实 验 报 告

课程名称 信息安全

学　院 软件学院

专　业 软件工程

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实验项目名　　称	Needham-Schroeder Protocol	成绩	

一、实验目的

1. 理解 Needham-Schroeder 协议
2. 理解针对 Needham-Schroeder 协议的中间人攻击

二、实验内容

1. The public-key protocol

Needham-Schroeder 协议是基于可信第三方实现**密钥分发**与**身份认证**的协议，可信第三方为通信双方分发密钥，采用 Challenge/Response 的方式，使得通信双方互相认证对方的身份。

2. Attacking the Needham-Scroeder (Public Key) Protocol

这个协议很容易受到中间人攻击。如果一个冒名顶替者可以欺骗 A 与他开始一个会话，他可以将信息传递给 B，并使 B 相信他正在与 A 进行通信。在攻击结束时，B 错误地认为 A 正在与他通信。

三、实验步骤

1.实现 PKI

此处 PKI 作为可信第三方，其作用在于为通信双方进行密钥的分发，代码逻辑是接受请求，解析出请求方通信对象，并将其公钥回复给请求方。

```
def extract():
    """() -> NoneType
    Opens the public key infrastructure server to extract RSA public keys.
    The public keys must have already been in the server's folder.
    """
    with socket(AF_INET, SOCK_STREAM) as sock:
        sock.bind((PKI_HOST, PKI_PORT))
        sock.listen()

        while True:
            conn, addr = sock.accept()
            with conn:
                print('PKI: connection from address', addr)
                # A, B --->
                # <--- {K_PB, B}(K_PA)
                # WRITE YOUR CODE HERE!
                data = conn.recv(1024)
                data = data.decode()
                sender, target = data.split(",")

                sender_public_key_file = f"{sender}.asc"
                target_public_key_file = f"{target}.asc"
```

```
                with open(sender_public_key_file, "rb") as file:
                    sender_public_key = file.read()
                    sender_public_key_str = sender_public_key.decode('utf-8')

                with open(target_public_key_file, "rb") as file:
                    target_public_key = file.read()
                    target_public_key_str = target_public_key.decode('utf-8')

                response = rsa.big_encrypt(rsa.import_key(sender_public_key),
f"{target_public_key_str},{target}")

                conn.sendall(b','.join(response))
```

2.实现 NS 公钥协议

该环节分为两个部分：client 和 server，也就是该协议中提到的通信双方 A、B。两部分的代码是相互关联的，大体过程是 A 从 PKI 得到 B 的公钥后，向 B 发送自身标识与随机数字 N_a，B 也从 PKI 得到 A 的公钥，向 A 发送收到的 N_a 与生成的随机数 N_b，A 检验 N_a 的正确性，再向 B 发送对称密钥与收到的 N_b，B 检验 N_b 的正确性，之后确认连接。

client：

```
def ns_authentication(sock, server_name):
    # get RSA key of Client
    with open("RsaKey.asc", "rb") as file:
        private_key = file.read()

    pks_address = (PKI_HOST, PKI_PORT)
    server_public_key = ns.get_public_key(pks_address, host_name, NAME,
rsa.import_key(private_key))

    # A -- {N_A, A}(K_PB) --> B
    n_a = ns.generate_nonce()
    # print(server_public_key)
    request = rsa.big_encrypt(rsa.import_key(server_public_key),
f"{n_a},{NAME}")
    # print(request)
    sock.sendall(b','.join(request))

    # A <-- {N_A, N_B}(K_PA) -- B
    response = sock.recv(1024)
    response = rsa.big_decrypt(rsa.import_key(private_key),
response.split(b','))
    n_a_received, n_b_received = response.split(",")
    if n_a != int(n_a_received):
        raise SystemExit(f"n_a != n_a_received")

    # A -- {K, N_B}(K_PB) --> B
    aes_key = aes.generate_key()
    request2 = rsa.big_encrypt(rsa.import_key(server_public_key),
```

```
f"{aes_key.decode()},{n_b_received}")
    sock.sendall(b','.join(request2))

    # get confirmation
    if int(sock.recv(1024)) != RESP_VERIFIED:
        raise SystemExit(f"no RESP_VERIFIED")

    print("Client: connection verified!")
    return aes_key
```

server:

```
def ns_authentication(conn):
    # get RSA key of Server for decrypting
    with open("RsaKey.asc", "rb") as file:
        private_key = file.read()

    # A -- {N_A, A}(K_PB) --> B
    response = conn.recv(1024)
    # print(response)
    response = rsa.big_decrypt(rsa.import_key(private_key),
response.split(b','))
    # print(response)
    n_a_received, client = response.split(",")

    # get client's public key
    pks_address = (PKI_HOST, PKI_PORT)
    client_public_key = ns.get_public_key(pks_address, client, NAME,
rsa.import_key(private_key))

    # A <-- {N_A, N_B}(K_PA) -- B
    n_b = ns.generate_nonce()
    request = rsa.big_encrypt(rsa.import_key(client_public_key),
f"{n_a_received},{n_b}")
    conn.sendall(b','.join(request))

    # A -- {K, N_B}(K_PB) --> B
    response2 = conn.recv(1024)
    response2 = rsa.big_decrypt(rsa.import_key(private_key),
response2.split(b','))
    aes_key, n_b_received = response2.split(",")
    if n_b != int(n_b_received):
        raise SystemExit(f"n_b != n_b_received")

    conn.sendall(bytes(str(RESP_VERIFIED), "utf-8"))

    return aes_key.encode(), client
```

3.实现对 NS 公钥协议的中间人攻击

该部分中间人的做法主要是借助 A 实现了与 B 的连接，将 B 的发送转发给 A，将回复结果经由自

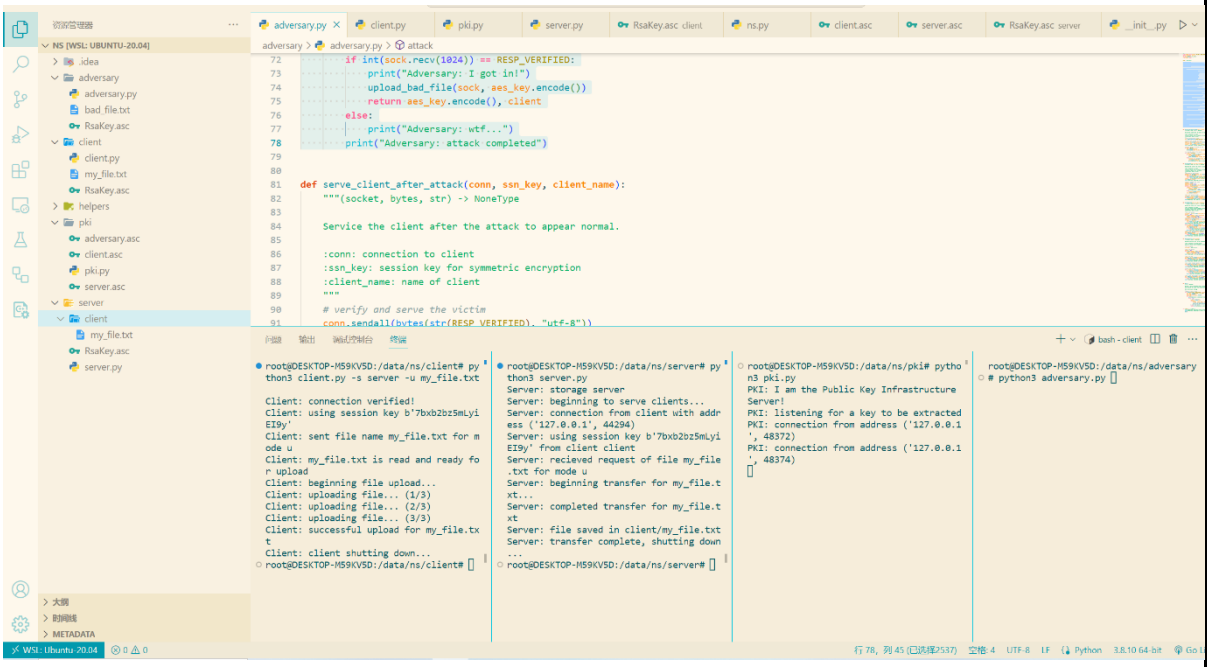
己加工转发给 B。

```
def attack(conn):
    # get RSA key of Adversary for decrypting
    with open("RsaKey.asc", "rb") as file:
        private_key = file.read()

    # A -- {N_A, A}(KP_M) --> M (server)
    response = conn.recv(1024)
    response = rsa.big_decrypt(rsa.import_key(private_key),
response.split(b','))
    n_a_received, client = response.split(",")

    # get public key of Server for encrypting
    pks_address = (PKI_HOST, PKI_PORT)
    server_public_key = ns.get_public_key(pks_address, "server", NAME,
rsa.import_key(private_key))

    # open connection with Server (client)
    address = (SERVER_HOST, SERVER_PORT)
    aes_key = None
    with socket(AF_INET, SOCK_STREAM) as sock:
        sock.connect(address)

        # M -- {N_A, A}(KP_B) --> B (client)
        request = rsa.big_encrypt(rsa.import_key(server_public_key),
f"{n_a_received},{client}")
        sock.sendall(b','.join(request))

        # M <-- {N_A, N_B}(KP_A) -- B (client)
        response2 = sock.recv(1024)

        # A <-- {N_A, N_B}(KP_A) -- M (server)
        conn.sendall(response2)

        # A -- {K, N_B}(KP_M) --> M (server)
        response3 = conn.recv(1024)
        response3 = rsa.big_decrypt(rsa.import_key(private_key),
response3.split(b','))
        aes_key, n_b_received = response3.split(",")

        # M -- {K, N_B}(KP_B) --> B (client)
        request2 = rsa.big_encrypt(rsa.import_key(server_public_key),
f"{aes_key},{n_b_received}")
        sock.sendall(b','.join(request2))

        # check if MITM attack was successful
        if int(sock.recv(1024)) == RESP_VERIFIED:
            print("Adversary: I got in!")
```

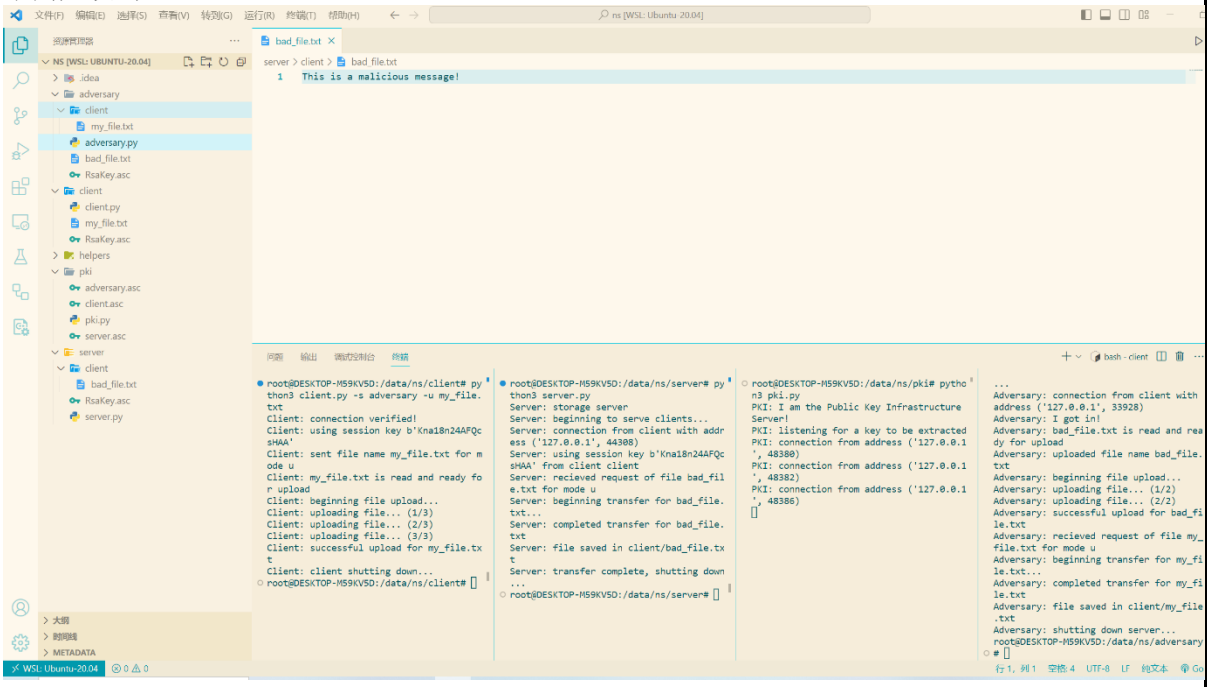
```
            upload_bad_file(sock, aes_key.encode())
            return aes_key.encode(), client
        else:
            print("Adversary: wtf...")
        print("Adversary: attack completed")
```

四、实验结果及分析

正常情况下：



中间人攻击：



五、实验总结

该实验实现了 Needham-Schroeder 协议，这是一个基于可信第三方的协议；同时，根据该协议的特点，实践了针对该协议的中间人攻击。