



Holistic Software Security

Introduction

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What this class is not about!

Writing exploits - Although, you will have better idea to do after the class.

Binary analysis - Although, the principles are similar.



Software Security

- What do we mean by this?
- Why do we need this?
- How to achieve this?



What?

- Ensuring that the given software (e.g., a program, OS) does not have security flaws.
- Security flaws:
 - Arbitrary code execution.
 - Arbitrary read/write.
 - Denial-of-Service.
 - Race condition.



What?

- Depending on the software, flaws might be more serious.
 - Race condition on a **local program `ls`** v/s in **Linux Kernel**.

CVE-2017-2636: exploit the race condition in the n_hdlc Linux kernel driver bypassing SMEP



Bug v/s Vulnerability

- **Bug:** Program misbehaves and/or does not produce desired outcome.

```
scanf("%d", &i);
```

```
j = i + 2;
```

- **Vulnerability:** A bug which could be exploited to cause a security flaw.

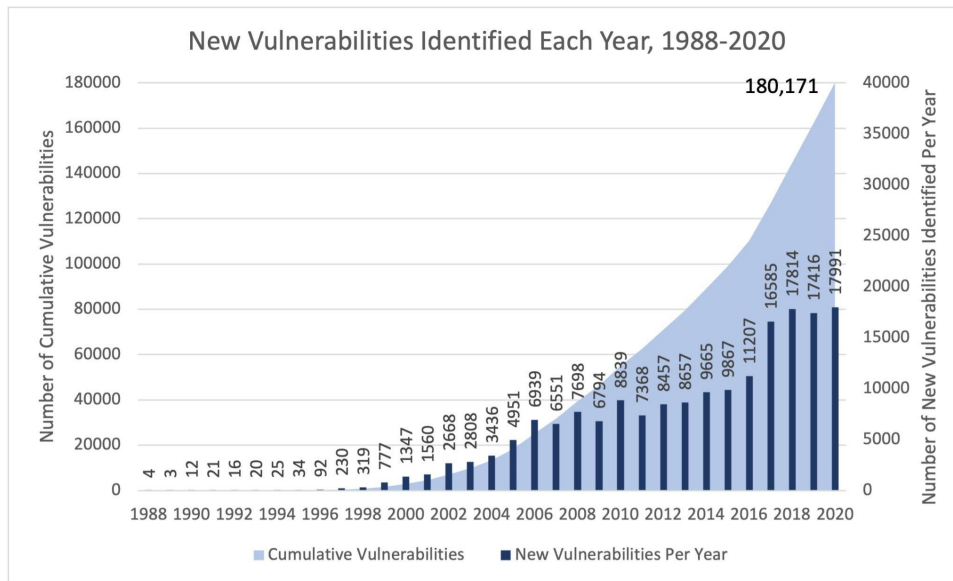
```
p = malloc(j);
```

```
p[i] = ...
```

Why we need Software Security?



Why we need Software Security?



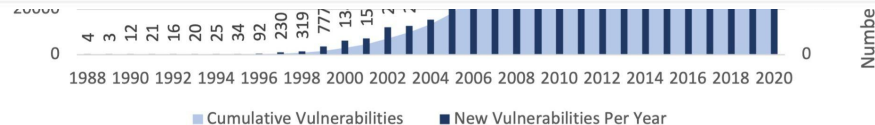
Why we need Software Security?

New Vulnerabilities Identified Each Year, 1988-2020

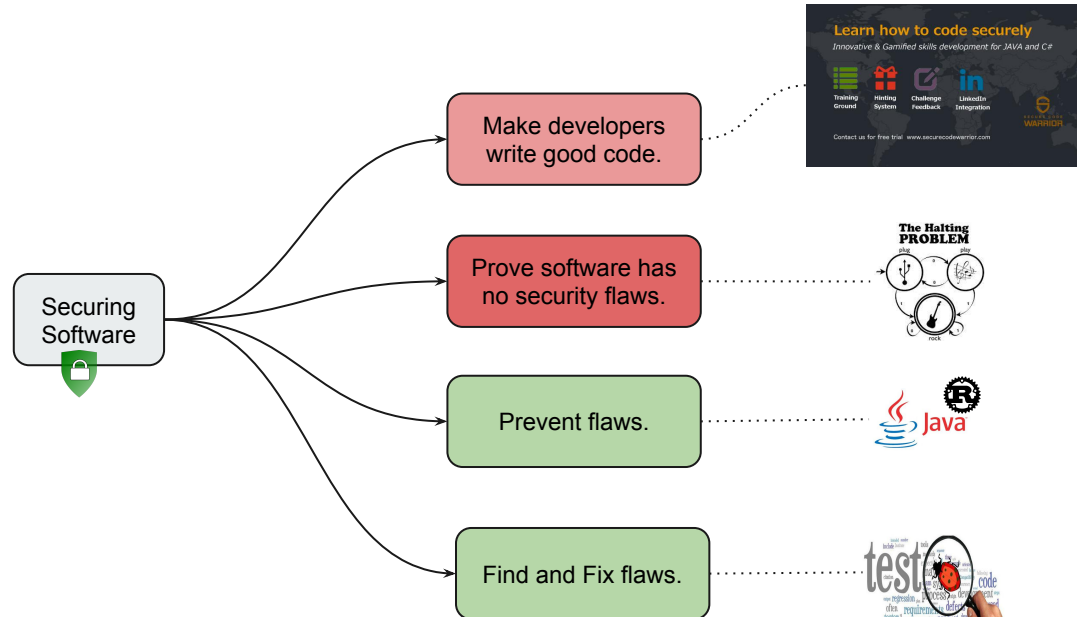
Mirai Botnet Pummels Internet DNS in Unprecedented Attack

Mirai-Infected IoT Devices Are Involved, Security Firm Flashpoint Reports

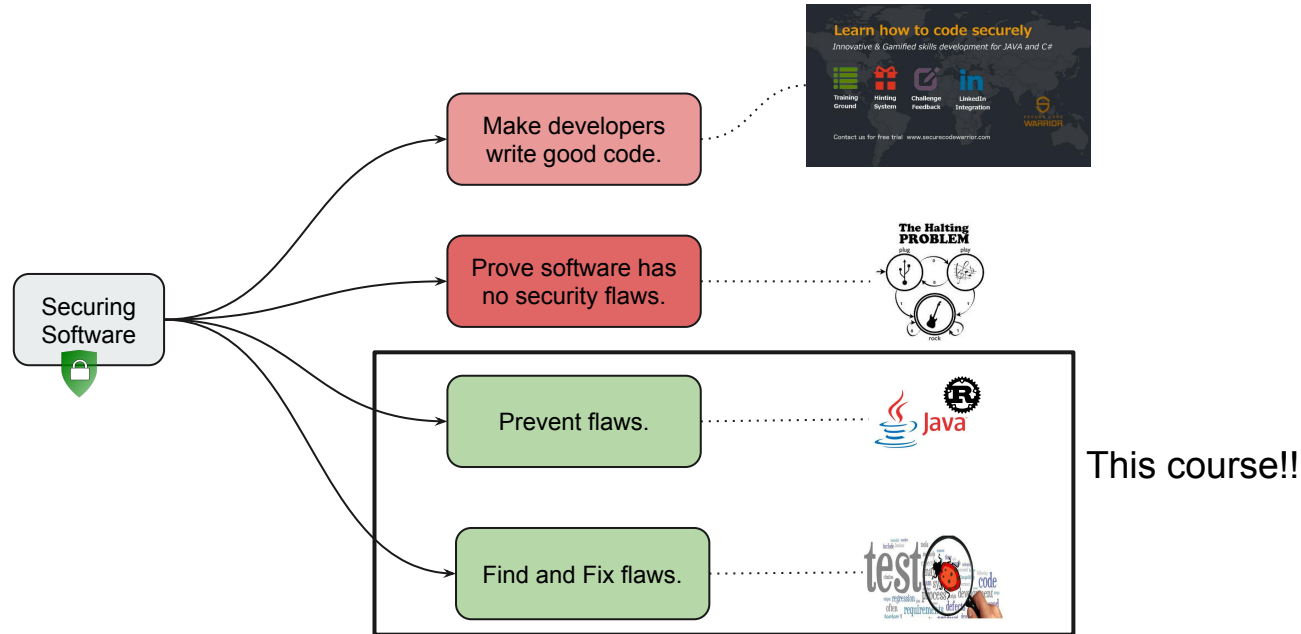
Mathew J. Schwartz ([@euroinfosec](#)) • October 22, 2016



How can we achieve this?

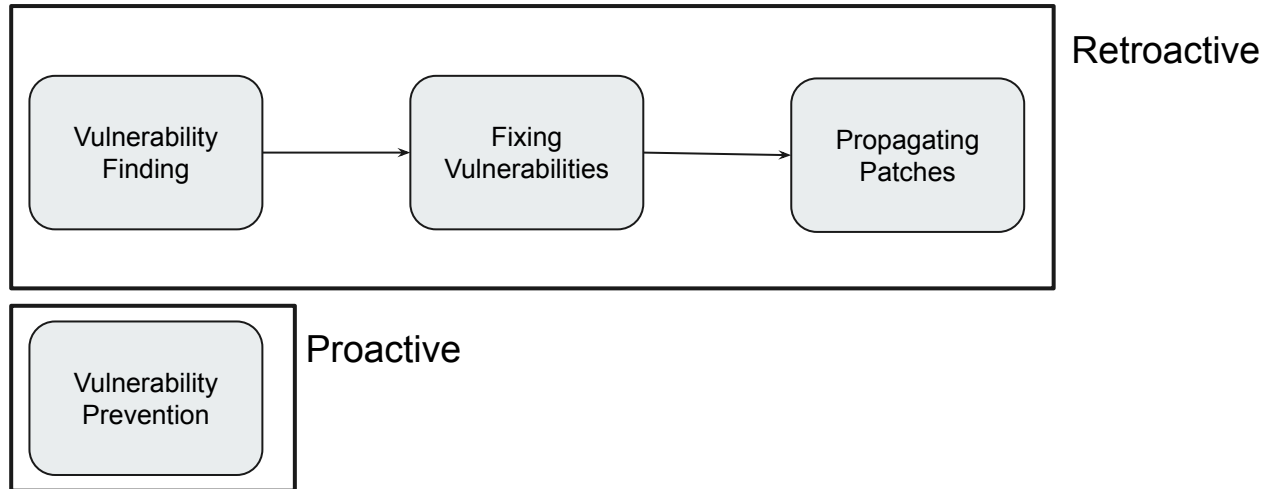


How can we achieve this?





Course: Organization





Course: Details

- We focus on software written in C/C++.
- Assume source code is available.
- Main focus on memory safety (but will be covering other flaws):
 - Arbitrary read/write.
- Lectures/Research Papers.



Course: Expectations

- Proficiency in C/C++: Ability to work with large code bases.
- OS concepts: Process isolation, User space/kernel space, virtual memory.
- Ability to read scientific papers:
 - <https://web.stanford.edu/class/ee384m/Handouts/HowtoReadPaper.pdf>
- Lectures/Research Papers.



Course: Expectations (Hopeful)

- Real world impact:
 - You may find zero days in open-source software.
- Get a scientific publication.



Course: Grading

- Five Assignments (10% each = 50%).
- Paper presentation (10%):
 - You need to pick a paper and present to the class.
- Paper Review (10%):
 - Pick a paper (different from the presentation) and write a academic review.
 - 1-2 pages: Summary, Overview, Pros and Cons.
- Project (30%)



Project (30%)

- Semester long project:
 - Related to software security (Fairly open ended).
 - Research project.
 - Report, Implementation and Presentation.
- Group of 2 - 3 students (define the project accordingly).
 - Will share the potential list in email.
 - Can pick your own, but should get approval from the professor.



Projects

- Solve halting problem.
- Develop IoT cloud: use idle IoT devices as compute resources.
- Implement stack canaries.
- Automatically fuzz a given program.
- Use Active Learning to find vulnerable functions.
- Runtime shuffling of stack variables.



Thank you!

- Course Webpage: <https://purs3lab.github.io/hss/>
- Join slack using your @purdue email (Link in webpage).
- Think about your projects.