coverity

Static Analysis Use Case

Samba and Coverity

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Scale 9x

Coverity Scan

- Launched, March 2006
- DHS sponsored “Open Source Hardening Project”
  - 2006-2009
- Using Coverity’s commercial static analysis product to identify bugs at the source code level
- 35 open source projects on day one
- Since grown to 300+ projects
- Over 15,000 bugs fixed

Evaluating Effectiveness

There is no single measure of the effectiveness of a tool on the software development process.

Evaluating Effectiveness

Since we can never run the same development effort twice, with identical teams, portions of this evaluation are highly subjective.

Evaluating Effectiveness

- Objective measures
  - Static Analysis produced defect counts
  - Numbers of Bug Reports
  - Defects confirmed as ‘real’ by the developers

- Subjective measures
  - Anecdotal comments by developers
  - Community feedback
  - ‘Support Load’ reduction

Objective measures

- Static Analysis produced defect counts
  - Good objective measure
    - Reproducible
    - Consistent
    - Low effort to collect
    - Automatable
    - “Static Analysis Tools as Early Indicators of Pre-Release Defect Density” - Microsoft Research Paper

Objective measures

- Numbers of Bug Reports
  - Potentially useful if all other factors are controlled
  - Not the case in our example
    - Multiple development branches
    - Concurrent new development during defect resolution
    - Userbase changes over time
    - Platform support changes over time

Objective measures

- Defects confirmed as ‘real’ by the developers
  - A high False Positive rate would bring the defect count metric into question
  - Would also affect future developer trust in the analysis tool

Subjective measures

- Anecdotal comments by developers
  - Informative, but not comparable between projects
- Community feedback
  - Dependent on the nature of each project’s community

Subjective measures

- ‘Support Load’ reduction
  - Difficult to quantify in an open source environment, due to the variety of support channels

Your Measures?

As in most engineering problems…

What do you want to minimize?

- Immediate Cost
- Long Term Cost
- Time
- Manpower
- Ongoing Support

Use Case – Samba & Coverity

coverity

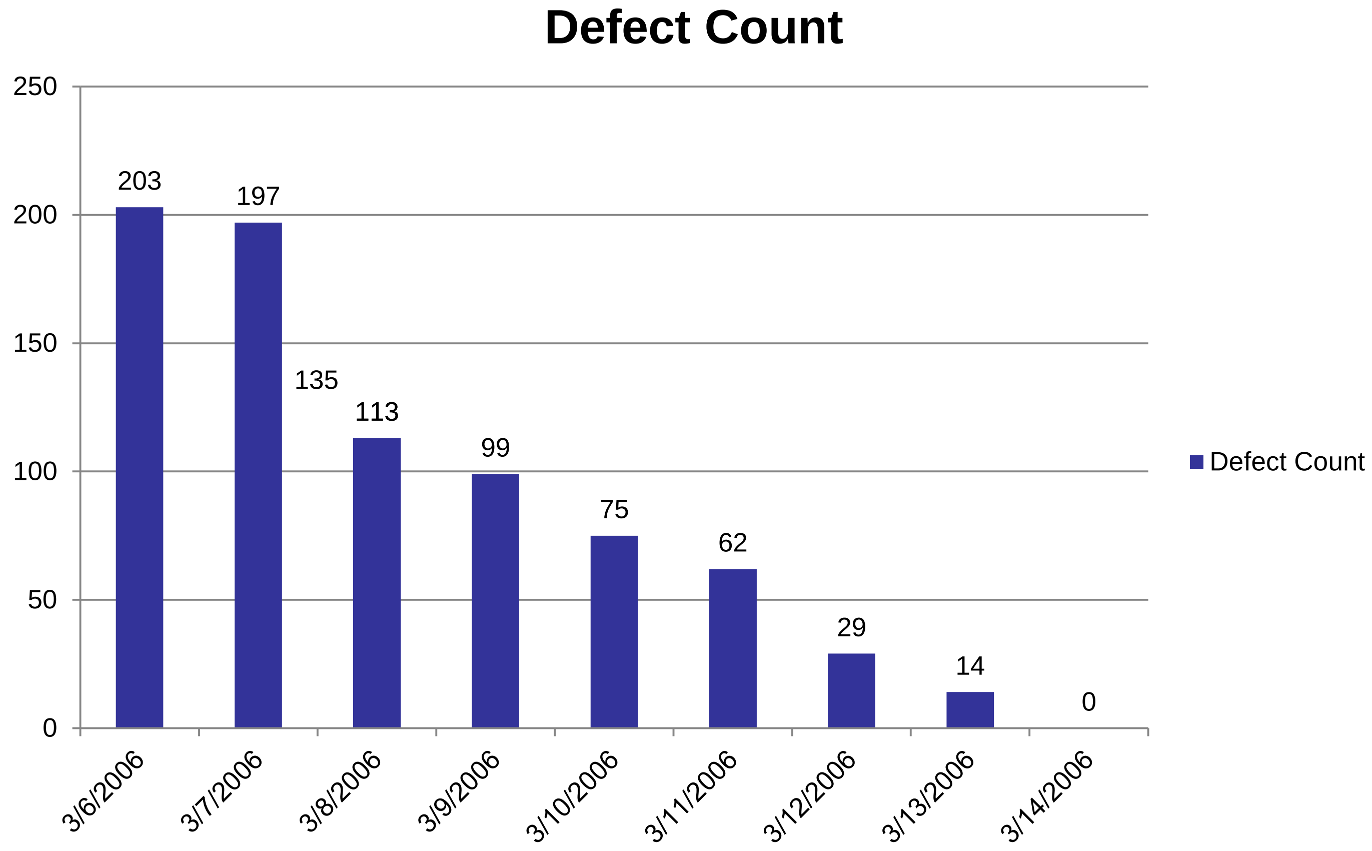
- Samba
  - Open source networking suite
  - Provides Microsoft protocol compatibility
  - International team, started in Australia
  - Project founded in 1992
  - ~300KLOC -> 850KLOC   2006-now

Use Case – Samba & Coverity

- Started regular scanning March 2006
- 14 Developers accessing the results
- Database available 24/7, SAAS
- New analysis every 2 days on average
  - (797 builds in database)

Use Case – Samba & Coverity

- Static Analysis defect counts, 310KLOC



Use Case – Samba & Coverity

Day 1: Fixed

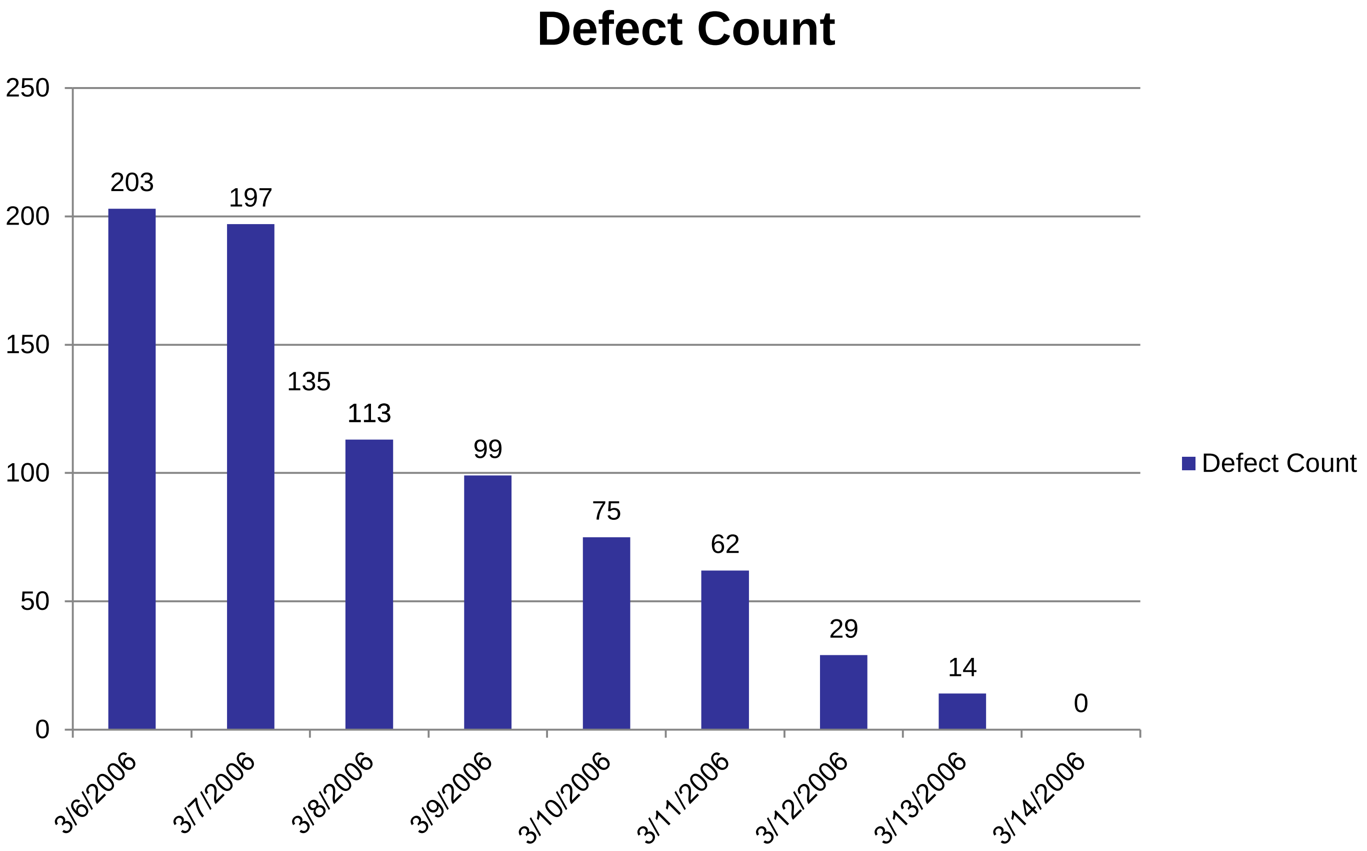
4 NULL Pointer derefs

10 Resource leaks

1 Uninitialized data

31 Use after free

But – other changes
that day introduced
new defects



Use Case – Samba & Coverity

Day 2: Fixed

15 NULL Pointer derefs

4 Resource leaks

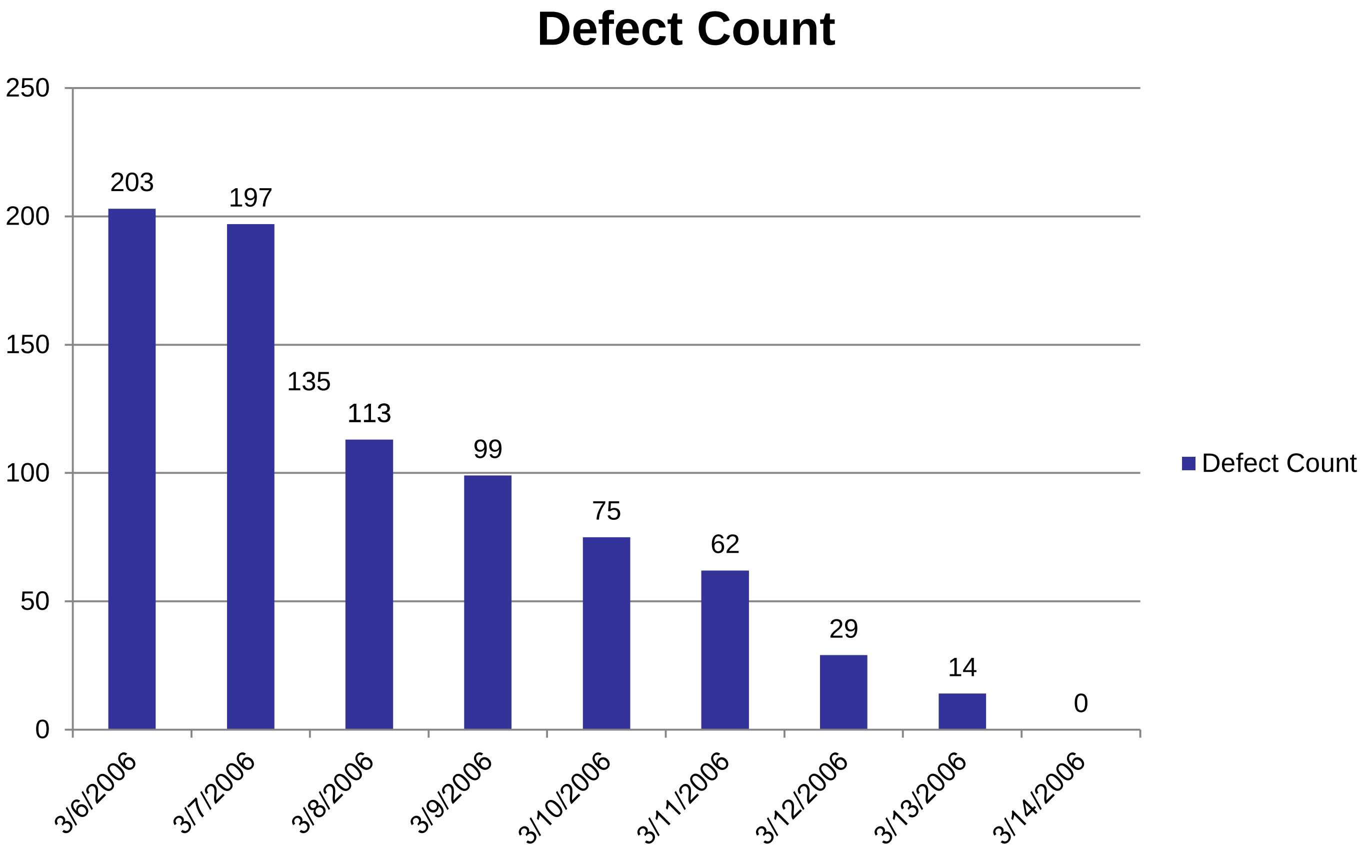
1 static buffer overrun

53 Use after free

3 returned NULL

2 bad comparison

1 Dead code



Use Case – Samba & Coverity

```
if (!brl_lock) {
                return False;
}
```

Use Case – Samba & Coverity

Event **func_conv**: Suspicious implicit conversion to function pointer:

"&brl_lock == 0";

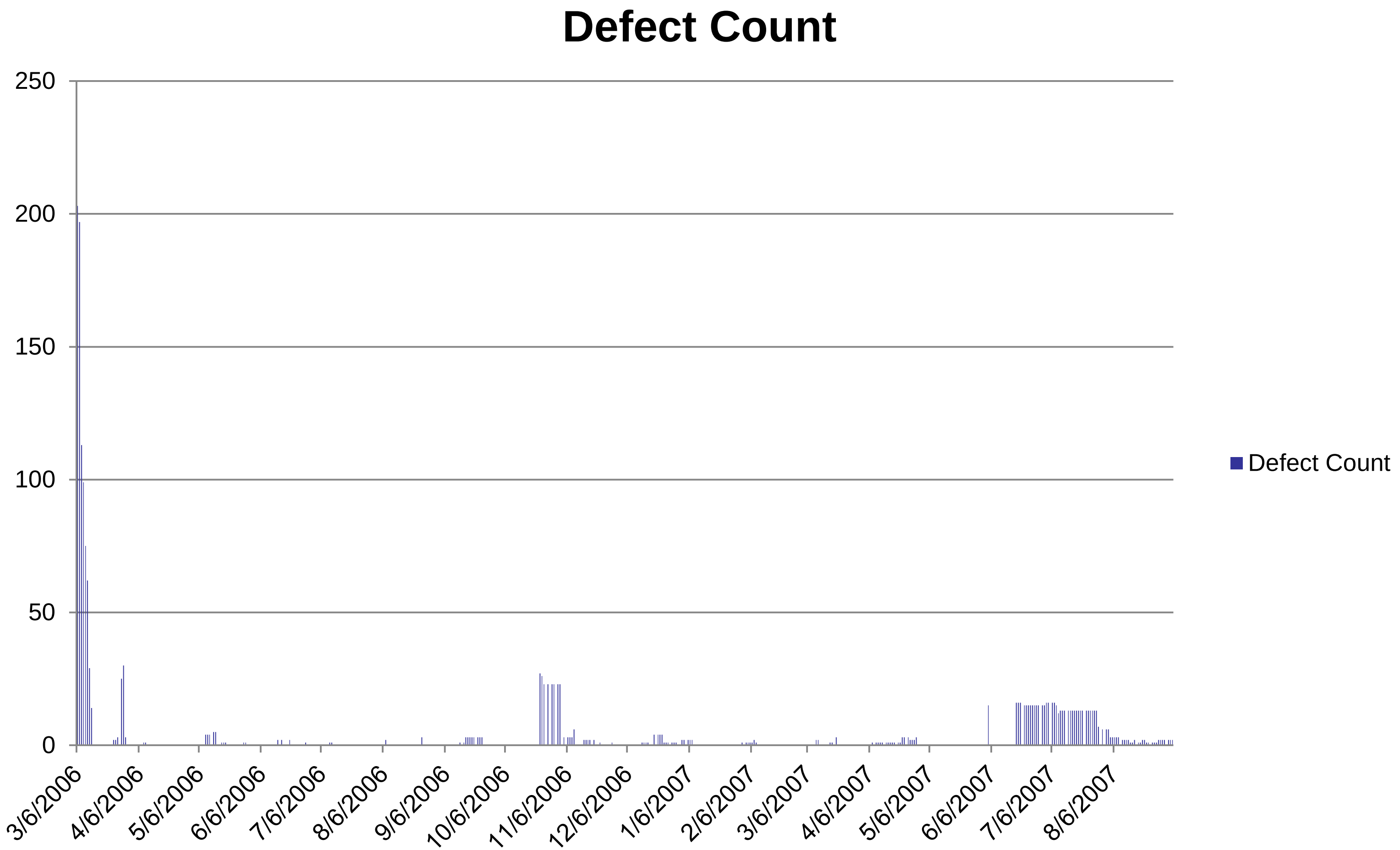
did you intend to call the function?

```
if (!brl_lock) {
        return False;
}
```

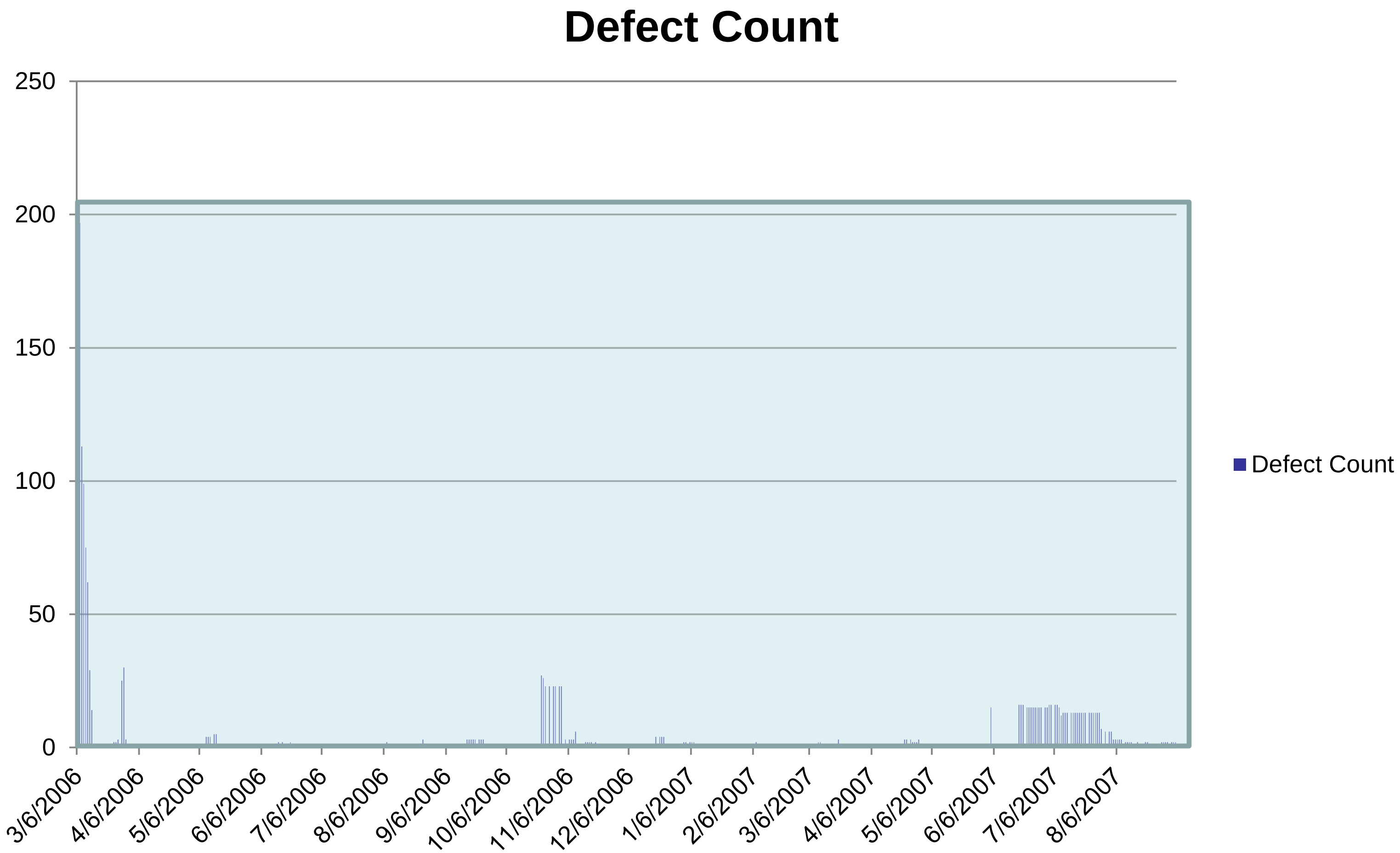
Use Case – Samba & Coverity

```
/***************************************************************************************
Lock a range of bytes.
***************************************************************************************/

NTSTATUS brl_lock(struct byte_range_lock *br_lck,
                  uint16 smbpid,
                  struct process_id pid,
                  br_off start,
                  br_off size,
                  enum brl_type lock_type,
                  enum brl_flavour lock_flav,
                  BOOL *my_lock_ctx)
{
        NTSTATUS ret;
        struct lock_struct lock;

        *my_lock_ctx = False;
```

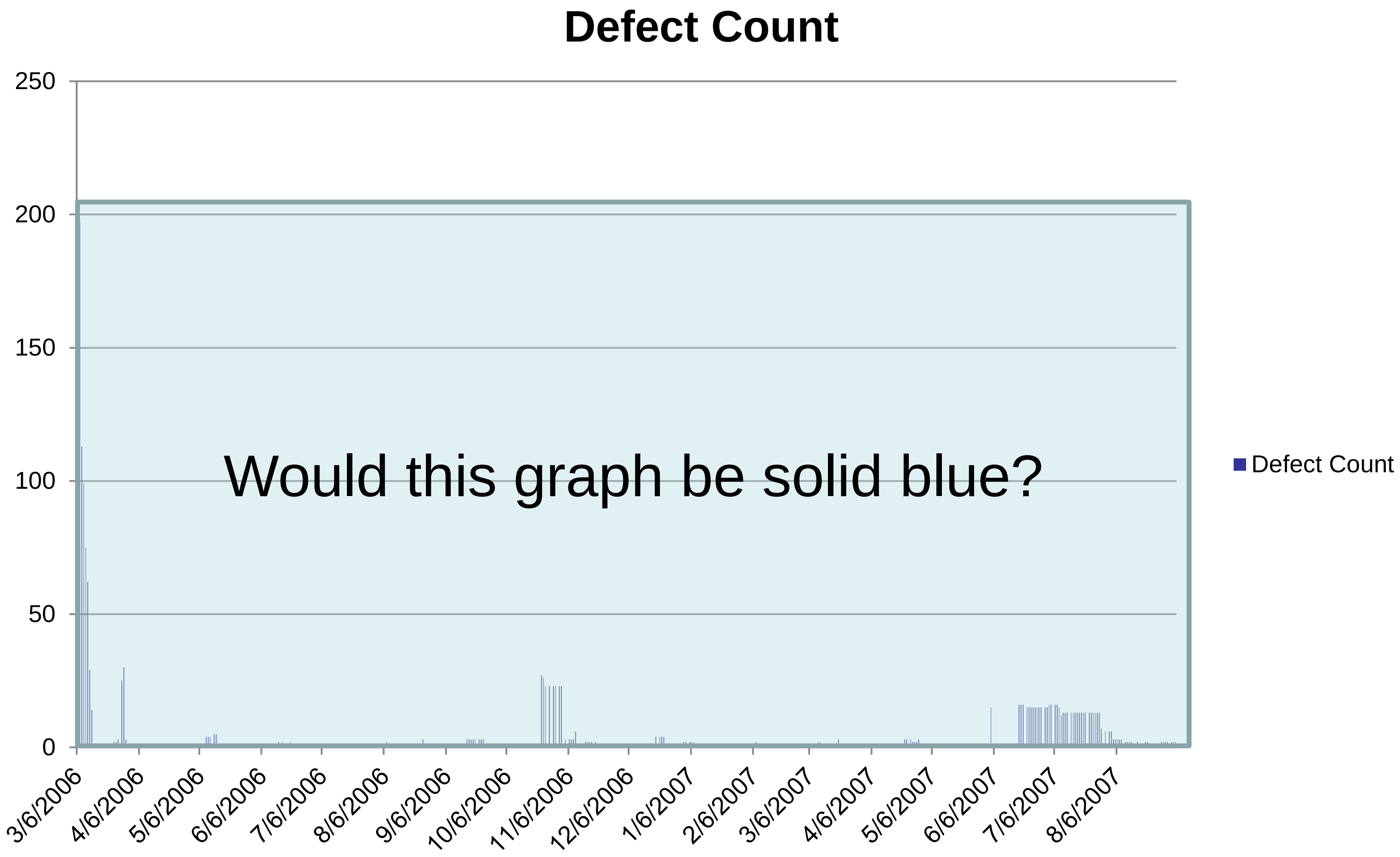
Use Case – Samba & Coverity



Use Case – Samba & Coverity

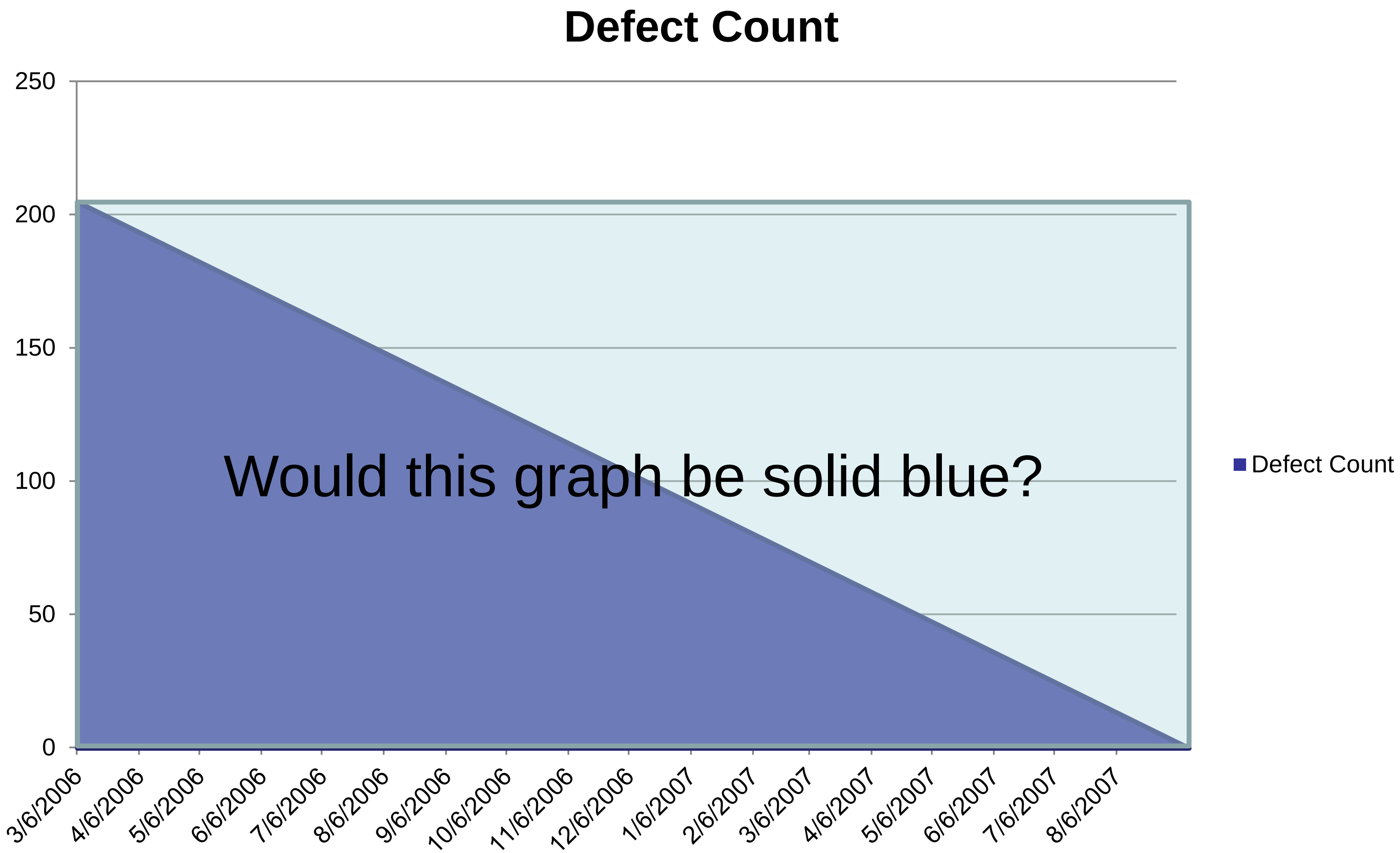


Use Case – Samba & Coverity



Would this graph be solid blue?

Use Case – Samba & Coverity



Would this graph be solid blue?

Use Case – Samba & Coverity

- Defects confirmed as ‘real’ by the developers

13 defects marked False Positive

216 total defects

13 / 216 = 6%

Use Case – Samba & Coverity

- Subjective measures
  - Anecdotal comments by developers

“This tool has become part of our process”

Use Case – Samba & Coverity

“Using […] source code analysis technology is like having a developer on the team with an inhuman attention to detail, who points out all the corner cases and boundary conditions developers didn’t consider when they first wrote the code.”

Use Case – Samba & Coverity

“I code more carefully, because I know my laziness will be caught and embarrass me.”

Use Case – Samba & Coverity

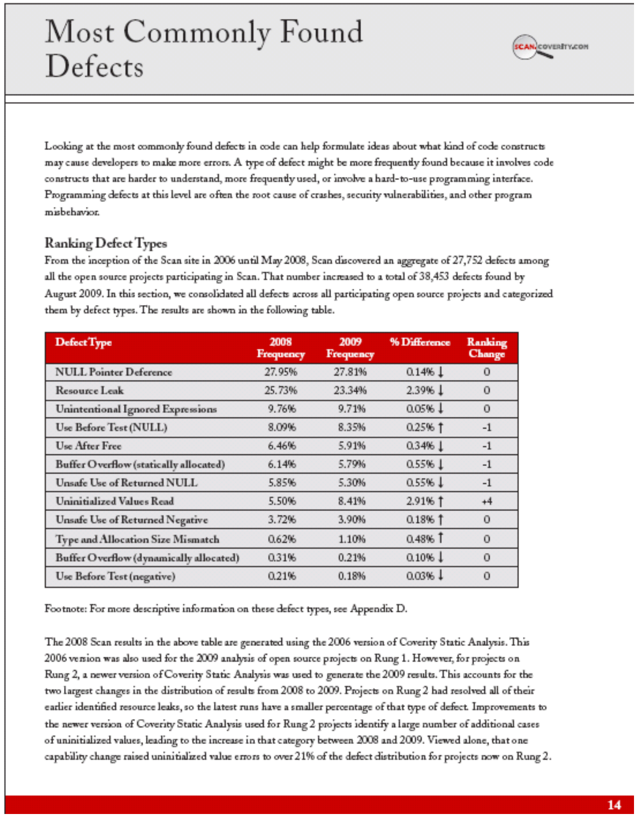
- Community feedback

Use Case – Samba & Coverity

- Community feedback
  - Invited to give opening keynote at annual Samba conference in 2009

Open Source Reports

- Whitepaper series - http://scan.coverity.com/report/
  - Open Source Report 2008
  - Open Source Report 2009
  - Open Source Report 2010 (Android & Supply Chain)



Most Commonly Found Defects

Looking at the most commonly found defects in code can help formulate ideas about what kind of code constructs may cause developers to make more errors. A type of defect might be more frequently found because it involves code constructs that are harder to understand, more frequently used, or involve a hard-to-use programming interface. Programming defects at this level are often the root cause of crashes, security vulnerabilities, and other program misbehavior.

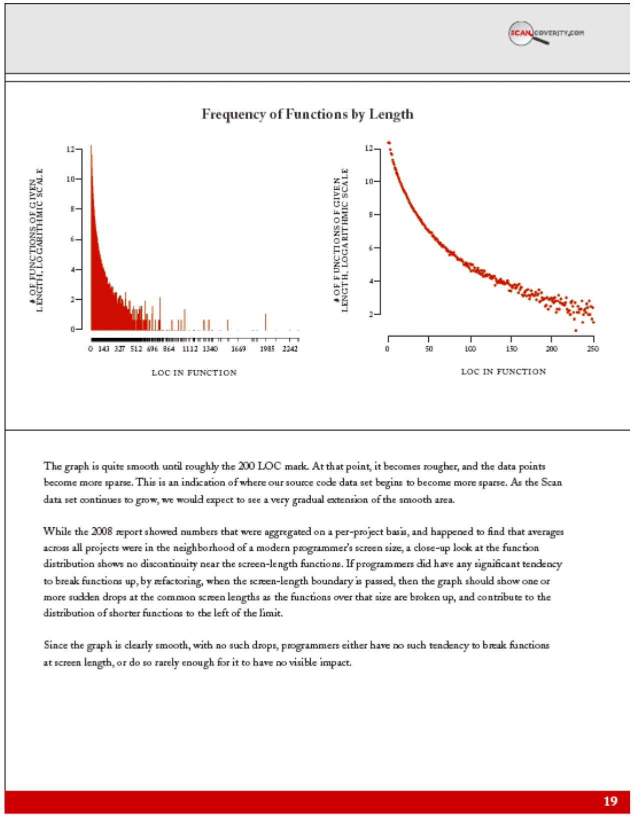
Ranking Defect Types

From the inception of the Scan site in 2006 until May 2008, Scan discovered an aggregate of 27,752 defects among all the open source projects participating in Scan. That number increased to a total of 38,453 defects found by August 2009. In this section, we consolidated all defects across all participating open source projects and categorized them by defect types. The results are shown in the following table.

Defect Type	2008 Frequency	2009 Frequency	% Difference	Ranking Change
NULL Pointer Deference	27.95%	27.81%	0.14% ↓	0
Resource Leak	25.73%	23.34%	2.39% ↓	0
Unintentional Ignored Expressions	9.76%	9.71%	0.05% ↓	0
Use Before Test (NULL)	8.09%	8.35%	0.25% ↑	-1
Use After Free	6.46%	5.91%	0.34% ↓	-1
Buffer Overflow (statically allocated)	6.14%	5.79%	0.55% ↓	-1
Unsafe Use of Returned NULL	5.85%	5.30%	0.55% ↓	-1
Uninitialized Values Read	5.50%	8.41%	2.91% ↑	+4
Unsafe Use of Returned Negative	3.72%	3.90%	0.18% ↑	0
Type and Allocation Size Mismatch	0.62%	1.10%	0.48% ↑	0
Buffer Overflow (dynamically allocated)	0.31%	0.21%	0.10% ↓	0
Use Before Test (negative)	0.21%	0.18%	0.03% ↓	0

Footnote: For more descriptive information on these defect types, see Appendix D.

The 2008 Scan results in the above table are generated using the 2006 version of Coverity Static Analysis. This 2006 version was also used for the 2009 analysis of open source projects on Rung 1. However, for projects on Rung 2, a newer version of Coverity Static Analysis was used to generate the 2009 results. This accounts for the two largest changes in the distribution of results from 2008 to 2009. Projects on Rung 2 had resolved all of their earlier identified resource leaks, so the latest runs have a smaller percentage of that type of defect. Improvements to the newer version of Coverity Static Analysis used for Rung 2 projects identify a large number of additional cases of uninitialized values, leading to the increase in that category between 2008 and 2009. Viewed alone, that one capability change raised uninitialized value errors to over 21% of the defect distribution for projects now on Rung 2.



Frequency of Functions by Length

# OF FUNCTIONS OF GIVEN LENGTH, LOGARITHMIC SCALE
12
10
8
6
4
2
0
0
143
327
512
696
864
1112
1340
1669
1985
2242
LOC IN FUNCTION
# OF FUNCTIONS OF GIVEN LENGTH, LOGARITHMIC SCALE
12
10
8
6
4
2
0
50
100
150
200
250
LOC IN FUNCTION

The graph is quite smooth until roughly the 200 LOC mark. At that point, it becomes rougher, and the data points become more sparse. This is an indication of where our source code data set begins to become more sparse. As the Scan data set continues to grow, we would expect to see a very gradual extension of the smooth area.

While the 2008 report showed numbers that were aggregated on a per-project basis, and happened to find that averages across all projects were in the neighborhood of a modern programmer's screen size, a close-up look at the function distribution shows no discontinuity near the screen-length functions. If programmers did have any significant tendency to break functions up, by refactoring, when the screen-length boundary is passed, then the graph should show one or more sudden drops at the common screen lengths as the functions over that size are broken up, and contribute to the distribution of shorter functions to the left of the limit.

Since the graph is clearly smooth, with no such drops, programmers either have no such tendency to break functions at screen length, or do so rarely enough for it to have no visible impact.

Q & A

- Questions?