SECURITY TESTBED:

SCALABLE INFRASTRUCTURE FOR INTERACTIVE ATTACK REPLAY AND TESTING OF SECURITY MONITORING TOOLS

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SCIENCE OF SECURITY
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Introduction

WHAT is the Security Testbed?

- A controlled system and network environment where attacks can be replicated and replayed

WHY do we need the testbed?

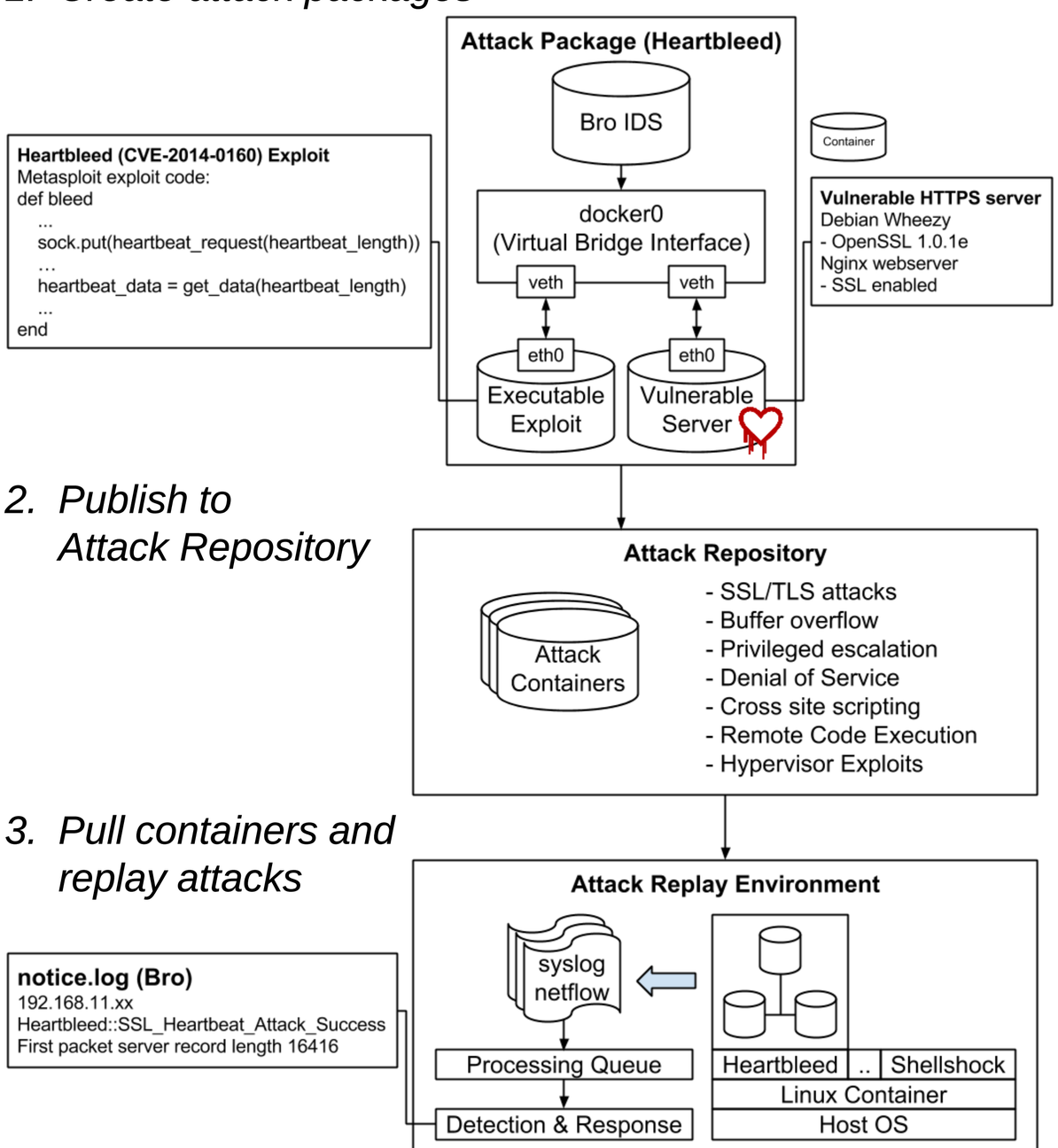
- Allows security researchers to safely reproduce and evaluate vulnerabilities and attacks
- Serves as an attack database for sharing information on security threats among security researchers
- Provides an environment to test and evaluate security monitoring tools against attacks

Requirements

- Isolation: prevent replayed attacks from affecting production infrastructure
- Instrumentation: collect system and network events in various attack stages
- Repeatability: provide a convenient platform for users to reproduce attacks

Architecture of Security Testbed

1. Create attack packages



Implementation

Isolation:

- Linux containers – a virtualization environment that enables running multiple isolated systems using process' models on a shared kernel

Instrumentation:

- OSSEC – system log analyzer
- Bro IDS – network traffic analyzer

Repeatability:

- Docker – provides a layer of abstraction and automation of virtualization
- Attack Repository – maintains attack container images

Categories of Attack Containers

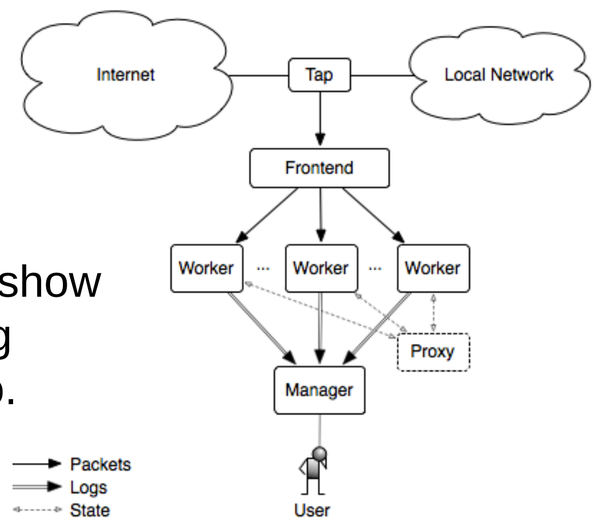
Category	Description	Attack Container
SSL/TLS	Attacks exploit vulnerabilities in the widely used cryptographic protocol SSL/TLS.	Heartbleed • OpenSSL 1.0.1e (vulnerable software) • Metasploit (exploit tool)
Arbitrary Command Execution	Attacks exploit vulnerabilities to get full access to a machine.	Shellshock (Bashdoor) • Apache 2 • Bash 4.3
Web App	Attacks exploit web application vulnerabilities to insert malicious code, for example, for the purpose of obtaining user credentials.	XSS (cross-site scripting) • Apache 2 • PHP 5
Injection	Attacks inject commands into a web server to make it behave abnormally.	SQL Injection • Apache 2 • PHP 5 • MySQL
Denial of Service	Attacks attempt to restrict access to a resource.	SlowDOS • Apache2 • slowhttptest • Kali Linux (exploit tool)

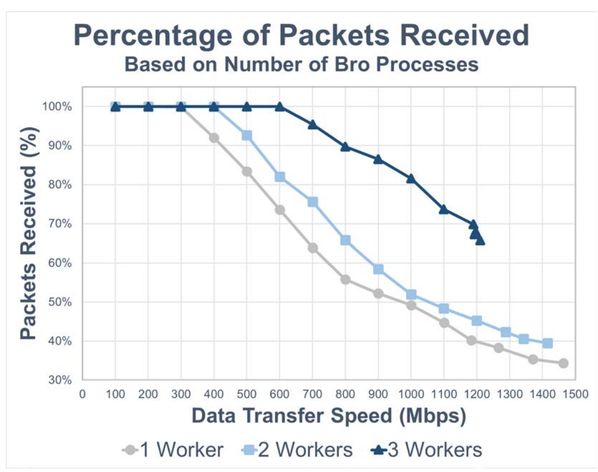
Performance Evaluation

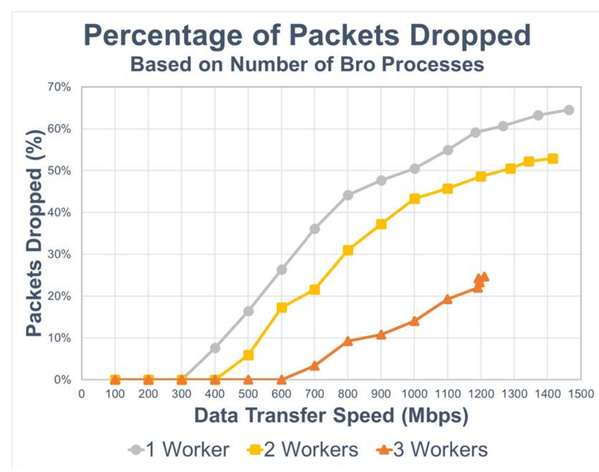
1. Network packet analysis on bare metal vs. container
   - *Challenge*: running "containerized Bro" may result in performance loss.
   - Measured 19% overhead when running containerized Bro to analyze network packets collected over 5 minutes (368MB).

Capture Details	
Size	368MB
Packets	791,615
Flows	40,686

   - Most of the attacks replayed in the testbed last less than a minute (a few MB in size).
     - Performance loss from using containerized Bro would be much smaller.
2. Real-time monitoring with single vs. multiple Bro instances
   - *Challenge*: single Bro instance may not be able to process a large volume of replayed traffic (for instance, when simulating DoS attack).
   - Bro can be deployed in a cluster of multiple Bro instances.
   - Measured packets received/dropped ratios show the advantage of running multiple instances of Bro.







Future Work

- Create an interactive interface for the security testbed
- Implement attack containers for hypervisor and kernel-level exploits

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