# Manual vs. Automated Vulnerability Assessment: A Case Study

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# Study Motivation

## How should we view static analysis tools?

- Literature on static analysis tools, papers are almost self limiting:
  - missing is comparison against security as a whole
  - Very hard to look beyond the immediate techniques and say what they are not finding
  - tool writers write about what they have found
- Every valid new thing tools find is progress, but it’s easy to lose perspective on what these tools are not able to do
- Good science and engineering quantifies and verifies limitations instead of just stating them

# Our Work

- We have a strong manual assessment protocol
- Applied it to several significant projects:

**Condor**

University of Wisconsin

Batch queuing workload management system

**SRB**

SDSC

Storage Resource Broker - data grid

**MyProxy**

NCSA

Credential Management System

**glExec** (in progress)

NIKHEF

Identity mapping service

# Our Work (cont.)

**Technique has been extremely successful**

- found critical problems
- helped groups redesign software
- changed their development practices and release cycle management

# First Principles Vulnerability Assessment (FPVA)

- Insider - have access to
  - developers
  - source code
  - documentation
- Independent from development team
  - no agenda
  - no blinders
- First Principles - let the process guide where to look

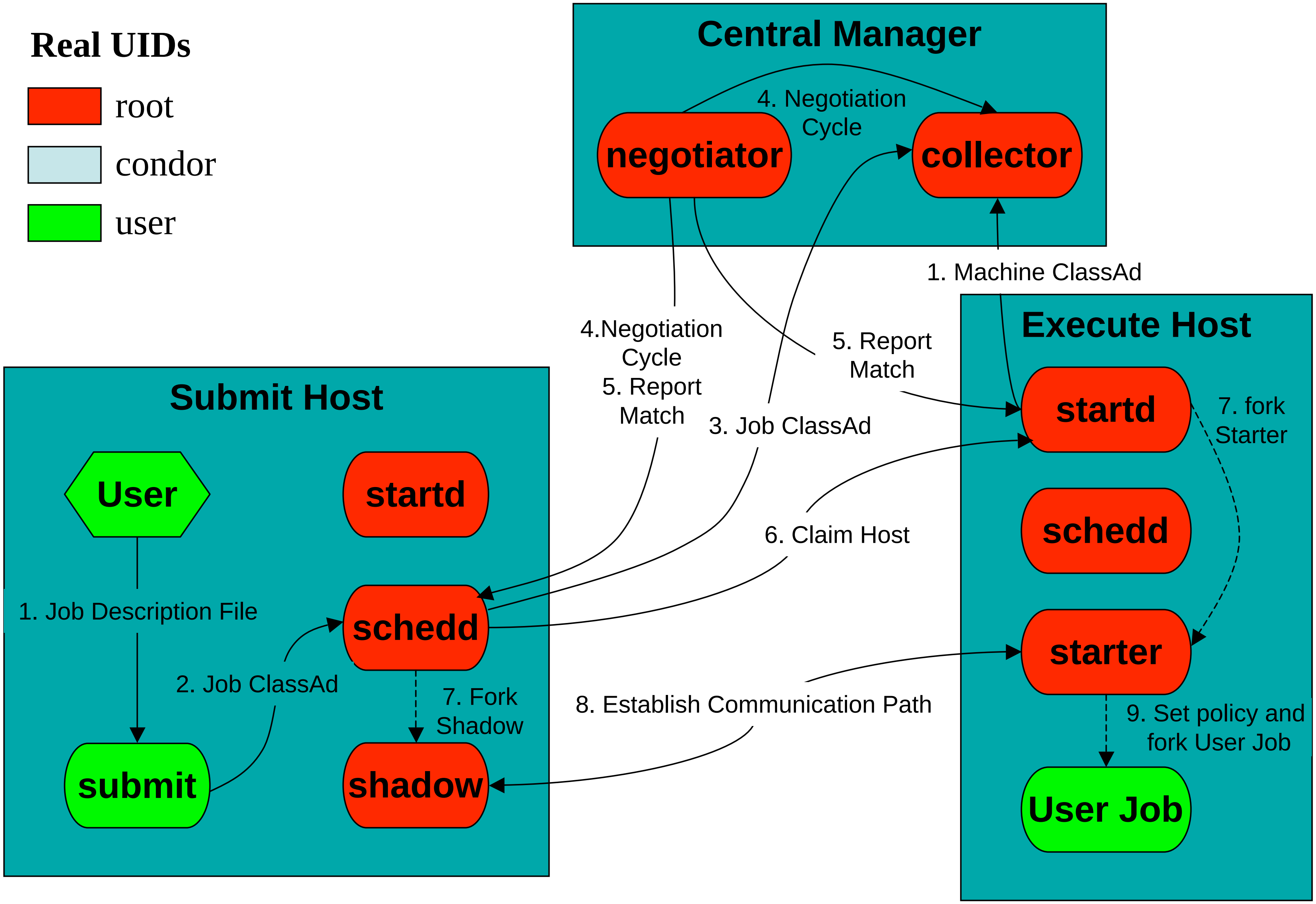
# FPVA
## Understanding the System

Architectural Analysis - functionality and structure of the system, major components, communication channels

Resource Analysis - objects in the system and operations allowed

Trust & Privilege Analysis - trust boundaries of components, privilege presented to users, and external privilege model used components

# Condor Data Flow Diagram



# FPVA - Component Analysis
## Search for Vulnerabilities

- Connect user supplied data to security violation
- Audit source code
- Guide search using
  - previous analyses results and diagrams
  - knowledge of vulnerabilities

# FPVA Condor Results

## 15 significant vulnerabilities discovered

`http://www.cs.wisc.edu/condor/security/vulnerabilities`

- 7 implementation bugs
  - easy to discover - localized in code
  - use of troublesome functions:
    `exec`, `popen`, `system`, `strcpy`, `tmpnam`
- 8 design flaws
  - hard to discover in code - higher order problems
  - defects include:
    - injections, directory traversals, file permissions, authorization & authentication, and a vulnerability in third party library

# Case Study

- Condor 6.7.12
  - 15 discovered vulnerabilities present
  - small changes to build with newer compiler
- Talked to academics, military, and industry people about what they thought were the best tools: Coverity and Fortify
- Analyze Condor 6.7.12 with tools
  - Coverity Prevent 4.1.0
  - Fortify SCA 5.1.0016
- Review tool output
  - defect with matching location of known vulnerability is a positive result
  - sample tool output to understand results

# Using the Tools

**Three step process:**

1. **Collect Build Information**
   - easy, no modification to build process
   - tool monitors complete build of project
2. **Run Analysis Phase**
   - uses build information
3. **View Results**
   - categorized by type, location, …
   - presents evidence of defect - what, where, how
   - source code browser
   - defect management capabilities

# Tool Result Summary

| | Coverity | Fortify | |
|---|---|---|---|
| Defects Found: | 2,986 | 15,466 | total |
| | | 3 | critical |
| | | 2301 | hot |
| | | 8101 | warm |
| | | 5061 | info |
| Defect Categories: | 70 | 45 | |
| FPVA Defects Found: | 1 | 6 | total |
| | 1 | 6 | impl. bug |
| | 0 | 0 | design flaw |

# FPVA Tool Discovered Defects

- Simple implementation bugs found
  - Coverity found 1
    - errs on the side of false negatives
    - only flags certain functions when input can be proven to come from untrusted sources
  - Fortify found 6
    - errs on the side of false positives
    - will always flag certain functions
  - One defect not present on platform, neither found
- No design flaw defects found

# Other Tool Discovered Defects

- Security Issues
  - potential null pointer dereferences
  - minor resource leaks
  - no other major security issues in sample
- Correctness Issues
  - buffer overflows (small number of bytes)
  - uninitialized variables
  - failure to check errors
- Code Quality Issues
  - maintenance problems
  - future problems
- False Positives
  - also can be a code quality issue
  - can be tool misinterpreting code

# Defect Comments

- Number of defects can be overwhelming for mature projects
- Easier with new project
  - require 0 new defects
  - learn to program in tool’s style
- Requires manual inspection to determine defect’s real severity (may be faster to fix)
- Defect can easily change from one category to another as code is modified (even far away code)

# Tuning the Tools

- Both tools allow some types of user defined checks
- Make Coverity find all FPVA defects that Fortify found:
  - flag uses of functions: `exec`, `popen`, `system`
  - even without proving tainted arguments

# Contributions

- Showed limitations of current tools
- Presented manual vulnerability assessment as a required part of a comprehensive security assessment
- Creating a reference set of vulnerabilities to perform apples-to-apples comparisons

# Questions

**For more information see:**

**http://pages.cs.wisc.edu/~kupsch/vuln_assessment**