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**.

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?

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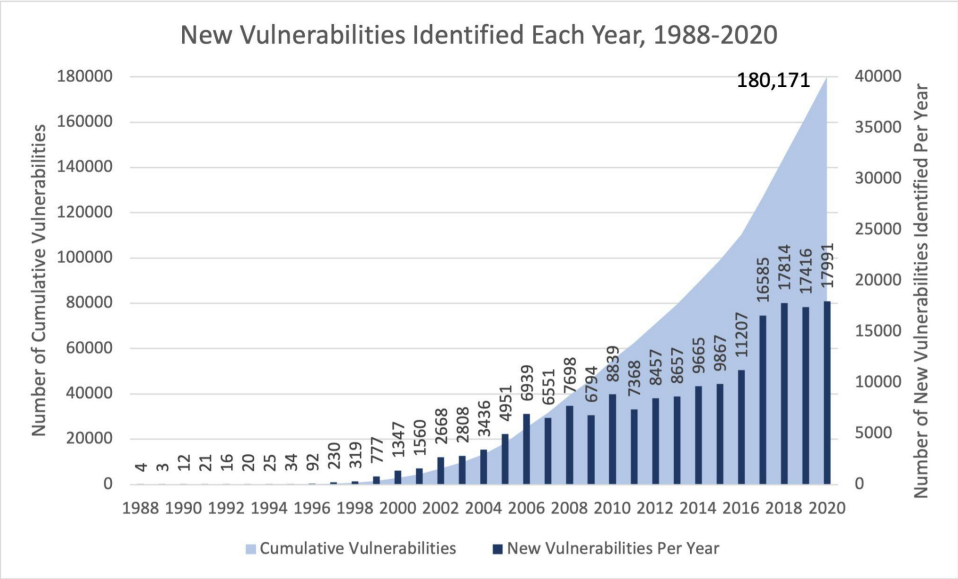


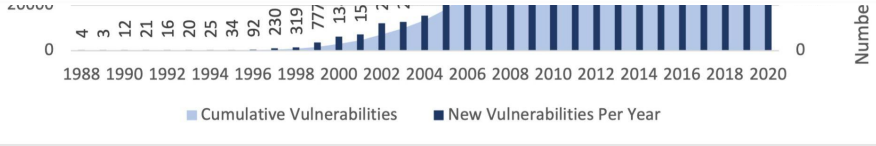
Why we need Software Security?

New Vulnerabilities Identified Each Year, 1988-2020

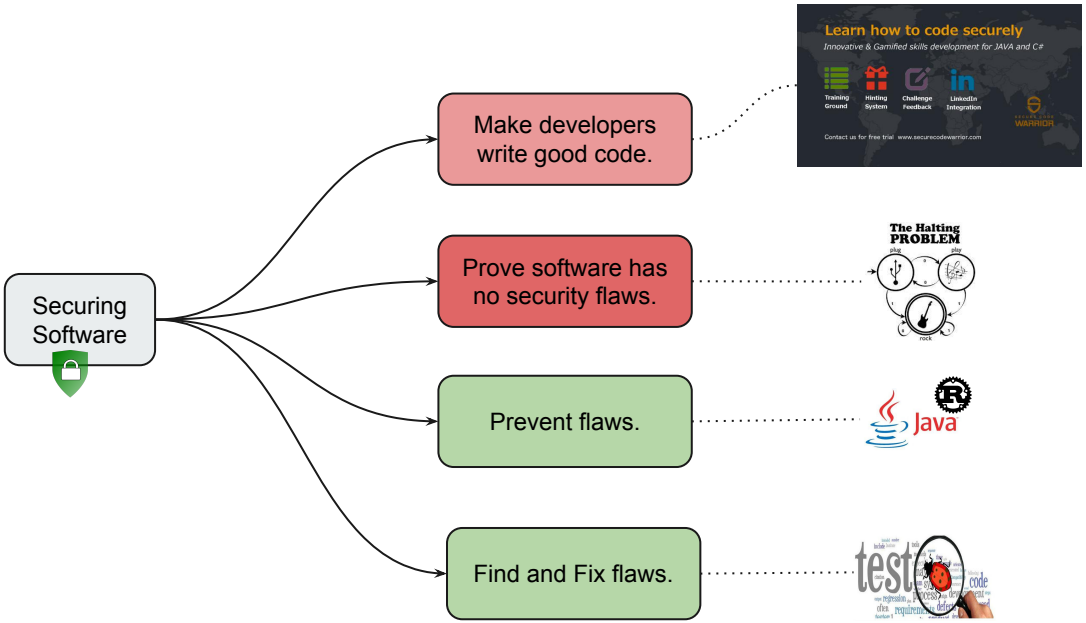
Mirai Botnet Pummels Internet DNS in Unprecedented Attack

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

Mathew J. Schwartz (euroinfosec) · October 22, 2016



How can we achieve this?



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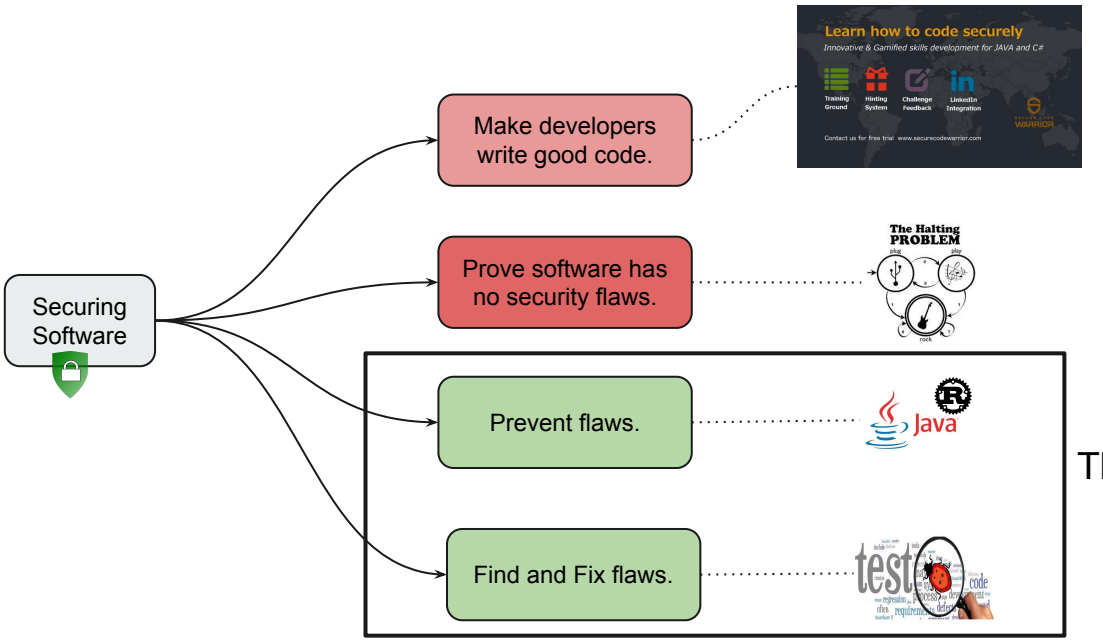
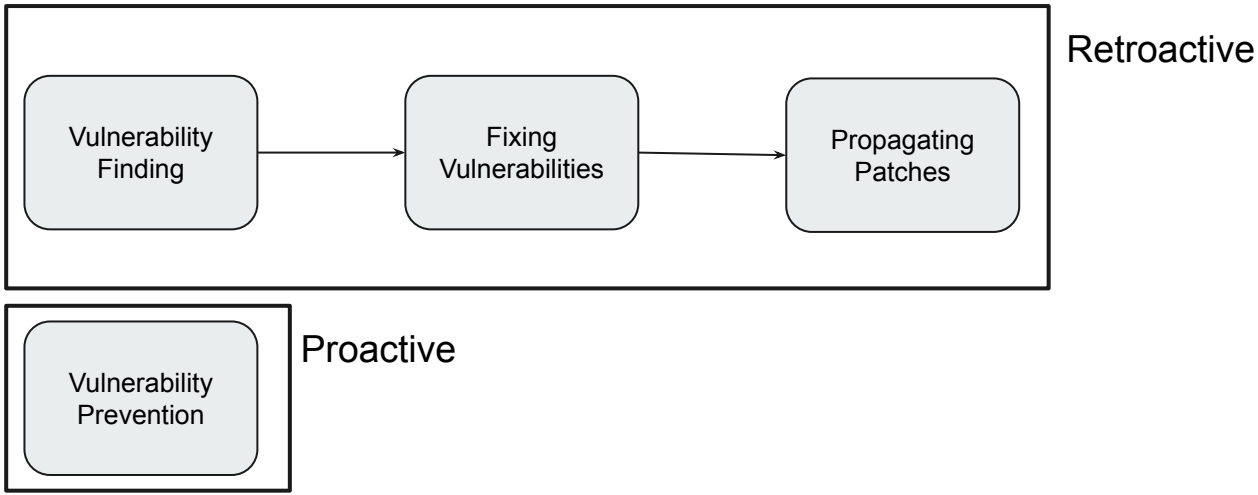


This course!!

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

- Three Assignments (10% each = 30%).
- Midterm 1 and 2 (10% each = 20%).
- Paper presentation (10%):
    - You need to pick a paper and present to the class.
- Project (40%)

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- Semester long project:
  - Related to software security (Fairly open ended).
  - Research project.
  - Report, Implementation and Presentation.

- Group of 1 - 2 students (define the project accordingly).
- Details: https://purs3lab.github.io/hss/project/ (Will update with more details by EoD)

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.
- Study to find effectiveness of certain class of techniques.

Lets do your intro!

- ➔ Your name (UG, MS, PhD)
- ➔ Area of interest or research?
- ➔ Expectations from this course?

Thank you!

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