MerCuriuzz: a novel black-box fuzzing framework designed to automatically uncover logical vulnerabilities in QUIC implementations

MerCuriuzz: a novel black-box fuzzing framework designed to automatically uncover logical vulnerabilities in QUIC implementations - Kaihua Wang, Zenodo.

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Content

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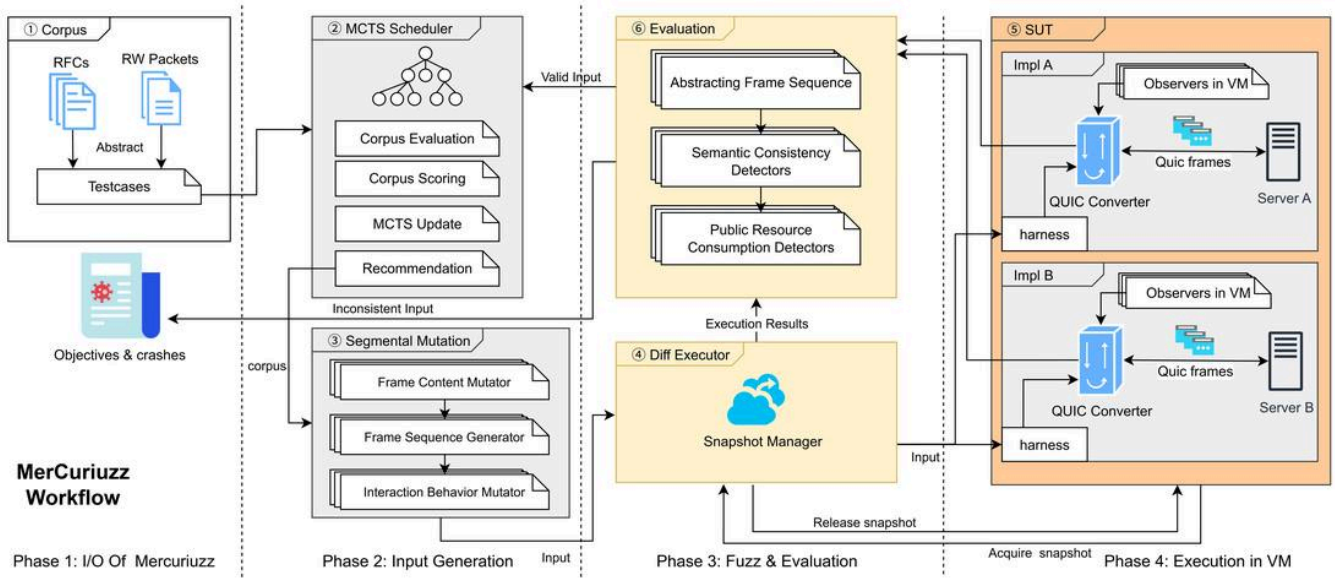
MerCuriuzz

MerCuriuzz is a testing method capable of automatically discovering logical vulnerabilities in QUIC implementations.



Usage

Currently, we have released our fuzzer developed with LibAFL and our mutator and validator module. You can get more detail in its Usage.md.

How to cite us?

This framework is based on our latest research,"Identifying Logical Vulnerabilities in QUIC Implementations", accepted at NDSS '26.

If you want to cite us, please use the following (BibTeX) reference:

```
TBA
```

We have also uploaded our artifacts to a DOI-providing platform. Here is our DOI link: `https://doi.org/10.5281/zenodo.17015304`

Disclaimer

Do not attempt to use these tools to violate the law. The author is not responsible for any illegal action. Misuse of the provided information can result in criminal charges.

Usage.md (same repository revision)

USAGE

The following tests were completed on ubuntu24.04

Environment

```
sudo apt update && sudo apt upgrade -y

sudo apt install -y build-essential pkg-config openssl libssl-dev zlib1g-dev gyp

sudo apt install -y curl git net-tools htop

sudo apt install -y gcc-multilib g++-multilib cmake make python3-pip llvm-dev libclang-dev clang ninja-build

pip install wsproto starlette --break-system-packages
```

Install cargo:

```
curl --proto '=https' --tlsv1.2 -sSf https://sh.rustup.rs | sh
source $HOME/.cargo/env
rustc --version && cargo --version
```

Target Installation

```
cd ~/MerCuriuzz/vendors/app_deploy
mkdir -p certs && cd certs
openssl req -x509 -newkey rsa:4096 -nodes -keyout server.key -out server.crt -days 365 -subj "/CN=localhost" -addext "
```

Lsquic

```
git clone https://boringssl.googlesource.com/boringssl
cd boringssl
cmake . &&  make
cd ..
git clone https://github.com/litespeedtech/lsquic.git
cd lsquic
git submodule update --init
mkdir build && cd build
cmake -DBORINGSSL_DIR=$HOME/MerCuriuzz/vendors/app_deploy/boringssl ..
make -j$(nproc)
```

```
cd build/bin
./http_server -s 0.0.0.0:25443 -L ERROR -r ./ -c 127.0.0.1,$HOME/MerCuriuzz/vendors/app_deploy/certs/server.crt,$HOM
```

Neqo

```
git clone https://github.com/mozilla/neqo.git
cd neqo
wget https://ftp.mozilla.org/pub/security/nss/releases/NSS_3_111_RTM/src/nss-3.111-with-nspr-4.36.tar.gz
tar -zxvf nss-3.111-with-nspr-4.36.tar.gz
mv nss-3.111-with-nspr-4.36 nss-3.111
cd nss-3.111/nspr
./configure
make && sudo make install
cd ../nss
./build.sh
cd ../../
NSS_DIR=./nss-3.111/nss NSS_TARGET=./nss-3.111/nss/ cargo build
```

```
target/debug/neqo-server -d ./test-fixture/db 0.0.0.0:30443
```

h2o

```
cd $HOME/MerCuriuzz/vendors/app_deploy
git clone https://github.com/h2o/h2o.git
cd h2o
mkdir build && cd build
cmake .. -DCMAKE_INSTALL_PREFIX=$HOME/MerCuriuzz/vendors/app_deploy/h2o/Debug -DCMAKE_BUILD_TYPE=Debu
make -j$(nproc)
make install
cd ..
cp -r examples/h2o Debug/etc
vim Debug/etc/h2o.conf
```

replace like this($HOME may not work, you should replace it with your home directory path):

```
# to find out the configuration commands, run: h2o --help

num-threads: 1
listen: &ssl_listen
 port: 38440
 ssl:
  certificate-file: $HOME/MerCuriuzz/vendors/app_deploy/certs/server.crt
  key-file: $HOME/MerCuriuzz/vendors/app_deploy/certs/server.key
  minimum-version: TLSv1.3
  cipher-preference: server
  cipher-suite: "ECDHE-ECDSA-AES256-GCM-SHA384:ECDHE-RSA-AES256-GCM-SHA384:ECDHE-ECDSA-CHACHA20-POL
  # Oldest compatible clients: Firefox 27, Chrome 30, IE 11 on Windows 7, Edge, Opera 17, Safari 9, Android 5.0, and Ja
  # see: https://wiki.mozilla.org/Security/Server_Side_TLS
# The following three lines enable HTTP/3
listen:
 <<: *ssl_listen
 type: quic

header.set: "Alt-Svc: h3-25=\":38440\""
quic-nodes:
 self: 1
 mapping:
  1: "127.0.0.1:38440"
hosts:
 "alternate.localhost.examp1e.net:38440":
  paths:
   /:
    file.custom-handler:
     extension: .php
     fastcgi.connect:
      port: /tmp/fcgi.sock
      type: unix
  access-log: /dev/stdout
```

```
Debug/bin/h2o
```

Aioquic

```
git clone https://github.com/aiortc/aioquic.git
pip install . --break-system-packages
pip install wsproto starlette --break-system-packages
python3 examples/http3_server.py -c $HOME/MerCuriuzz/vendors/app_deploy/certs/server.crt --port 4443
```

Building

The following is a sample that compiles a MerCuriuzz minimizer instance.

```
cd $HOME/MerCuriuzz/vendors/

git clone https://github.com/k4ra5u/LibAFL
git clone --recursive https://github.com/k4ra5u/quiche
git clone https://github.com/k4ra5u/QEMU-Nyx
git clone https://github.com/k4ra5u/packer
git clone https://github.com/k4ra5u/libnyx
mv LibAFL/libafl_nyx ./
cd ../fuzzers/network_quic_fuzz
export RUSTFLAGS="-C link-arg=-lstdc++"
CARGO_TARGET_DIR=target  cargo build
```

Usage: Before testing, you need to configure the startup parameters and judgment parameters of the two QUIC implementations, which are located in the start and judge directories of the main program project. You need to replace the parameters of the original `<program_name>.sh` file with the program path of the local machine, and modify the content of the ports file in the start directory, which describes the CPU resources and port information used by each QUIC implementation.

Run: `target/debug/network_quic_fuzz <procA> <procB>`

Configuration files for QUIC applications

> h2o: h2o.conf, haproxy: quix.cfg, msquic: src/tools/sample/sample.c, nginx: nginx.conf, s2n-quic: quic_echo_server.rs,