A Field Study of Refactoring Benefits and Challenges

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Contradicting Beliefs on Refactoring Benefits

- Refactoring improves **software quality** and **maintainability**
- A lack of refactoring incurs **technical debt**

VS.

- Refactorings do not provide immediate benefits unlike bug fixes and new features

Conflicting Evidences on Refactoring Benefits

- **Bug fix time decreases** after refactoring **[Carriere et al.]**
- **Defect density decreases** after refactoring **[Ratzinger et al.]**

VS.

- Inconsistent refactorings **cause bugs** **[Görg and Weißgerber, Kim et al.]**
- Code **churns** are correlated with defect density **[Nagappan & Ball]**

Key Findings

- Refactoring is not confined to behavior preserving transformation.
- Developers perceive that refactoring involves **substantial cost** and **risk**.
- Refactored modules experienced significant reduction in inter-module **dependencies** and post-release **defects**.

Outline

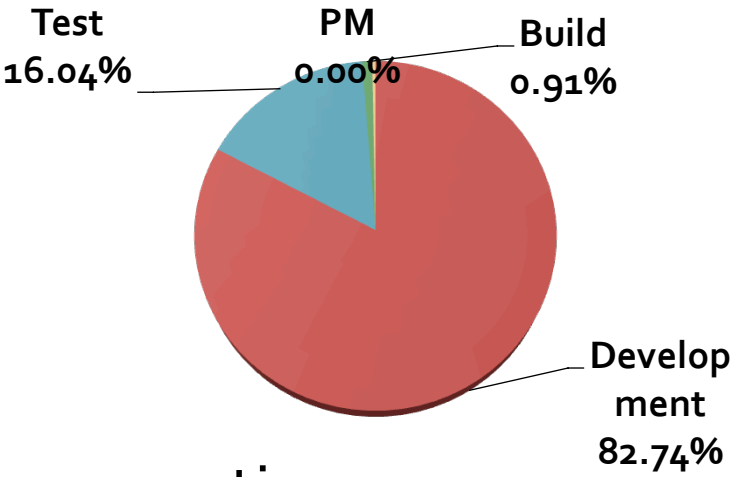
A Survey of Refactoring Practices

Interviews with Windows Refactoring Team

Quantitative Analysis of Windows 7 Version History

Survey Participants

- Target: 1290 engineers whose check-in comments include a keyword '**refactor***' in the last 2 years
  - Windows, exchange, ocs, office, Win7mobile,
- Participants: 328 engineers
  - 6.35 years at MS
  - 9.74 years in software industry



- 22 multiple choice and free form questions

Finding 1. Refactoring is not confined to behavior-preserving transformations

- 46% did **not** mention preservation of behavior, semantics, or functionality
- 78% define refactoring improves *some aspects of program behavior*
- 71% said basic refactorings are often **a part of larger, architecture level effort**

Finding 2. Engineers face various challenges of doing refactoring

- 29% pointed out a lack of support for refactoring integration, code reviews targeting refactoring edits, and custom refactoring engine.

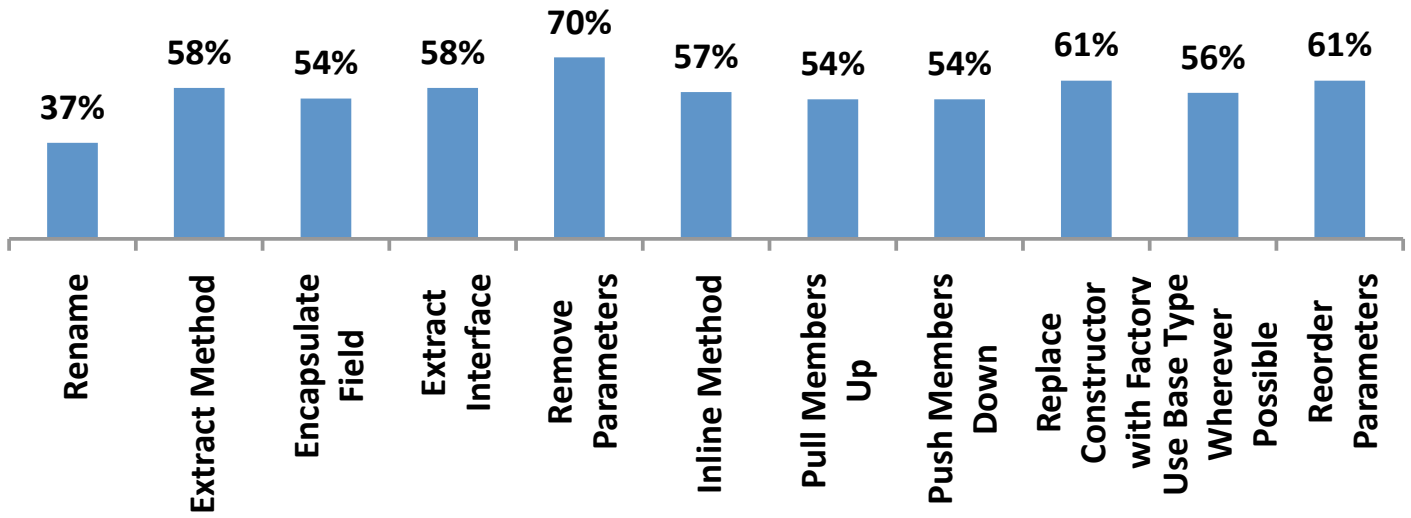
  "Cross-branch integration was the biggest problem."

  "Refactoring typically increases the number of lines involved in a check-in. That burdens code reviewers."

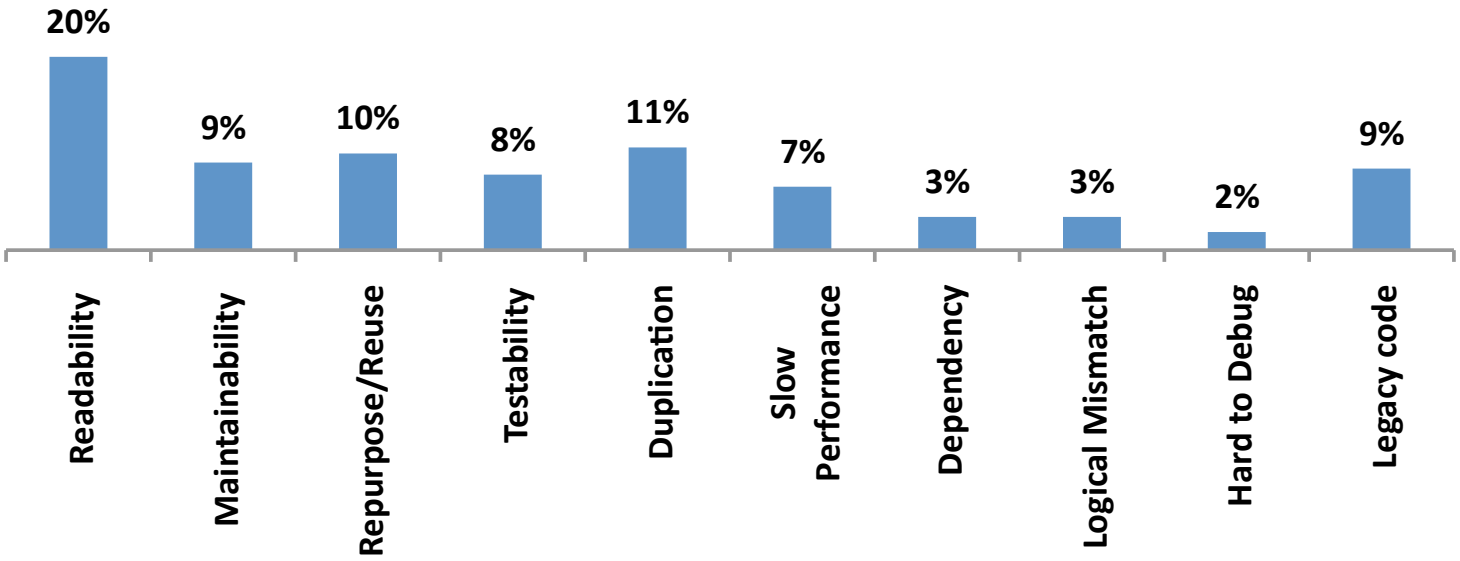
- When a regression test suite is inadequate, there is no safety net for checking the correctness of refactoring.

Finding 3. Refactoring engines are not used much

- Developers do 86% of refactorings manually, despite awareness of automated tools.



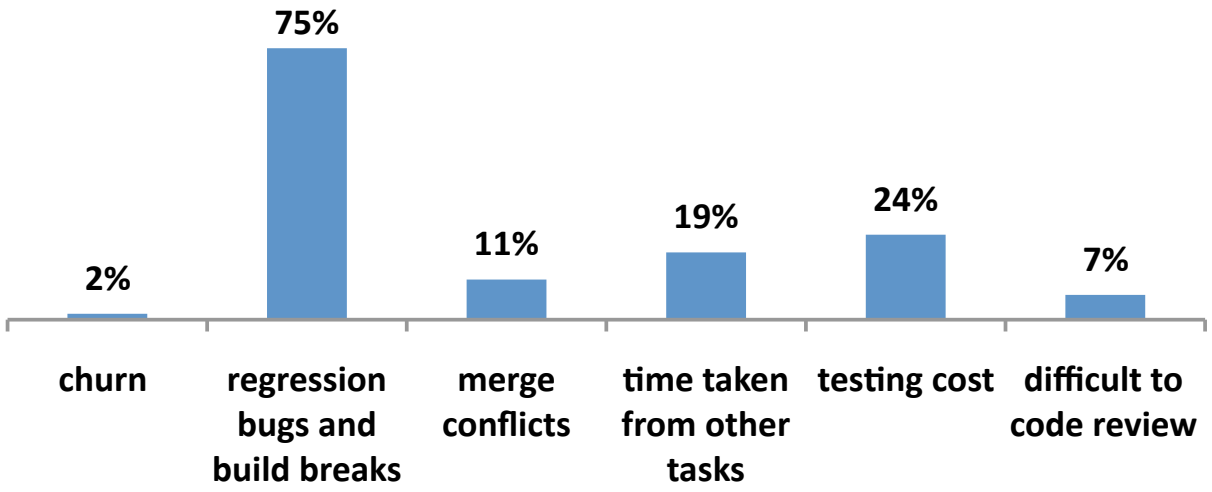
Finding 4. Refactoring is driven by immediate, concrete needs.



- **46%** refactor code as a part of bug fixes and feature additions.
- **More than 95%** of developers refactor code across all milestones not only in quality milestones (MQ).

Finding 5. Refactoring involves substantial cost and risks

- 75% perceive that refactoring has a risk of functionality regression and **bugs**.



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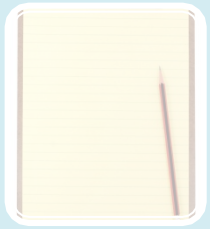

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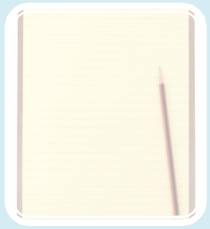
Details on Interviewees

- Architect (90 mins)
- Architect / Dev Manager (30 mins)
- Dev Team Lead (75 mins)
- Dev Team Lead (85 mins)
- Developer (75 mins)
- Researcher (60 mins)

Refactoring of Windows

- A **designated team** initiated refactoring effort to improve **modularity** and **parallel development efficiency**
- Driven by foresights to repurpose Windows to **target different execution environments**
- Conducted analysis of de-facto dependency structure and created a **"layer map"**
- Developed **custom tools** and **processes** such as MaX and "quality gate check" **[Srivastava et al.]**

Outline



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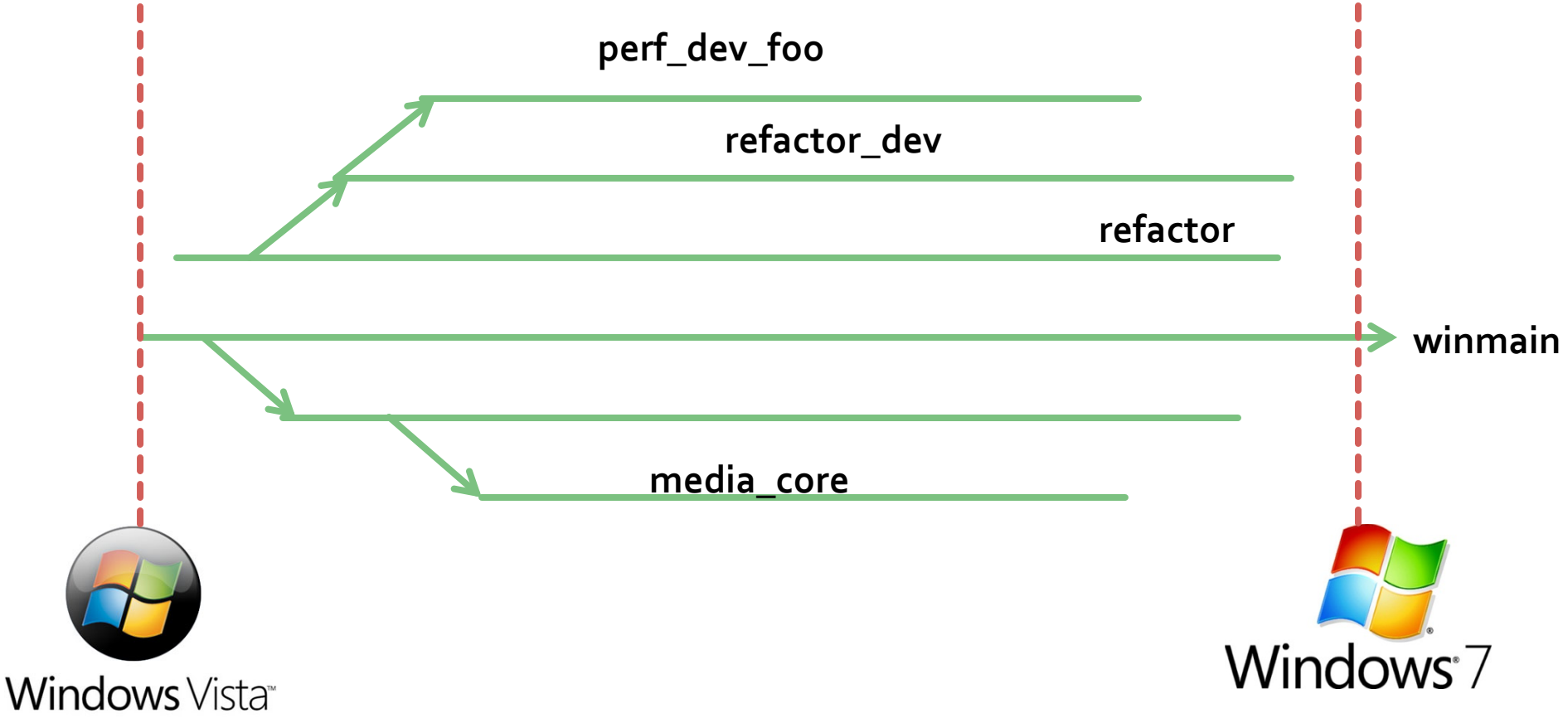
Research Questions

- Q1: Where was Windows 7 refactoring effort focused on?
- Q2: Did refactoring reduce binary-level **dependencies**?
- Q3: Are refactored binaries more **defect-prone** than non-refactored binaries?
- Q4: Did refactoring reduce **post-release defects**?

Windows 7 Refactoring Study Method



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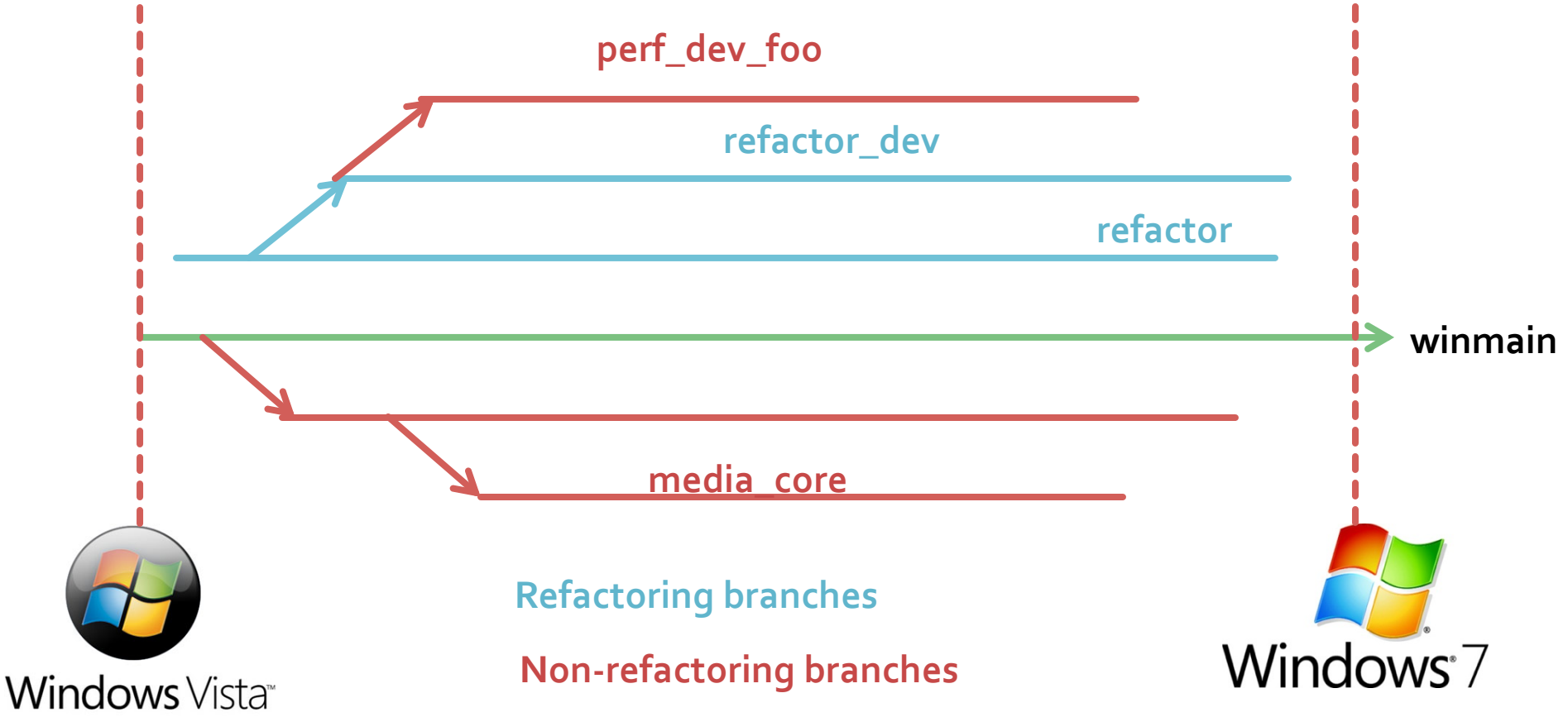
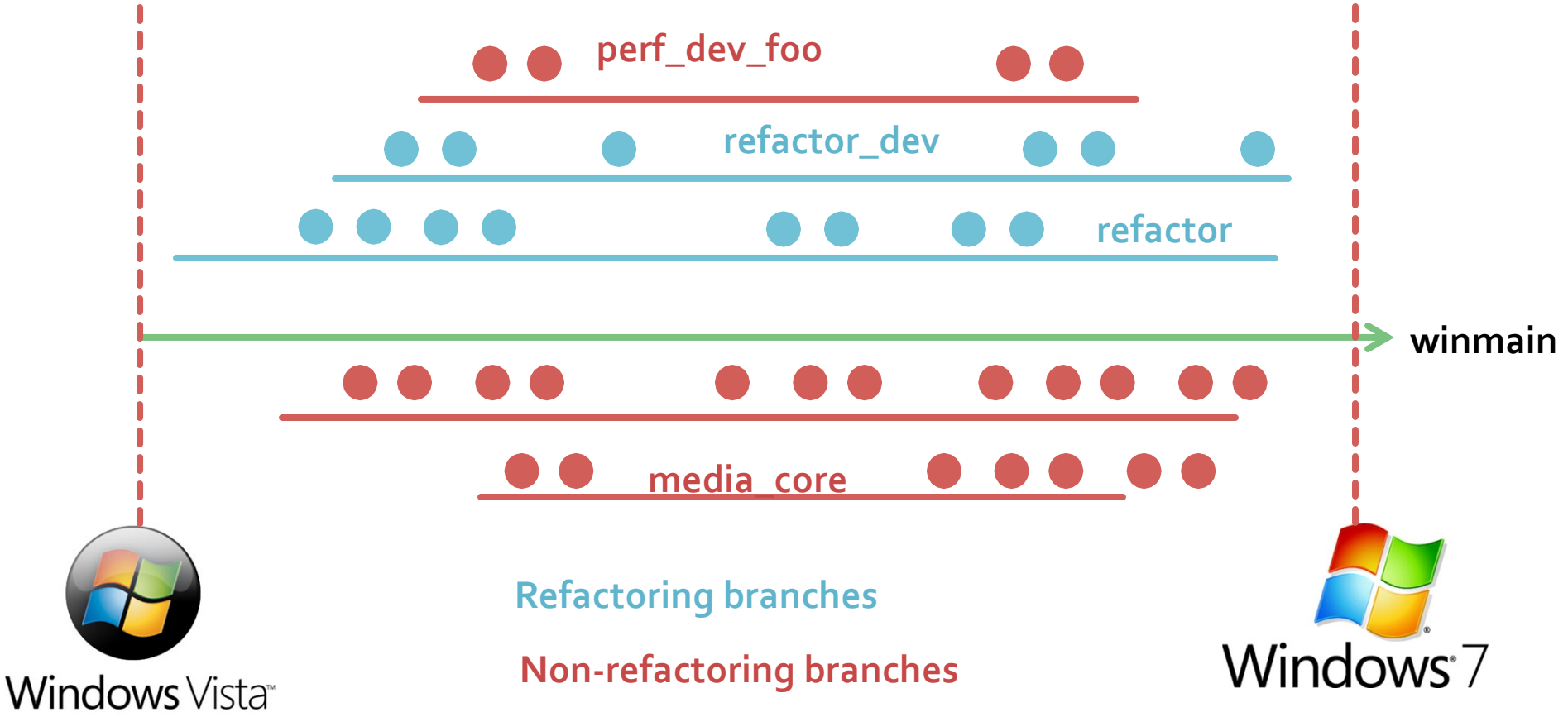


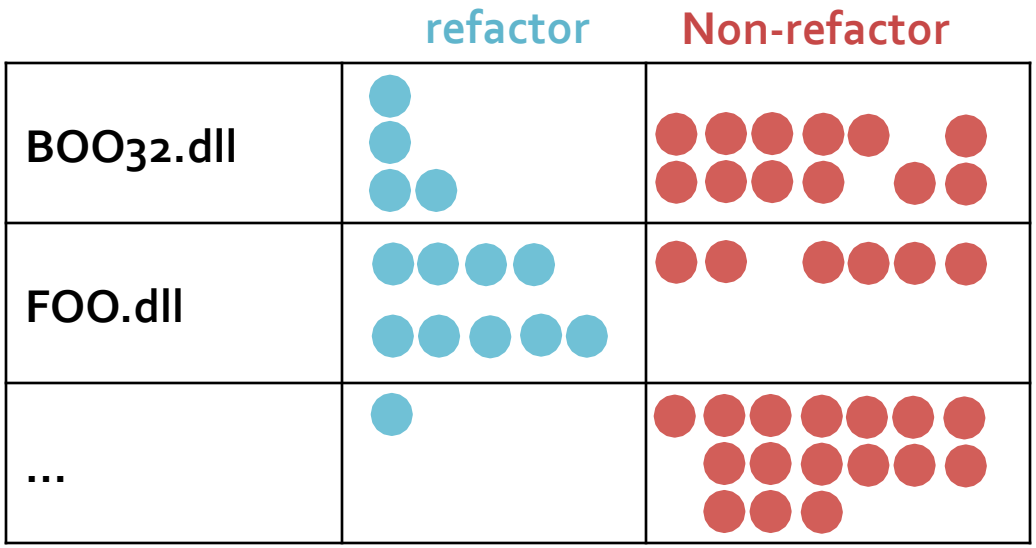
Identified branches where the refactoring team made frequent commits
The refactoring team confirmed refactoring branches

Windows 7 Refactoring Study Method



Categorize all Windows 7 commits into refactorings vs. non-refactorings

Windows 7 Refactoring Study Method

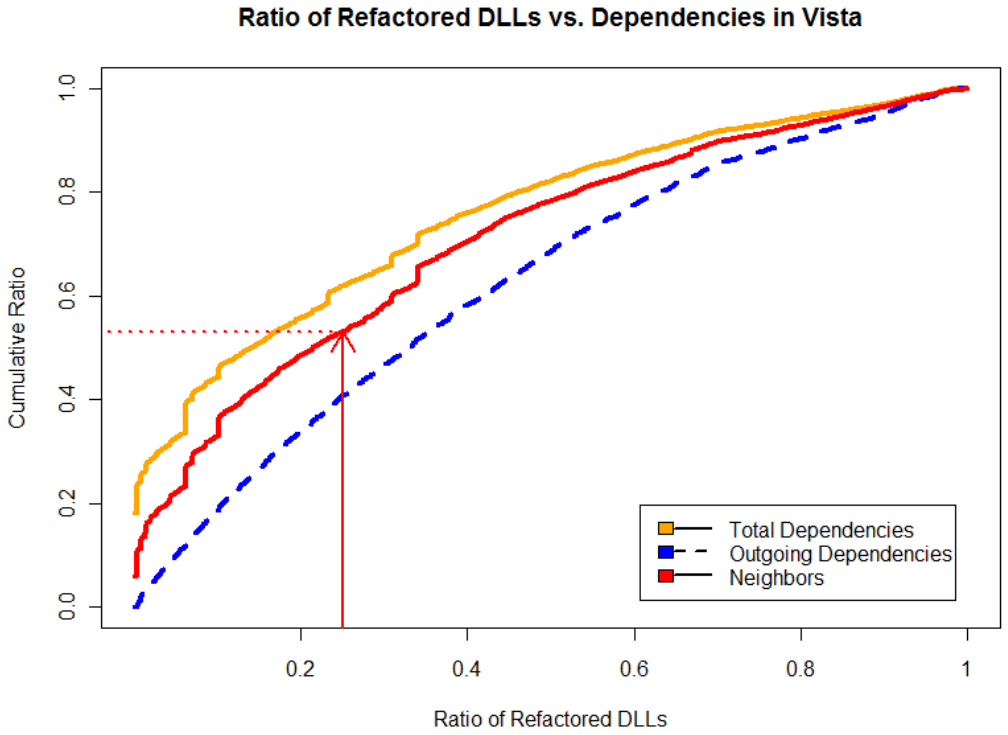


Map commits to DLLs (binary modules)

Windows 7 Refactoring Changes

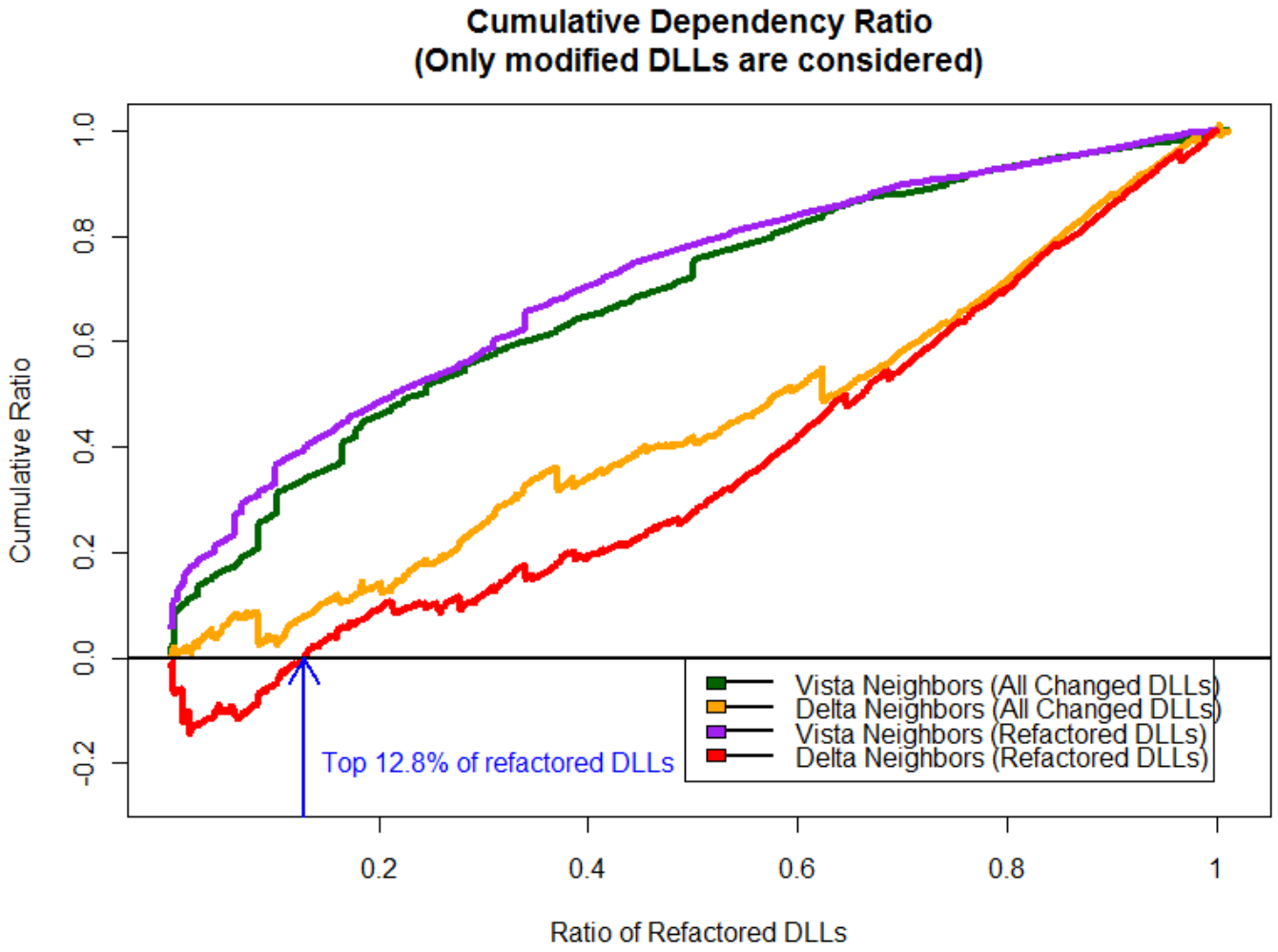
Granularity	Refactor Branches	Non Refactor Branches
Commits	1.27%	98.73%
Authors	2.04%	99.84%
Binary Modules	94.64%	99.05%

Q1. Where was the refactoring effort focused on?

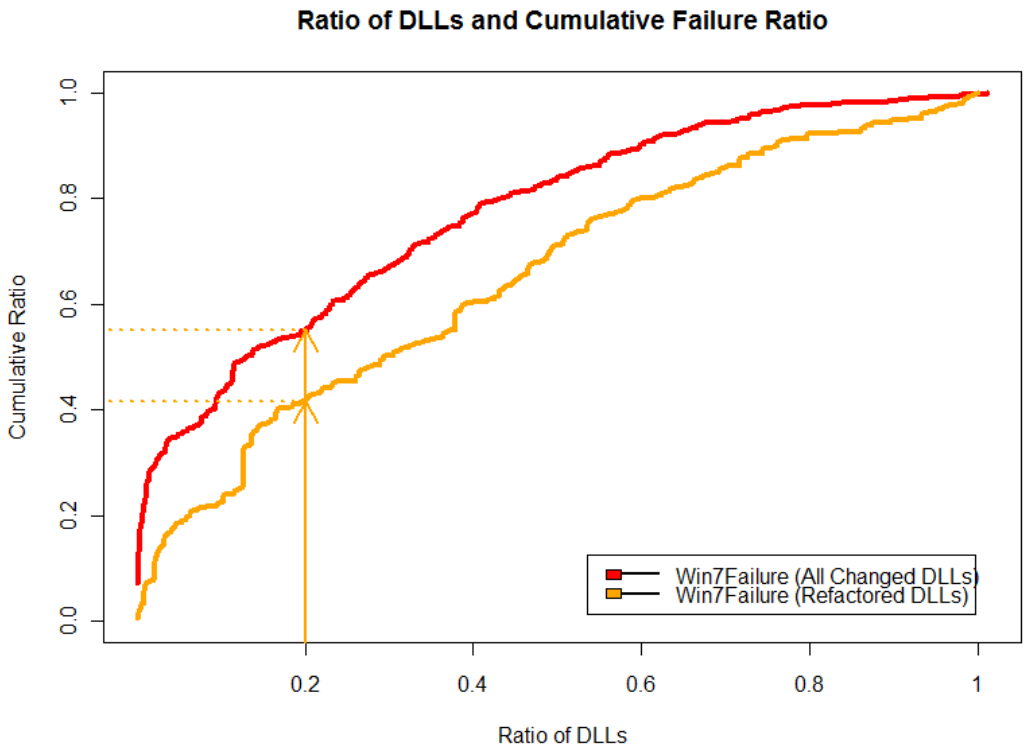


Top 25% of most frequently refactored DLLs cover 53% of all neighboring dependency counts in Vista for modified DLLs.

Q2. Did refactoring reduce binary-level dependencies?

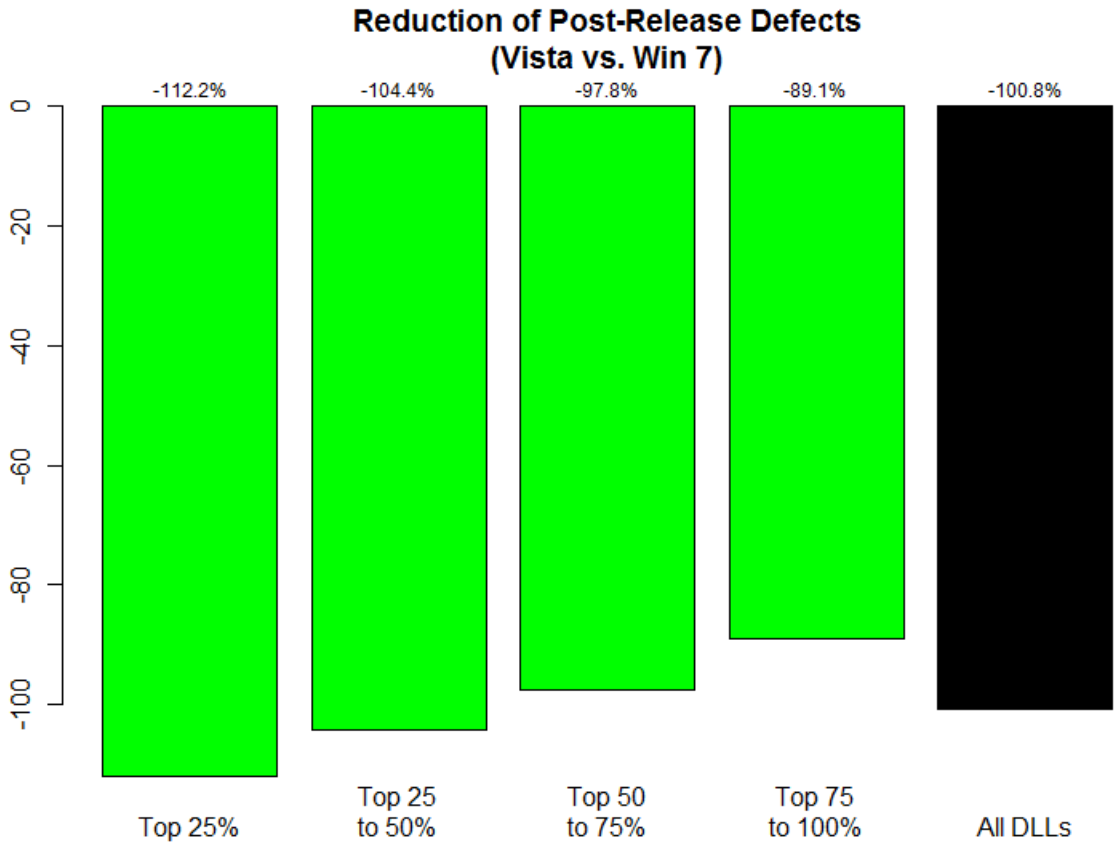


Q3. Are refactored binaries more likely defect-prone than non-refactored binaries?



No, Top 20% of most frequently refactored DLLs are responsible for 42 % of all Win 7 post release defects, while top 20% of most modified DLLs are responsible for 55%.

Q4. Did refactoring reduce post release defects more?



Summary

- We present a **three-pronged view** of refactoring in a **large company** through a survey, interviews, and version history analysis.
- The **definition** of refactoring in practice is broader than behavior-preserving program transformations.
- Developers perceive that refactoring involves **substantial cost and risks**.
- Developers need various types of tool support **beyond automated refactoring** within IDEs.

Summary

- **Centralized, system-wide refactoring** was facilitated by custom tools and processes such as MaX and quality gate check.
- Refactored modules experienced higher reduction in the number of **inter-module dependencies** and **post-release defects** than other changed modules.

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