Distributed Programming University Project

H.D.S

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Screenshots

Brief

> **H.D.S (Hashcat-Distributed-Service)** is a university project written entirely in **Go**, designed to distribute WPA handshake cracking tasks across multiple **Hashcat** clients. It serves as a practical proof of concept for distributed password-cracking workloads.

Run the Application (in Test Mode) with Docker

Since `client` within docker runs a GUI application using **Raylib**, it requires access to the host's desktop environment. A utility called `xhost` is needed (`xorg-xhost` on Arch Linux).

Run the following commands:

```
export DISPLAY=:0.0 && \
xhost +local:docker && \
docker compose up --build
```

Access the **Frontend (FE)** by visiting:
➡️ `http://localhost:4748`

Docker Containers

The setup will spawn four containers: - **dp-database** - **dp-server** - **emulate-raspberrypi** - **dp-client**

The provided `docker-compose.yml` file already includes all necessary environment variables for a functional **test environment**. No changes are required to run the project for demonstration purposes.

Default credentials: `admin:test1234`
This account can be used on the frontend to upload and submit WPA handshakes for cracking.

> While the software is primarily designed for **Linux**, GPU capabilities can potentially be shared with a containerized `client` via **WSL** on Windows. Future improvements may include native support for additional operating systems.

Project Features

1. **Handshake Capturing and Uploading:**
   Users can capture WPA handshakes using tools like **bettercap** (or similar) and use a **daemon** to upload them to the server. Although referred to as `RaspberryPI` in the project, the daemon can run on any platform supporting **Golang**.

2. **Frontend Management:**
   Users can access the **Frontend (FE)** to:
   - View captured handshakes.
   - Submit them to clients for cracking.
   - Manage connected clients and daemon devices.
   - Remove unnecessary handshakes.

3. **Independent Clients:**
   Each **client** operates independently and communicates directly with the server. Users can select which client will handle specific cracking tasks.

4. **Modularity:**
   The software is designed with modularity in mind to simplify future changes and improvements.

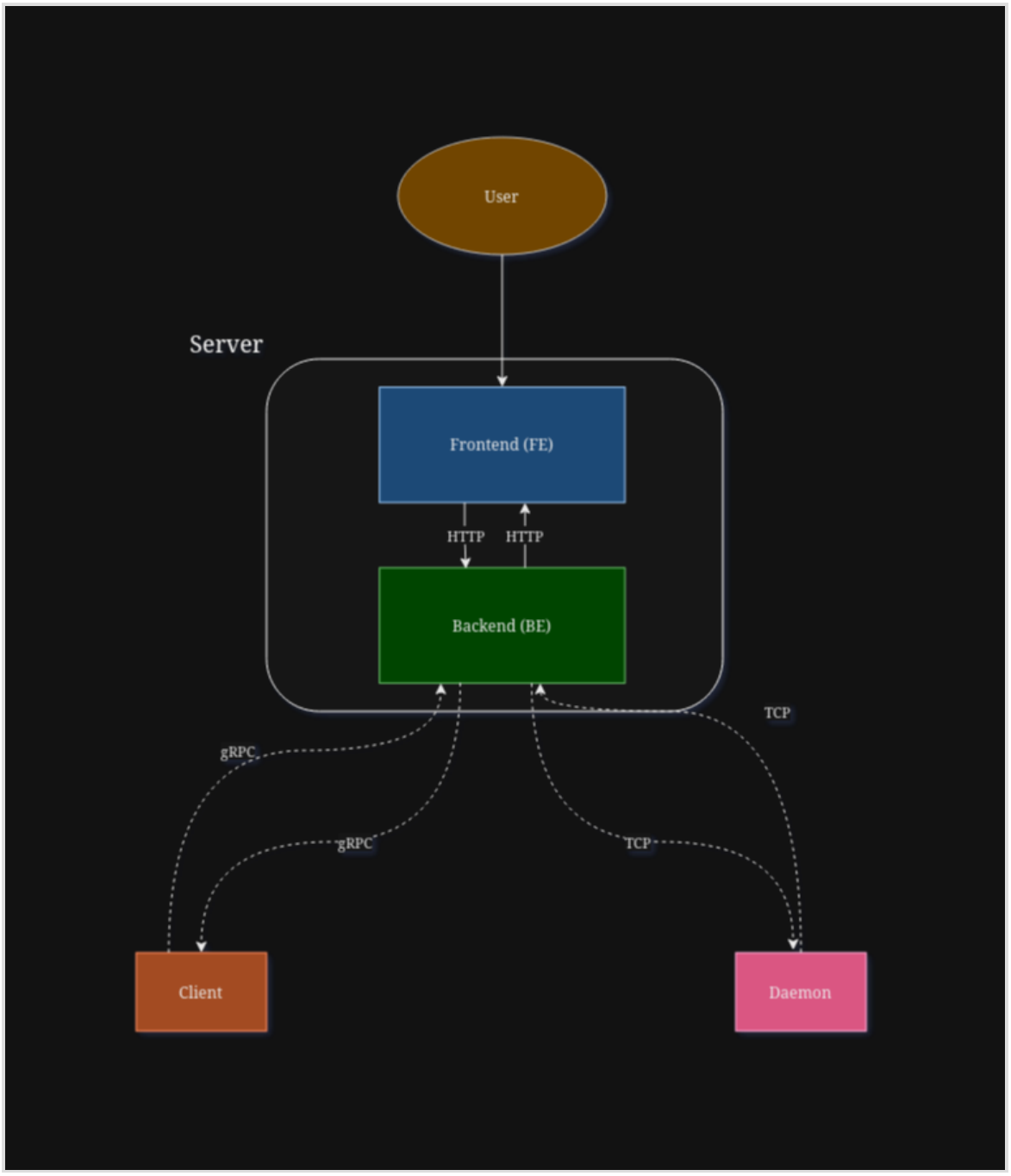
Architectural Notes

- While a fully **Clean Architecture** approach wasn't strictly followed, both the **Frontend (FE)** and **Backend (BE)** adopt a similar structure.

- **Entities (database models)** reside in the `server` folder and are shared between **FE** and **BE**.
    - If FE and BE are deployed on separate servers, the `entities` directory must be moved into each respective folder. Minor refactoring will be required.
- **gRPC Communication:**
  Clients and the backend use **gRPC** for communication. Both must include compiled **protobuf** files:

```
cd client && make proto
cd server/backend && make proto
```

Project Scheme



As shown in the diagram, the **Backend (BE)** is isolated and can only be accessed through the **Frontend (FE)**.

Communication Flow:

- **FE ↔ BE (HTTP/REST API):**
  - **FE:** Sends HTTP requests to BE.
  - **BE:** Handles database interactions and returns data.

- **Daemon ↔ BE (TCP):**
  - After authenticating via **REST API**, the daemon communicates with BE via raw **TCP**.
- **Client ↔ BE (gRPC):**
  - A **bidirectional gRPC stream** allows clients to dynamically send logs and receive updates during **Hashcat** operations.

Directory Mapping:

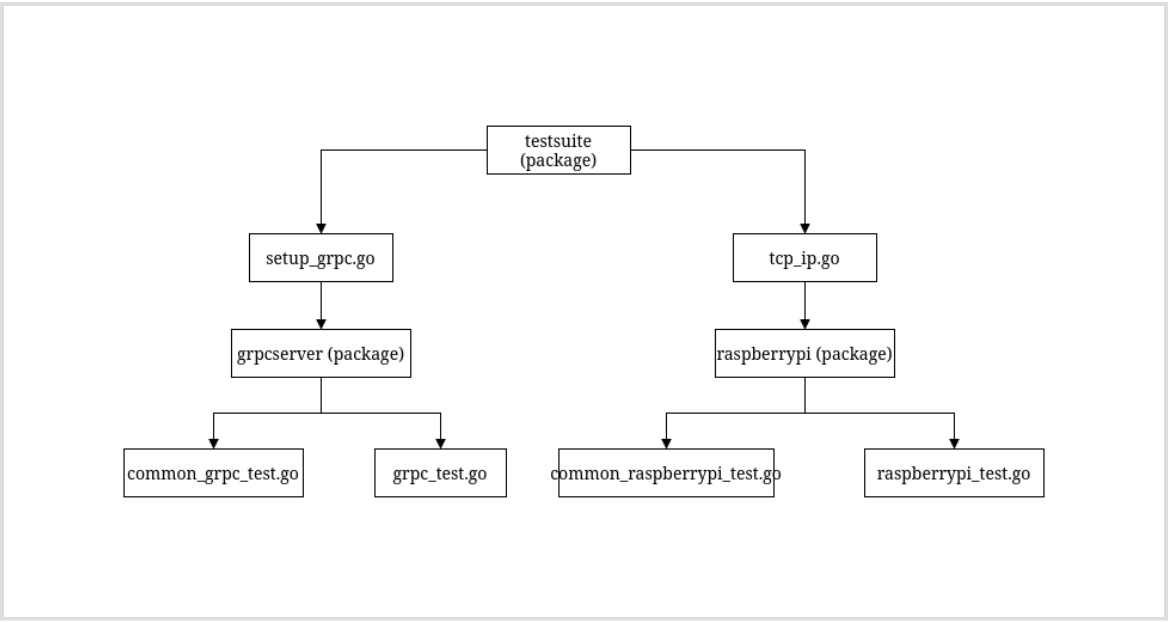
- **Client:** -> `/client`
- **Daemon:** -> `/raspberry-pi`
- **Server:** -> `/server`
  - **Backend:** -> `/server/backend`
  - **Frontend:** -> `/server/frontend`

Test scheme

The tests have been implemented in the backend, emulating `gRPC` and `daemon` clients to test out the methods of these 2 protocols.

When running a test, a `gRPC` server or `tcp` server, along with the rest API, is initialized. It depends on what tests you're running.

It was not that easy to achieve a good solid test scheme, but in the end, it should look something like this.



- `setup_grpc.go` -> set up a grpc mock server to communicate with. It is initialized during `SetupSuite`. The server is killed on `TeardownSuite`. A rest API server is initialized too.
- `tcp_ip.go` -> Set up a tcp mock server to communicate with. It is initialized during `SetupSuite`. The server is killed on `TeardownSuite`. A rest API server is initialized too.
- `common_grpc.go` -> calls `SetupSuite` and `TeardownSuite`, define a structure with mock data useful in tests
- `common_raspberrypi_test.go` -> calls `SetupSuite` and `TeardownSuite`, define a structure with mock data useful in tests
- `grpc_test.go` -> contains tests for grpc infrastructure
- `raspberrypi_test.go` -> contains tests for raspberrypi infrastructure

> A database container must be up and running on port 3306 to run tests.

> You can run tests using `cd server && make test` but env variables must be set before proceeding

```
export BACKEND_HOST="0.0.0.0"
export BACKEND_PORT="4747"
export FRONTEND_HOST="0.0.0.0"
export FRONTEND_PORT="4748"
```

```
export DB_USER="agent"
export DB_PASSWORD="SUPERSECUREUNCRACKABLEPASSWORD" # This
        should be changed (remember to change it in
        database/initialize.sql too)
export DB_HOST="localhost"
export DB_PORT="3306"
export DB_NAME="dp_hashcat"
export ALLOW_REGISTRATIONS="True" # Disable if needed
export DEBUG="True"  # This will enable seeds for having
        some accounts for testing purposes. admin:test1234
        will be created
export RESET="True"
export GRPC_URL="0.0.0.0:7777"
export GRPC_TIMEOUT="10s"
export TCP_ADDRESS="0.0.0.0"
export TCP_PORT="4749"
```

Security and Future Improvements

While security auditing and privacy were not primary objectives for this project, some measures and considerations have been noted:

1. **Encryption:**
    - Currently, **pcap files** sent by the daemon are **not encrypted**.
    - A symmetric encryption key has been generated, but encryption is yet to be implemented.
2. **Daemon Authentication:**
    - Daemon authenticates via **REST API** before establishing a **TCP** connection.
    - Credentials are sent via command-line arguments, which could be stolen easily if a malicious actor have access remotely to the machine.
3. **Client GUI:**
    - A GUI exists in the codebase but remains unfinished due to time constraints.
    - This feature is not critical to the core functionality and may be revisited later.
4. **gRPC Security:**
    - gRPC communication currently lacks **SSL/TLS certificates** for encryption.

Security Measures Implemented:

- Basic protection against vulnerabilities like **SQL Injection** and **IDORs** has been considered.

> If you have suggestions or improvements, feel free to **open a pull request**.

Project files

List of files

```
├── client
│   ├── Dockerfile
│   ├── go.mod
│   ├── go.sum
│   ├── internal
│   │   ├── constants
│   │   │   └── constants.go
│   │   ├── entities
│   │   │   ├── auth_request.go
│   │   │   └── handshake.go
│   │   ├── environment
│   │   │   └── init.go
│   │   ├── grpcclient
│   │   │   ├── communication.go
│   │   │   └── init.go
│   │   ├── gui
│   │   │   ├── login_window.go
│   │   │   └── process_window.go
│   │   ├── hcxtools
│   │   │   └── hcxpcapngtool.go
│   │   ├── mygocat
│   │   │   ├── gocat.go
│   │   │   └── task_handler.go
│   │   ├── resources
│   │   │   └── fonts
```

```
│   │   │       ├── Roboto-BlackItalic.ttf
│   │   │       ├── Roboto-Black.ttf
│   │   │       ├── Roboto-BoldItalic.ttf
│   │   │       ├── Roboto-Bold.ttf
│   │   │       ├── Roboto-Italic.ttf
│   │   │       ├── Roboto-LightItalic.ttf
│   │   │       ├── Roboto-Light.ttf
│   │   │       ├── Roboto-MediumItalic.ttf
│   │   │       ├── Roboto-Medium.ttf
│   │   │       ├── Roboto-Regular.ttf
│   │   │       ├── Roboto-ThinItalic.ttf
│   │   │       └── Roboto-Thin.ttf
│   │   └── utils
│   │       └── utils.go
│   ├── main.go
│   ├── Makefile
│   └── wordlists
├── database
│   ├── Dockerfile
│   ├── initialize.sql
│   └── my.cnf
├── docker-compose.yaml
├── externals
│   ├── gocat
│   ├── hashcat
│   └── hcxtools
├── LICENSE
├── proto-definitions
│   └── hds
│       ├── hds.proto
│       ├── hds_request.proto
│       └── hds_response.proto
├── proto.sh
├── raspberry-pi
│   ├── Dockerfile
│   ├── go.mod
│   ├── go.sum
│   ├── handshakes
```

```
│   │   └── test.pcap
│   ├── internal
│   │   ├── authapi
│   │   │   └── authenticate.go
│   │   ├── cmd
│   │   │   └── command_parser.go
│   │   ├── constants
│   │   │   └── constants.go
│   │   ├── daemon
│   │   │   ├── communication.go
│   │   │   ├── environment.go
│   │   │   └── init.go
│   │   ├── entities
│   │   │   ├── api_entities.go
│   │   │   └── handshake.go
│   │   ├── utils
│   │   │   └── utils.go
│   │   ├── wifi
│   │   │   └── wifi.go
│   │   └── wpaparser
│   │       ├── getwpa.go
│   │       └── parser.go
│   ├── main.go
│   └── Makefile
├── README.md
└── server
    ├── backend
    │   ├── cmd
    │   │   └── main.go
    │   └── internal
    │       ├── constants
    │       │   └── constants.go
    │       ├── errors
    │       │   └── errors.go
    │       ├── grpcserver
    │       │   ├── commands.go
    │       │   ├── common_grpc_test.go
    │       │   ├── controllers.go
```

```
    |       |   ├── grpc_test.go
    |       |   ├── init.go
    |       |   └── options.go
    |       ├── infrastructure
    |       |   └── database.go
    |       ├── raspberrypi
    |       |   ├── common_raspberrypi_test.go
    |       |   ├── components.go
    |       |   ├── init.go
    |       |   ├── raspberrypi_test.go
    |       |   └── tcp_server.go
    |       ├── repository
    |       |   └── repository.go
    |       ├── response
    |       |   └── response.go
    |       ├── restapi
    |       |   ├── authenticate
    |       |   |   ├── handler_anonymous.go
    |       |   |   └── handler_user.go
    |       |   ├── client
    |       |   |   └── handler_user.go
    |       |   ├── handlers.go
    |       |   ├── handshake
    |       |   |   └── handler_user.go
    |       |   ├── logout
    |       |   |   └── handler_user.go
    |       |   ├── middlewares
    |       |   |   ├── auth_middlware.go
    |       |   |   ├── common_middleware.go
    |       |   |   └── log_requests.go
    |       |   ├── raspberrypi
    |       |   |   └── handler_user.go
    |       |   ├── register
    |       |   |   └── anonymous_handler.go
    |       |   └── routes.go
    |       ├── seed
    |       |   └── seed_api.go
    |       ├── testsuite
```

```
    │       │   ├── auth_api.go
    │       │   ├── setup_grpc.go
    │       │   └── tcp_ip.go
    │       ├── usecase
    │       │   └── usecase.go
    │       └── utils
    │           ├── utils.go
    │           └── validator.go
    ├── Dockerfile
    ├── entities
    │   ├── client.go
    │   ├── handshake.go
    │   ├── raspberry_pi.go
    │   ├── role.go
    │   ├── uniform_response.go
    │   └── user.go
    ├── frontend
    │   ├── cmd
    │   │   ├── custom.go
    │   │   └── main.go
    │   ├── internal
    │   │   ├── constants
    │   │   │   └── constants.go
    │   │   ├── errors
    │   │   │   └── errors.go
    │   │   ├── middlewares
    │   │   │   ├── auth_middleware.go
    │   │   │   ├── cookie_middleware.go
    │   │   │   └── log_requests.go
    │   │   ├── pages
    │   │   │   ├── clients
    │   │   │   │   └── clients.go
    │   │   │   ├── handshakes
    │   │   │   │   └── handshake.go
    │   │   │   ├── login
    │   │   │   │   └── login.go
    │   │   │   ├── logout
    │   │   │   │   └── logout.go
```

```
    │   │   │   ├── pages.go
    │   │   │   ├── raspberrypi
    │   │   │   │   └── raspberrypi.go
    │   │   │   ├── register
    │   │   │   │   └── register.go
    │   │   │   ├── routes.go
    │   │   │   └── welcome
    │   │   │       └── welcome.go
    │   │   ├── repository
    │   │   │   └── repository.go
    │   │   ├── response
    │   │   │   └── response.go
    │   │   ├── usecase
    │   │   │   └── usecase.go
    │   │   └── utils
    │   │       ├── utils.go
    │   │       └── validator.go
    │   ├── static
    │   │   ├── images
    │   │   │   └── logo.png
    │   │   ├── scripts
    │   │   │   ├── bootstrap.min.js
    │   │   │   ├── dashboard.js
    │   │   │   ├── github-stats.js
    │   │   │   ├── jquery-3.3.1.min.js
    │   │   │   ├── popper.min.js
    │   │   │   └── theme-toggle.js
    │   │   ├── static.go
    │   │   └── styles
    │   │       ├── bootstrap-4.3.1.min.css
    │   │       ├── custom.css
    │   │       └── main.css
    │   └── views
    │       ├── clients.html
    │       ├── handshake.html
    │       ├── login.html
    │       ├── raspberrypi.html
    │       ├── register.html
```

```
    │       ├── views.go
    │       └── welcome.html
    ├── go.mod
    ├── go.sum
    ├── main.go
    └── Makefile

79 directories, 143 files
```

Daemon

The Raspberry Pi component is designed to **send network captures performed by `bettercap` to the server**. Its functionality is straightforward: you run the `bettercap` daemon on the Raspberry Pi, and it automatically transmits captured handshakes to the server whenever your local Wi-Fi SSID is detected nearby.

> This feature is **disabled** if the `TEST` environment variable is set to `False`. Ensure that your Raspberry Pi has at least **two network interfaces**, with one interface always connected to a stable network.

> **Tested on Raspberry Pi 5 Model B Rev. 2**

> Update the `wlan1` interface to match your network interface. Make sure your Wi-Fi card supports **monitor mode** and **packet injection**.

What Does the Daemon Do?

The daemon performs the following tasks:

1. Acts as a **TCP/IP client** to establish raw network connections.

2. Scans all `.PCAP` files located in the `~/handshakes` directory (typically where `bettercap` saves handshakes).
3. Utilizes the `gopacket` library to read `.PCAP` file layers, extracting **BSSID** and **SSID** information, and verifying if a **valid 4-way handshake** exists.
4. If a valid handshake is detected, the daemon **encodes the file in Base64** and sends it to the server.
5. Waits for a predefined **delay period** before repeating the process.

Run Bettercap

This configuration sets up `bettercap` to capture handshakes and save them in the correct directory.

```
sudo bettercap -iface wlan1 -eval 'set
        wifi.handshakes.aggregate false; set
        wifi.handshakes.file ~/handshakes; wifi.recon on;
        set wifi.show.sort clients desc; set ticker.commands
        "wifi.deauth *; clear; wifi.show"; set ticker.period
        60; ticker on';
```

> The daemon uses the `HOME` directory as its base. Since `bettercap` requires `sudo`, you must run the daemon as `root`.

Other Useful Bettercap Commands

These commands can help you fine-tune your `bettercap` setup:

`sudo bettercap -iface wlan1`
`wifi.recon BBSID`
`wifi.recon on`
`wifi.recon.channel N; # N is the channel to recon`

Compile and Run the Daemon

Make sure the following requirements are met before building and running the daemon:

> The daemon requires `libpcap0.8-dev` to be installed on your system.

> The file `/etc/machine-id` must exist on your machine.

Follow these steps to compile and run the daemon:

```
cd raspberry-pi
go mod verify
go mod tidy
go build main.go
sudo ./main
```

Client

Clients communicate with the server using **`gRPC`**. This enables clients to identify whether they are the intended receiver for a specific cracking task.

The communication channel also supports a **bidirectional stream**, allowing the server and client to exchange messages in real time during `hashcat` execution.

What Does the Client Do?

A client performs the following tasks:

1. **Waits for tasks** from the server.
2. Upon receiving a task, it **acknowledges the server**.
3. The server then **removes the task from the `pending` queue** and updates its status. Meanwhile, the client saves the **base64-encoded hash file** into a temporary directory.

4. Once saved as a **`.PCAP` file**, the client converts it into a **hash format compatible with `hashcat`**.
5. The client uses **`hcxtools`** for the conversion. This library supports multiple operations on `.PCAP` files and beyond.
6. After conversion, **`hashcat` begins execution**, applying user-defined or default options.
7. **Logs and status updates** generated by `hashcat` are sent asynchronously to the server.
8. If `hashcat` successfully cracks the password, the **result is sent back to the server**.
9. The client then resets itself and **waits for the next task**.

Gocat

The client uses the **`gocat`** dependency to execute `hashcat` from within Go. Since `hashcat` is written in **C**, a **porting layer** was required to bridge the two environments.

Hcxtools

For our use case, we rely specifically on **`hcxpcapngtool`** from the `hcxtools` suite.

This tool doesn't natively support building as a shared library. To work around this limitation and enable its integration with Go, we **modified its entry point** using `sed`:

```
sed -i 's/int main(int argc, char \*argv\[\])/int
        convert_pcap(int argc, char *argv\[\])/'
        hcxpcapngtool.c
```

This command replaces the standard `main` function signature with `convert_pcap`. We then compile it into a shared library:

```
cc -fPIC -shared -o /app/client/libhcxpcapngtool.so /app/
        hcxtools/hcxpcapngtool.c -lz -lssl -lcrypto -
        DVERSION_TAG=\"6.3.5\" -DVERSION_YEAR=\"2024\"
```

This shared library can now be directly imported and used in Go:

File: `client/internal/hcxtools/hcxpcapngtool.go`

```
/*
#cgo LDFLAGS: -L../../ -lhcxpcapngtool
#include <stdlib.h>

// Declare the convert_pcap function from the shared library
int convert_pcap(int argc, char *argv[]);
*/
import "C"
import (
"fmt"
"unsafe"
)

func ConvertPCAPToHashcatFormat(inputFile, outputFile string)
        error {
// Prepare arguments for the convert_pcap function
args := []string{"", inputFile, "-o", outputFile}
argc := C.int(len(args))
argv := make([]*C.char, len(args))

    // Convert Go string slices to C strings
    for i, arg := range args {
        argv[i] = C.CString(arg)
        defer C.free(unsafe.Pointer(argv[i]))
    }

    // Call the convert_pcap function from the shared
        library
    ret := C.convert_pcap(argc, &argv[0])
    if ret != 0 {
        return fmt.Errorf("hcxpcapngtool conversion failed
        with code %d", ret)
    }
```

```
    return nil
}
```

While this solution works for our current requirements, future improvements could include **porting the library fully to Go**. However, this is considered **out of scope** for the current project.

Compile and Run

> The following dependencies are required before proceeding

```
apt update -y && \
    apt install -y --no-install-recommends \
    libminizip-dev \
    ocl-icd-libopencl1 \
    opencl-headers \
    pocl-opencl-icd \
    build-essential \
    wget \
    git \
    dumb-init \
    ca-certificates \
    libz-dev \
    libssl-dev \
    dbus \
    # Graphic libraries for raylib
    libgl1-mesa-dev libxi-dev libxcursor-dev libxrandr-dev
        libxinerama-dev libwayland-dev libxkbcommon-dev
```

> The file `/etc/machine-id` must exist on your machine.

Follow these steps to compile and run the client, run it from project root dir

```
git submodule init
git submodule update
git pull --recurse-submodule
```

Then

```
BASE=${PWD}

# Environment Variables
export HASHCAT_SRC_PATH="${BASE}/client/hashcat"
export CGO_CFLAGS="-I$HASHCAT_SRC_PATH/OpenCL -
I$HASHCAT_SRC_PATH/deps/LZMA-SDK/C -I$HASHCAT_SRC_PATH/deps/
zlib -I$HASHCAT_SRC_PATH/deps/zlib/contrib -
I$HASHCAT_SRC_PATH/deps/OpenCL-Headers $CGO_CFLAGS"

# Proto:
cd client
make proto

cd ${BASE}/externals/hashcat
git checkout v6.1.1

cd ${BASE}

# Directories
mkdir -p "${BASE}/client/hashcat" "${BASE}/client/gocat" "$
{BASE}/client/hcxtools"

cp -r externals/hashcat/* "${BASE}/client/hashcat/"
cd "${BASE}/client/hashcat"
sudo make install SHARED=1 ENABLE_BRAIN=0
sudo cp deps/LZMA-SDK/C/LzmaDec.h /usr/local/include/
hashcat/
sudo cp deps/LZMA-SDK/C/7zTypes.h /usr/local/include/
hashcat/
sudo cp deps/LZMA-SDK/C/Lzma2Dec.h /usr/local/include/
hashcat/
sudo cp -r OpenCL/inc_types.h /usr/local/include/hashcat/
sudo cp -r deps/zlib/contrib /usr/local/include/hashcat
```

```
sudo ln -sf /usr/local/lib/libhashcat.so.6.1.1 /usr/local/
lib/libhashcat.so
sudo ln -sf /usr/local/lib/libhashcat.so.6.1.1 /usr/lib/
libhashcat.so.6.1.1


cd ${BASE}

cp -r externals/gocat/* "${BASE}/client/gocat/"
cd "${BASE}/client/gocat"
go test -c
sudo cp gocat.test /usr/local/share/hashcat
sudo cp -r testdata /usr/local/share/hashcat
/usr/local/share/hashcat/gocat.test


cd ${BASE}

sudo chown -R ${USER}:${USER} "${BASE}/client"
sudo chown -R ${USER}:${USER} /usr/local/share/hashcat

ln -sf /usr/local/share/hashcat/hashcat.hcstat2 "${BASE}/
client/hashcat.hcstat2"
ln -sf /usr/local/share/hashcat/hashcat.hctune "${BASE}/
client/hashcat.hctune"
ln -sf /usr/local/share/hashcat/OpenCL "${BASE}/client/
OpenCL"
ln -sf /usr/local/share/hashcat/kernels "${BASE}/client/
kernels"
ln -sf /usr/local/share/hashcat/modules "${BASE}/client/
modules"

cp -r externals/hcxtools/* "${BASE}/client/hcxtools/"
sed -i 's/int main(int argc, char \*argv\[\])/int
convert_pcap(int argc, char *argv\[\])/' "${BASE}/client/
hcxtools/hcxpcapngtool.c"
cc -fPIC -shared -o "${BASE}/client/libhcxpcapngtool.so" "$
```

```
{BASE}/client/hcxtools/hcxpcapngtool.c" -lz -lssl -lcrypto -
DVERSION_TAG=\"6.3.5\" -DVERSION_YEAR=\"2024\"


cd "${BASE}/client"
go mod verify
go mod tidy
go build main.go
```

Run:

```
export GRPC_URL=localhost:7777
export GRPC_TIMEOUT=10s
export DISPLAY=${DISPLAY} # Pass display variable from
terminal
export LD_LIBRARY_PATH=client/:$LD_LIBRARY_PATH
./main
```

Produces files tree

```
├── hashcat
├── gocat        <-- From /externals/gocat
├── hcxtools     <-- From /externals/hcxtools
├── client
│   ├── main
│   ├── hashcat.hcstat2 (symlink)
│   ├── hashcat.hctune (symlink)
│   ├── OpenCL (symlink)
│   ├── kernels (symlink)
│   ├── modules (symlink)
│   ├── libhcxpcapngtool.so
```

Server

The **Server** is divided into two main components:

- **Backend**
- **Frontend**

What Does the Backend Do?

The **backend** performs the following tasks:

1. Initializes a connection with the **database**.
2. Starts a basic `HTTPServer` to expose the **REST API**, potentially creating **seeds/mock data** for testing purposes.
3. Initializes a `gRPC` server to handle communication with **clients**.
4. Initializes a `TCP` server to handle communication with **daemons**.
5. Encapsulates the **core application logic queue**.

What Does the Frontend Do?

The **frontend** performs the following tasks:

1. Starts a basic `HTTPServer` and parses **template files** to expose a user interface.
2. Accepts **user inputs** and communicates with the **backend** using `REST API` by performing **HTTP requests**.

Compile and Run

> You need to export the following **environment variables**. Customize them as needed.

1. Start Database

```
cd database
docker build -t dp-database .
docker run -d \
--name dp-database \
-e MYSQL_RANDOM_ROOT_PASSWORD=yes \
--restart unless-stopped \
-p 3306:3306 \
--health-cmd="mysqladmin ping -h localhost -uagent -
```

```
pSUPERSECUREUNCRACKABLEPASSWORD" \
--health-interval=20s \
--health-retries=10 \
dp-database
```

---

2. Export Environment Variables

```
export BACKEND_HOST="0.0.0.0"
export BACKEND_PORT="4747"
export FRONTEND_HOST="0.0.0.0"
export FRONTEND_PORT="4748"
export DB_USER="agent"
export DB_PASSWORD="SUPERSECUREUNCRACKABLEPASSWORD" # This should be changed (remember to change it in database/initialize.sql too)
export DB_HOST="localhost"
export DB_PORT="3306"
export DB_NAME="dp_hashcat"
export ALLOW_REGISTRATIONS="True" # Disable if needed
export DEBUG="True"  # This will enable seeds for having some accounts for testing purposes. admin:test1234 will be created
export RESET="True"
export GRPC_URL="0.0.0.0:7777"
export GRPC_TIMEOUT="10s"
export TCP_ADDRESS="0.0.0.0"
export TCP_PORT="4749"
```

---

3. Compile and Run the Server

```
cd server
make proto
go mod tidy
go build main.go
./main
```

After completing these steps, the **server** should be up and running, with both the **frontend** and **backend** components functioning as expected.

External Dependencies

Ignoring gRPC and other basic deps

- **RayLib** `github.com/gen2brain/raylib-go/raylib` A basic graphic library
- **Gocat** `github.com/mandiant/gocat/v6` Used for running hashcat in go via `hashcatlib`
- **Validator** `github.com/go-playground/validator/v10` Validator for go structures
- **Mux** `github.com/gorilla/mux` HTTP router
- **Testify** `github.com/stretchr/testify` A test library for simplifying test syntax
- **Gopacket** `github.com/google/gopacket` Parse `.PCAP` files as layers
- **Wifi** `github.com/mdlayher/wifi` used by daemon for understanding if we're connected to our local network
- **Cobra** `github.com/spf13/cobra` used for parsing command line arguments easily in daemon