

Team-UI→UI-workbench (internal)

https://bugs.eclipse.org/bugs/show_bug.cgi?id=90582



E:\e3.4cdt5\eclipse-SDK-3
Bug 90582 – [EditorMgmt] (regression) openEditor does not throw PartInitException anymore - Mozilla Firefox
File Edit View History Bookmarks ScrapBook Tools Help
eclipse.org
https://bugs.eclipse.org/bugs/show_bug.cgi?id=90582
Bug 90582 – [EditorMgmt] (regressi...

```
        public st
            String
            try {
                IEd
                //
->              if

                }
                if

                }
                ret
            } catc
                if

                } e

                }
            }
        }
```

be to get this fixed for 3.5? I am willing to upgrade to P2 again based on your feedback.

Michael Valenta 2008-11-17 10:49:21 EST Comment 46

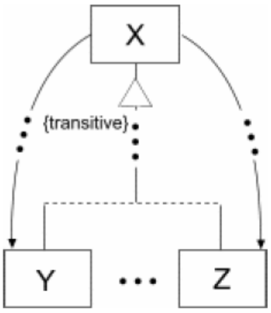
We just got hit by this again (i.e. bug report from customer) since we did not implement the CVS hack workaround in Jazz because it requires the use of workbench internals. If the internal editor fails to open on an IStorageInput, we need a fallback which allows the default text editor to be opened. Perhaps the ErrorEditorPart could just have a button that provides the option to open the file in a text editor.

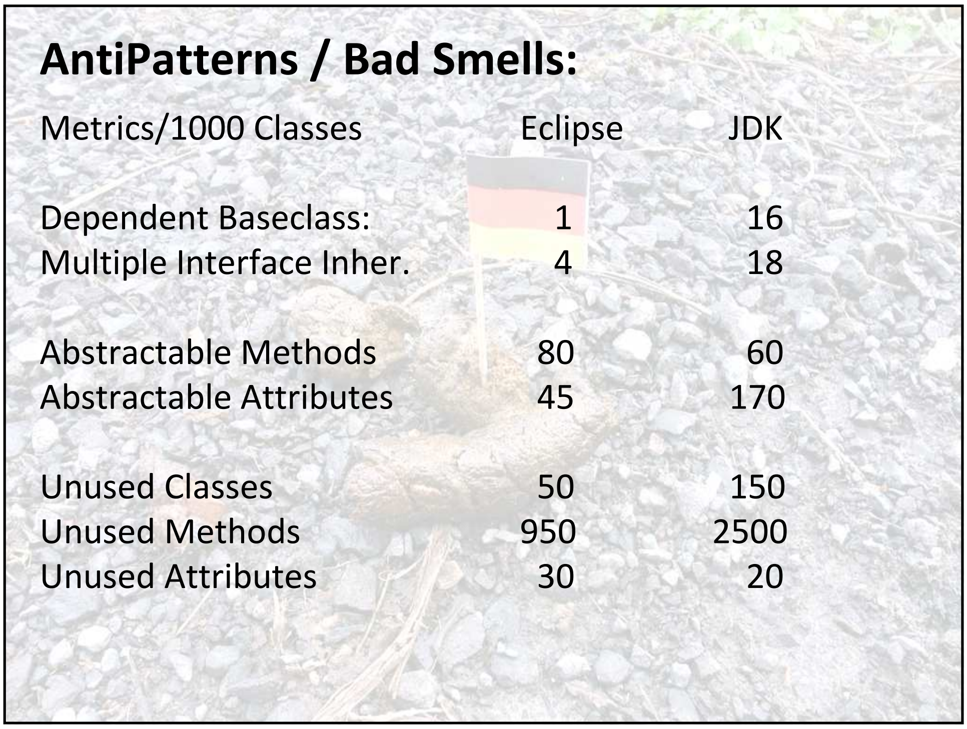
Here's the hack CVS does to get around this problem:

```
plugin: org.eclipse.team.ui
class: org.eclipse.team.internal.ui.Utils
method:
    public static IEditorPart openEditor(IWorkbenchPage page,
FileRevisionEditorInput editorInput) throws PartInitException {
        String id = getEditorId(editorInput);
        try {
            IEditorPart part = page.openEditor(editorInput, id);
```

Dependent BaseClass

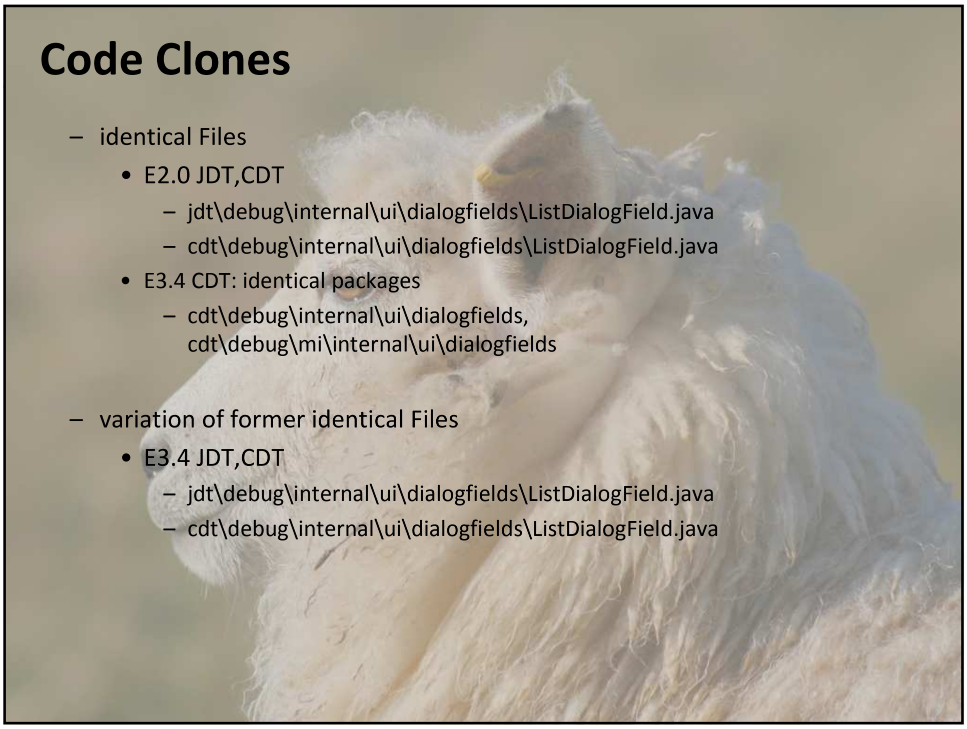
- Type:
  - Design Problem
- Problem:
  - one of more Methods shall implement differe behavior, depending on the type, passed in
- Context:
  - make “extensible” systems, frameworks
- Forces:
  - Programming languages offer, instanceof/typeid funcs.
- Antipattern:
  - Methods of the baseclass, depend on derived classes, e.g. accessing their members, doing switch/case depending on type information





AntiPatterns / Bad Smells:

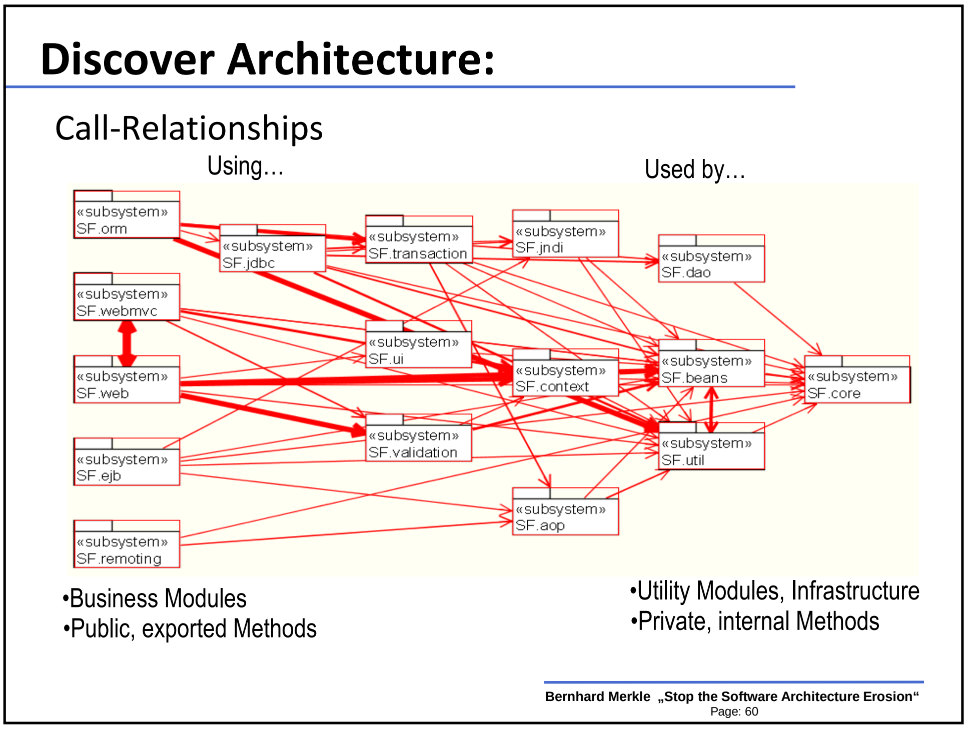
Metrics/1000 Classes	Eclipse	JDK
Dependent Baseclass:	1	16
Multiple Interface Inher.	4	18
Abstractable Methods	80	60
Abstractable Attributes	45	170
Unused Classes	50	150
Unused Methods	950	2500
Unused Attributes	30	20



Code Clones

- identical Files
  - E2.0 JDT,CDT
    - jdt\debug\internal\ui\dialogfields\ListDialogField.java
    - cdt\debug\internal\ui\dialogfields\ListDialogField.java
  - E3.4 CDT: identical packages
    - cdt\debug\internal\ui\dialogfields, cdt\debug\mi\internal\ui\dialogfields

- variation of former identical Files
  - E3.4 JDT,CDT
    - jdt\debug\internal\ui\dialogfields\ListDialogField.java
    - cdt\debug\internal\ui\dialogfields\ListDialogField.java



Discover Architecture:

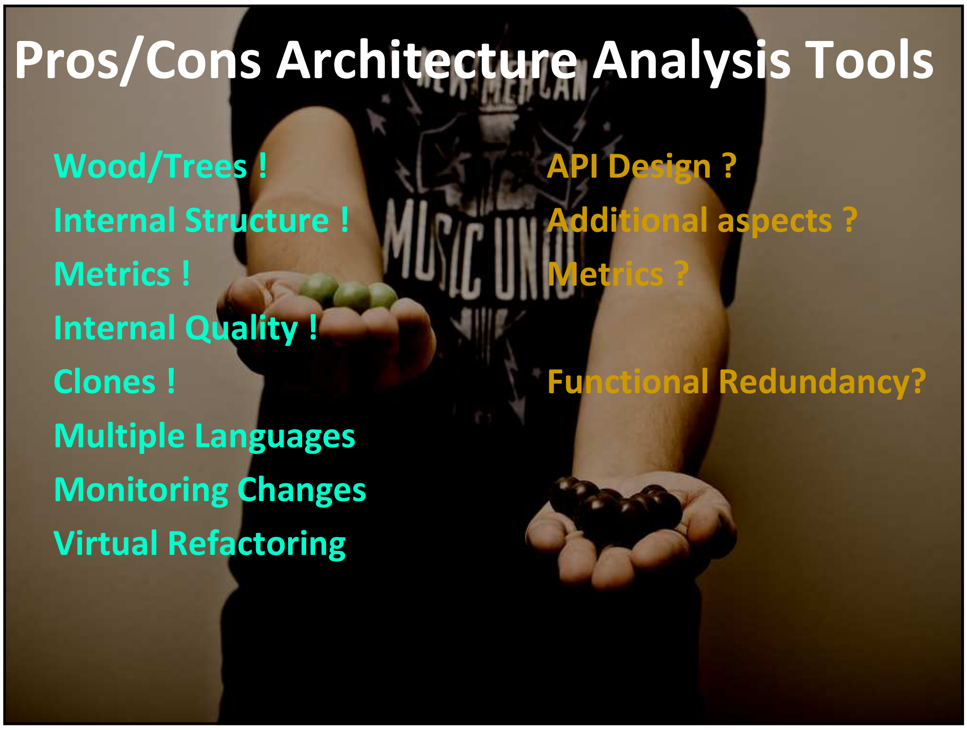
Call-Relationships

Using…

Used by…

- Business Modules
- Public, exported Methods

- Utility Modules, Infrastructure
- Private, internal Methods



Pros/Cons Architecture Analysis Tools

Wood/Trees !

Internal Structure !

Metrics !

Internal Quality !

Clones !

Multiple Languages

Monitoring Changes

Virtual Refactoring

API Design ?

Additional aspects ?

Metrics ?

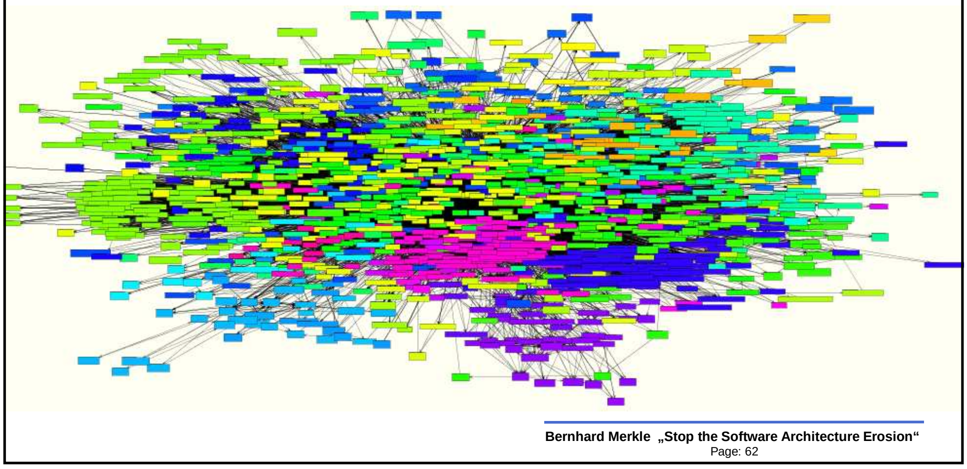
Functional Redundancy?

Rating of Architecture

1315 classes in 229 packages all depend on each other !!!

classes.zip, rt.jar (BIG BALL OF … ;-)

JDK^H^Hdecay

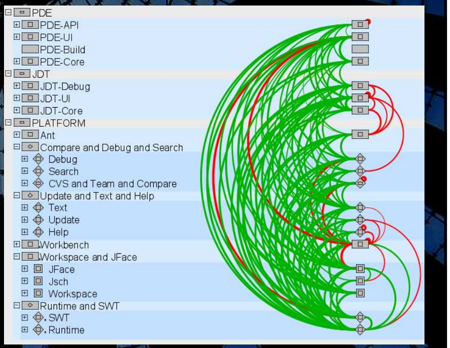


Still manageable ?

Rating Eclipse Architecture

Erosion not really dramatic, but happened/s

- large codebase, structured in plugins
- OSGI helps a lot
- API Police, Guidelines upcoming PDE tools



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    - Jsch
    - Workspace
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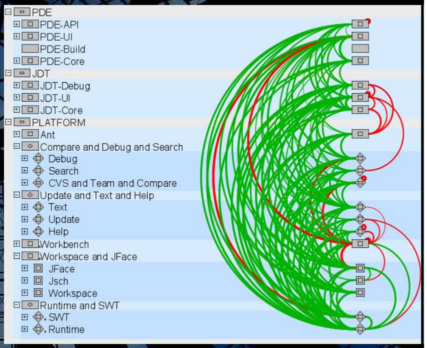
    - SWT
    - Runtime

Rating Eclipse Architecture:

- Violations
  - Upper layers
  - Internal access
- Small amount of
  - AntiPatterns
- Some amount of
  - CodeClones
- OSGI is not enough

→ People AND Tools !



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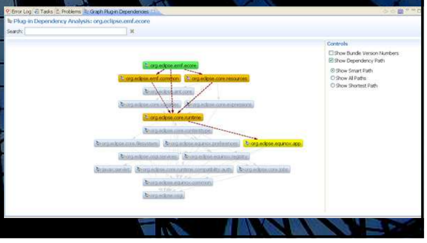


Plug-in Dependency Analysis: org.eclipse.emf.ecore

Search:

Controls

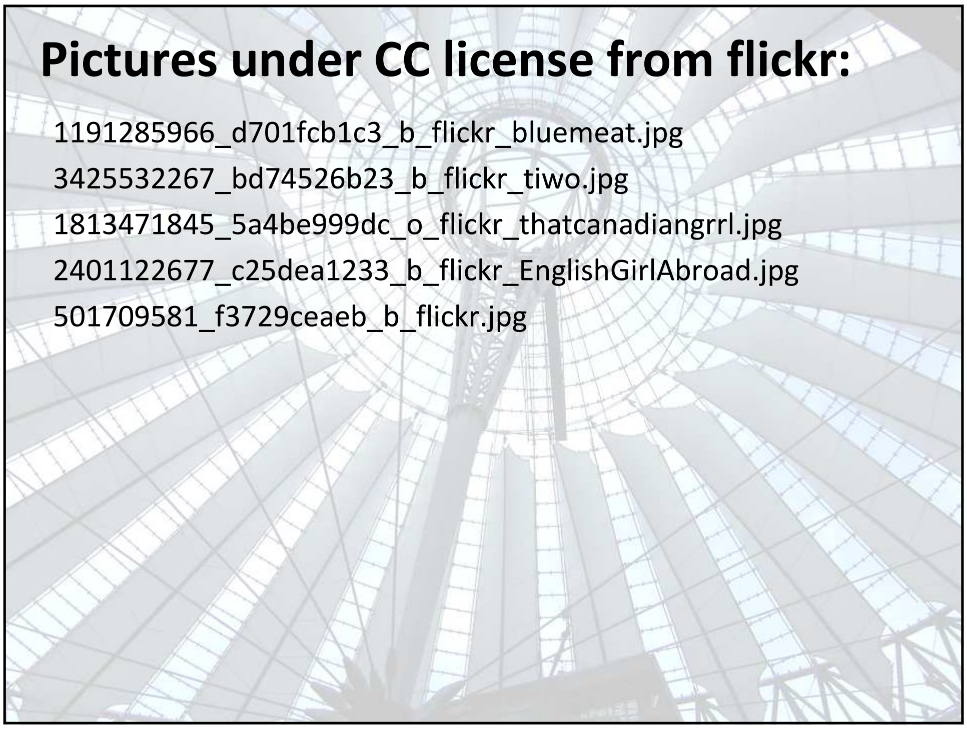
☐ Show Bundle Version Numbers
☑ Show Dependency Path
● Show Smart Path
○ Show All Paths
○ Show Shortest Path

URLs, References:

http://se-radio.net/podcast/2008-10/episode-115-architecture-analysis

Thanks to:

- Headways: Structure101:
  - Ian Sutton
  - Paul Hickey
- hello2morrow: SotoArc
  - Thomas Schoen
  - Norman Wenzel
  - Heinrich Rust



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2401122677_c25dea1233_b_flickr_EnglishGirlAbroad.jpg

501709581_f3729ceaeb_b_flickr.jpg

Stop the Software Architecture Erosion

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Central Research & Development
Software-Engineering
SICK-AG Waldkirch
mailto: Bernhard.Merkle@gmail.com
Contact on linkedin.com or xing.com