Charger Active Shield v1.0 - User Guide

Noah Sickels, Adam Brannon, William Lochte – G12

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 [](https://www.python.org/downloads)  

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## Project Overview

Our senior design group is the second team working on the Charger Active Defense project. This project aims to develop a fuzzing workflow that effectively tests the networking aspects of the selected target applications, Medusa and Masscan. We strive to identify any hangs or crashes that may occur, which can then be sent back to the host machine to potentially disrupt or halt the adversary’s tool.

This project is divided into two main phases - the fuzzing workflow and the active defense tool. The fuzzing workflow phase consists of the selection of fuzzing tools, two attack tools to fuzz, and the development of a fuzzing workflow. The active defense tool phase consists of developing a tool that can detect and respond to attacks on the network and send the fuzzed responses back to the adversary’s tool.

You can find the sponsor’s project proposal slide below.

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### Project Directory Structure

#### **Highlights**

* **User\_Guide.docx:** User guide document for the project.
* **workflow.sh:** Bash script for installing and building the attack and fuzzing tools for the workflow.
* **Dockerfile:** WIP Dockerfile for fuzzing workflow.
* **Makefile:** Makefile for building and running the Docker container.
* **Background Screening:** Contains CVEs, LDRA Static Analysis test results, and Valgrind test results for all attack tool candidates.
* **Config:** Contains configuration files for the testbed.
* **Deliverables:** Contains project deliverables, including reports, briefings, design review, and final report.
  + **G12\_attack\_tool\_selection\_report.docx:** Attack tool selection report.
  + **G12\_fuzz\_tool\_selection\_report.docx:** Fuzz tool selection report.
  + **G12\_fuzzing\_results\_analysis.docx:** Fuzzing tools compatibility testing results and analysis report.
* **Fuzzing:** Contains fuzzing-related files, including attack tool commands and fuzzing tool files
  + **Attack\_Tool\_Commands.md:** Commands used for the attack tools.
  + **password\_list.txt:** Password list used for testing.\
  + **repeat\_medusa.sh:** Script to repeatedly run Medusa.

#### **Directory Tree**

Charger Active Defense v1.0 - Senior Design Project  
.  
├── README.md  
├── config  
│ ├── Metasploitable2\_Running\_Services.txt  
│ └── Testbed\_Config.md  
├── deliverables  
│ ├── Conference-template-A4.doc  
│ ├── G12\_attack\_tool\_selection\_report.docx  
│ ├── G12\_fuzz\_tool\_selection\_report.docx  
│ ├── G12\_fuzzing\_results\_analysis.docx  
│ ├── G12\_updated\_milestones.docx  
│ ├── G12\_updated\_timeline.png  
│ ├── Project\_Timeline\_v2.gan  
│ ├── briefings  
│ │ ├── brief\_1  
│ │ │ ├── G12\_briefing\_1\_progress\_report.docx  
│ │ ├── brief\_2  
│ │ │ ├── G12\_briefing\_2\_progress\_report.docx  
│ │ │ └── fuzzowski\_medusa\_telnet.pcap  
│ │ └── brief\_3  
│ │ └── G12\_briefing\_3\_progress\_report.docx  
│ ├── design\_review  
│ │ ├── 495\_488\_design\_review\_template.pptx  
│ │ ├── Behavioral\_Decomposition.vsdx  
│ │ ├── Functional\_Decomposition.vsdx  
│ │ ├── G12\_design\_review\_presentation.pptx  
│ │ ├── G12\_level\_of\_effort.docx  
│ │ ├── G12\_marketing\_requirements.docx  
│ │ ├── Updated\_Behavioral\_Decomposition.png  
│ │ ├── Updated\_Functional\_Decomposition.png  
│ │ └── individual\_level\_of\_effort.md  
│ ├── final\_report  
│ ├── proposal  
│ │ └── Project-Proposal-Submission.pdf  
│ └── timeline\_and\_milestones  
│ └── initial  
│ ├── Project\_Timeline\_Proposal.gan  
│ └── milestone\_analysis.md  
├── fuzzing  
│ ├── afl-qemu-trace  
│ ├── fuzzowski.medusa.ftp  
│ │ └── ftp.py  
│ ├── fuzzshark  
│ │ └── ~src  
| ├── icmp.masscan  
│ │ ├── fuzz\_ping.sh  
│ │ ├── grammer.bnf  
│ │ ├── internet\_checksum.py  
│ │ ├── requirements.txt  
│ │ └── send\_icmp.py   
│ ├── medusa.postgresql.afl\_1  
│ │ ├── cmdline  
│ │ ├── fuzz\_bitmap  
│ │ ├── fuzzer\_setup  
│ │ ├── fuzzer\_stats  
│ │ ├── ~hangs  
│ │ ├── init\_attempt  
│ │ │ ├── medusa\_config.txt  
│ │ │ ├── wrapper.c  
│ │ │ └── wrapper.sh  
│ │ ├── ~plot\_data  
│ │ └── ~queue  
│ ├── peach\_fuzz  
│ │ ├── network\_fuzzing.xml  
│ │ └── peachfuzzer.dockerfile  
│ ├── radamsa  
│ │ ├── Radamsa\_Instructions.md  
│ │ └── ~img  
│ ├── randbytes  
│ │ ├── ftp\_server.py  
│ │ └── pcap\_parsing.py  
│ ├── randpkt  
│ │ └── ~src  
│ └── scapy.radamsa  
│ └── radamsa\_scapy\_pcap\_fuzzing.py  
├── misc  
│ ├── Attack\_Tool\_Commands.md  
│ ├── Attack\_Tool\_Info.md  
│ ├── password\_list.txt  
│ └── repeat\_medusa.sh  
├── pcaps  
│ ├── baseline  
│ │ ├── masscan.pcap  
│ │ ├── medusa\_ftp.pcap  
│ │ ├── medusa\_postgresql.pcap  
│ │ └── medusa\_ssh.pcap  
│ └── scapy  
│ ├── ftp\_login\_packets.pcap  
│ ├── fuzz\_test\_1.pcap  
│ ├── medusa\_ftp\_brute\_force.pcap  
│ ├── medusa\_ftp\_fail.pcap  
│ └── nmap\_ftp\_scan.pcap  
├── project\_overview.png  
├── research  
│ ├── CVEs.md  
│ ├── Fuzzing\_Tools.md  
│ └── cmiller-csw-2010.pdf  
└── background\_screening  
 ├── ldra  
 │ ├── aircrack-ng  
 │ │ └── aircrack-ng.mts.htm  
 │ ├── masscan  
 │ │ └── masscan.mts.htm  
 │ ├── medusa  
 │ │ └── medusa.mts.htm  
 │ ├── netdiscover  
 │ │ └── netdiscover.mts.htm  
 │ ├── reaver  
 │ │ └── reaver.mts.htm  
 │ └── yersinia  
 │ └── yersinia.mts.htm  
 └── valgrind  
 ├── commands.txt  
 ├── masscan.txt  
 ├── medusa\_ftp.txt  
 ├── medusa\_postgres.txt  
 ├── medusa\_ssh.txt  
 └── netdiscover.txt

##### ***Full Explanation***

* **README.md:** This file.
* **project\_overview.png:** Image of the project overview.
* **config:** Contains configuration files.
  + **Testbed\_Config.md:** Configuration details for the testbed.
* **deliverables**: Contains project deliverables, including the tool reports, proposal presentation slides, briefings, design review, and final report.
  + **G12\_attack\_tool\_selection\_report.docx:** Attack tool selection report.
  + **G12\_fuzz\_tool\_selection\_report.docx:** Fuzz tool selection report.
  + **G12\_fuzzing\_results\_analysis.docx:** Fuzzing results analysis.
  + **G12\_updated\_milestones.docx:** Updated milestones.
  + **G12\_updated\_timeline.png:** Updated timeline.
  + **Project\_Timeline\_v2.gan:** Gantt chart file for the project timeline.
  + **briefings:** Contains briefing files.
    - **brief\_1:** Briefing 1 files.
      * **G12\_briefing\_1\_progress\_report.docx:** Briefing 1 progress report.
    - **brief\_2:** Briefing 2 files.
      * **G12\_briefing\_2\_progress\_report.docx:** Briefing 2 progress report.
      * **fuzzowski\_medusa\_telnet.pcap:** Fuzzowski Medusa Telnet PCAP file.
    - **brief\_3:** Briefing 3 files.
      * **G12\_briefing\_3\_progress\_report.docx:** Briefing 3 progress report.
  + **design\_review:** Contains design review files.
    - **495\_488\_design\_review\_template.pptx:** Design review template.
    - **Behavioral\_Decomposition.vsdx:** Behavioral decomposition Visio diagram.
    - **Functional\_Decomposition.vsdx:** Functional decomposition Visio diagram.
    - **G12\_design\_review\_presentation.pptx:** Design review presentation.
    - **G12\_level\_of\_effort.docx:** Level of effort document.
    - **G12\_marketing\_requirements.docx:** Marketing requirements document.
    - **Updated\_Behavioral\_Decomposition.png:** Updated behavioral decomposition diagram image.
    - **Updated\_Functional\_Decomposition.png:** Updated functional decomposition diagram image.
    - **individual\_level\_of\_effort.md:** Individual level of effort document.
  + **final\_report:** Final report files.
  + **proposal:** Proposal files.
    - **Project-Proposal-Submission.pdf:** Project proposal presentation slides.
  + **timeline\_and\_milestones:** Contains timeline and milestones files.
    - **initial:** Initial timeline and milestones.
      * **Project\_Timeline\_Proposal.gan:** Initial project timeline proposal.
      * **milestone\_analysis.md:** Milestone analysis.
* **fuzzing:** Contains fuzzing-related files.
  + **afl-qemu-trace:** AFL QEMU trace binary.
  + **fuzzowski.medusa.ftp:** Fuzzowski Medusa FTP files.
    - **ftp.py:** FTP file for Fuzzowski Medusa.
  + **fuzzshark:** Fuzzshark files.
  + **medusa.postgresql.afl\_1:** Medusa PostgreSQL AFL files.
    - **init\_attempt:** Initial attempts with AFLnet.
      * **medusa\_config.txt:** Medusa configuration file for wrapper.
      * **wrapper.c:** Custom wrapper source file.
      * **wrapper.sh:** Custom wrapper script.
  + **peach\_fuzz:** Peach Fuzz files.
    - **network\_fuzzing.xml:** Network fuzzing XML model file.
    - **peachfuzzer.dockerfile:** Peach Fuzzer Dockerfile.
  + **radamsa:** Radamsa files.
    - **Radamsa\_Instructions.md:** Radamsa testing instructions.
  + **randbytes:** Randbytes files.
    - **ftp\_server.py:** FTP server file.
    - **pcap\_parsing.py:** PCAP parsing file with Scapy.
  + **randpkt:** Randpkt files.
  + **scapy.radamsa:** Scapy Radamsa files.
    - **radamsa\_scapy\_pcap\_fuzzing.py:** Radamsa & Scapy PCAP fuzzing Python script.
* **misc:** Miscellaneous files.
  + **Attack\_Tool\_Commands.md:** Commands for attack tools used during compatibility testing.
  + **Attack\_Tool\_Info.md:** Information about attack tools.
  + **password\_list.txt:** Password list used for testing.
  + **repeat\_medusa.sh:** Script to repeatedly run Medusa.
* **pcaps:** Contains PCAP files.
  + **baseline:** Baseline PCAP files.
  + **scapy:** Scapy PCAP files.
* **background\_screening:** Contains test-related files.
  + **ldra:** LDRA test files.
    - **aircrack-ng/aircrack-ng.mts.htm:** Aircrack-ng LDRA test files.
    - **masscan/masscan.mts.htm:** Masscan LDRA test files.
    - **medusa/medusa.mts.htm** Medusa LDRA test files.
    - **netdiscover/netdiscover.mts.htm:** Netdiscover LDRA test report.
    - **reaver/reaver.mts.htm:** Reaver LDRA test report.
    - **yersinia/yersinia.mts.htm:** Yersinia LDRA test report.
  + **valgrind:** Valgrind test results for each attack tool candidate.
    - **commands.txt:** Commands used for running the Valgrind tests.
    - **masscan.txt:** Masscan Valgrind test results file.
    - **medusa\_ftp.txt:** Medusa FTP Valgrind test results file.
    - **medusa\_postgres.txt:** Medusa PostgreSQL Valgrind test results file.
    - **medusa\_ssh.txt:** Medusa SSH Valgrind test results file.
    - **netdiscover.txt:** Netdiscover Valgrind test results file.
* **research:** Contains research-related files.
  + **CVEs.md:** List of CVEs from all attack tool candidates.
  + **Fuzzing\_Tools.md:** Background research on possible fuzzing tools.
  + **cmiller-csw-2010.pdf:** Research paper on general fuzzing and fuzzing tools.

## Prerequisites

* VirtualBox 7.1.0 (or later)
* Kali Linux 2023.4 (or later) or Ubuntu 20.04 (or later)
* Wi-Fi/Ethernet Adapter that supports promiscuous mode.
* Packages: clang, graphviz-dev, libcap-dev, git, make, gcc, autoconf, automake, libssl-dev, wget, curl

## Testbed Configuration

The Chad workflow testbed comprises two virtual machines: Kali Linux 2023.4 (or newer) and Metasploitable2.

* You can download a pre-built Kali Linux VM from their website [here](https://www.kali.org/get-kali/#kali-virtual-machines).
* Rapid7 provides a pre-built Metasploitable2 VM from their website [here](https://www.rapid7.com/products/metasploit/metasploitable/).

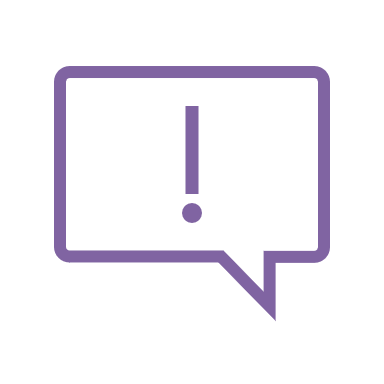
For detailed configuration information, please refer to the table below.

Table 1: VirtualBox VM Configurations

|  |  |  |
| --- | --- | --- |
| Component | Configuration |  |
| Hypervisor | VirtualBox | 7.1.0 |
| Virtual Machine 1 (Host) | OS | Kali Linux 2024.3 |
| Kernel Version | Linux kali 6.10.11-amd64 |
| GCC Version | 14.2.0 (Debian 14.2.0-3) |
| Network Adapter 1 | NAT |
| Network Adapter 2 | Internal Network *(intent)* |
| IP Address | 192.168.1.99 /24 |
| Miscellaneous | 16,384 MB RAM, 2 CPU cores, 80 GB HDD |
| Virtual Machine 2 (Target) | OS | Metasploitable2 |
| Kernel Version | Linux Metasploitable 2.6.24-16-server |
| GCC Version | 4.2.4 (Ubuntu 4.2.4-lubuntu4) |
| Network Adapter 1 | Internal Network *(intent)* |
| Network Adapter 2 | *Optional* |
| IP Address | 192.168.1.100 /24 |
| Miscellaneous | 2,048 MB RAM, 1 CPU core, 8 GB HDD |

**Important**

“*Virtual Machine 1 (Host*)”refers to the attacking virtual machine running Kali, which runs Medusa and Masscan against the target VM.  
  
“*Virtual Machine 2 (Target)*”refers to the virtual machine running Metasploitable2, which has vulnerable services active.



### Network Configuration

For both VMs to communicate with each other, you will need to configure the network adapters in VirtualBox and on the VMs’ network interfaces.

You can use either a physical network adapter that supports promiscuous mode or virtual adapters through your hypervisor; however, we recommend using the virtual adapters as shown below.

##### **VirtualBox Network Adapter Settings Configuration**

###### Kali Virtual Machine

1. Open VirtualBox and select the Kali VM.
2. Click on the *Settings* icon and choose the *Network* tab.
3. Under *Adapter 1,* select *Attached to: NAT*.
4. Now select the *Adapter 2* tab.
5. Check the box for *Enable Network Adapter*.
6. Select *Attached to: Internal Network*.
7. In the *Name*  field, enter `intent`
8. Click *Ok* to save the settings and close out of the window.

###### Metasploitable2 Virtual Machine

1. Open VirtualBox and select the Metasploitable2 VM.
2. Click on the *Settings* icon and navigate to the *Network* tab.
3. Under *Adapter 1*, select *Attached to: Internal Network*.
4. In the *Name* field, enter `intent`.
5. Click *Ok* to save the settings and close out of the window.

##### **Host Machine Network Configuration**

Once the virtual machines are configured, start both VMs and configure the network interfaces on each VM. Note that the network interface names may vary depending on the operating system and version. We will use the default network interface names for the examples below. The IP addresses used are default private IP addresses, but you can use any IP address within the same subnet.

###### Kali Host Machine

Open terminal and run the following command(s) to view the network interfaces:

|  |
| --- |
| sudo ip addr  *# or*  sudo ifconfig |

You should see the network interfaces listed. If you enabled network adapter 1, you should see your internet-facing network interface named `eth0` or `enp0s3`. If you enabled network adapter 2, you should see an interface named `eth1` or `enp0s8`. Otherwise, you may need to manually configure the network interfaces on your system.

We will use `eth1` for the internal network communication as an example for the commands below.

Set the IP address for the internal network interface `eth1` (***requires root privileges***):

|  |
| --- |
| sudo ip addr add 192.168.1.99 dev eth1  *# or*  sudo ifconfig eth1 192.168.1.99 |

You can verify the IP address is set correctly by running `sudo ip add` or `sudo ifconfig` again.

###### Metasploitable2 Target Machine

By default, the Metasploitable2 VM has no GUI and should boot into a terminal window. Verify the available network interfaces by running the following command(s):

|  |
| --- |
| sudo ip addr  *# or*  sudo ifconfig |

You should see the network interface `eth0` listed. Set the IP address for the internal network interface `eth0` (***requires root privileges***):

|  |
| --- |
| sudo ip addr add 192.168.1.100 dev eth0  *# or*  sudo ifconfig eth1 192.168.1.100 |

You can verify the IP address is set correctly by running `sudo ip add` or `sudo ifconfig` again.

##### Verify Network Connection

Once the network interfaces have been configured on both VMs, you can test the network connection between the two VMs by running the following commands:

|  |
| --- |
| *# On the Kali VM*  ping 192.168.1.100  *# On the Metasploitable2 VM*  ping 192.168.1.99 |

If the network connection is successful, you should see the ping responses from the target VM (e.g., `64 bytes from 192.168.1.100: icmp\_seq=1 ttl=64 time=0.171ms`).

If the connection is unsuccessful, restart the VMs and verify the network configurations.

Network adapters may reset at times, so we recommend checking the network adapter IP addresses to ensure they are still set correctly.

If they are not set, you can reconfigure them by repeating the steps above.

## Usage & Installation

There are three ways to install and use the tools necessary for the Chadv1.0 workflow: using the Bash script, the Dockerfile, or manually.

### Bash Script (Recommended)

To install the attack tools and fuzzing tools, you can use the provided Bash script as shown below (***requires root privileges***):

|  |
| --- |
| # Download the workflow script through curl or manually from the repository curl -O https://raw.githubusercontent.com/NCSickels/chadv1.0/main/workflow.sh  # Make the script executable chmod u+x workflow.sh  # Using the workflow script sudo ./workflow.sh --help  # To install all tools (attack and fuzzing) sudo ./workflow.sh install  # To build all tools (attack and fuzzing) sudo ./workflow.sh build |

**Note**

If you encounter the error: *-bash: ./workflow.sh: /bin/bash^M: bad interpreter: No such file or directory*, it is most likely due to the script being in DOS format for a UNIX system. To fix this, you can use the *dos2unix* command to convert the script to UNIX format. You can install it through Apt package manager using the command *sudo apt install dos2unix*.



### 

### Dockerfile *(WIP)*

**Warning**

*Requires Docker and Make to be installed on the host machine. Docker Desktop is available* [*here.*](https://www.docker.com/get-started/)



The Chad workflow Docker implementation utilizes a Makefile and the make utility to build and run the Dockerfile image in a streamlined manner.

* Build the Chadv1.0 Workflow Docker image: make build
* Run the Chadv1.0 Workflow Docker container: make run

Optionally, you can build the Docker image and run the container manually using the commands below.

**Build the Docker Image**

|  |
| --- |
| # Build the Docker image docker build -t workflow . |

**Run the Docker Container**

|  |
| --- |
| # Run the Docker container docker run --rm -it --name workflow -v . workflow /bin/bash |

### Manual Installation (Recommended)

**Clone the Repositories**

|  |
| --- |
| # Clone the attack tool repositories git clone https://salsa.debian.org/pkg-security-team/medusa.git  git clone https://github.com/robertdavidgraham/masscan.git  # Clone the fuzzing tool repositories git clone https://github.com/aflnet/aflnet.git git clone https://gitlab.com/akihe/radamsa.git |

**Install Necessary Dependencies**

|  |
| --- |
| sudo apt install -y clang graphviz-dev libcap-dev git make \  gcc autoconf automake libssl-dev wget curl |

**Build the Attack Tools**

|  |
| --- |
| # Build Medusa cd medusa ./configure make make install cd ..  # Build Masscan cd masscan # Optionally, can run `make -j` for faster compilation make  make install cd .. |

**Build the Fuzzing Tools**

|  |
| --- |
| # Build AFLnet cd aflnet make clean all  cd llvm\_mode make # If this command does not work, it most likely means that llvm-config is not in your PATH. If so, you can add it manually as shown below. # It should be named something like llvm-config-6.0 in /usr/bin/ export LLVM\_CONFIG=$(ls /usr/bin/llvm-config-\* 2>/dev/null | head -n 1) cd ../.. export AFLNET=$(pwd)/aflnet export WORKDIR=$(pwd) export PATH=$PATH:$AFLNET export AFL\_PATH=$AFLNET cd ..  # Build Radamsa cd radamsa make sudo make install cd .. |

This will install the necessary tools for the Chadv1.0 fuzzing workflow, including AFLnet, Radamsa, Medusa, and Masscan.

## References

### Attack Tools

* [Medusa](https://salsa.debian.org/pkg-security-team/medusa)
* [Masscan](https://github.com/robertdavidgraham/masscan.git)

### Fuzzing Tools

* [AFLnet](https://github.com/aflnet/aflnet)
* [Radamsa](https://gitlab.com/akihe/radamsa.git)

### Testbed Tools

* [VirtualBox](https://www.virtualbox.org/wiki/Downloads)
* [Docker Desktop](https://www.docker.com/get-started/)
* [Kali Linux 2023.4 Pre-built VMs](https://www.kali.org/get-kali/#kali-virtual-machines)
* [Ubuntu 20.04 LTS ISO](https://releases.ubuntu.com/focal/)
* [Metasploitable2 VM](https://www.rapid7.com/products/metasploit/metasploitable/)

### Miscellaneous Tools

* [dos2unix](https://dos2unix.sourceforge.io)
* [MD to DOCX Converter (Used to create User Guide from README)](https://cloudconvert.com/md-to-docx)