

MITM Attacks on HTTPS: Another Perspective

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MITM Attacks on HTTPS: Another Perspective

About me



- Pentester
- Security researcher
- WEB/info/network security fun
- Easyhack for "Kakep"
- Co-organizer ZeroNights
- Co-organizer Defcon Russia 7812



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![@ Digital Security 3 MITM Attacks on HTTPS: Another Perspective HTTPS • TLS (SSL)+ HTTP • Protects against man-in-the-middle attacks • Authentication, Encryption, Integrity – Silver bullet ? • Crypto attacks:

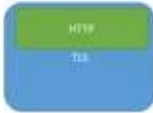
- POODLE, BEAST, CRIME... Hard to exploit](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-3-320.jpg>)

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MITM Attacks on HTTPS: Another Perspective

TLS specifics

- Knows nothing including protocol: HTTP/SMTP/POP3/TDS/...+TLS



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MITM Attacks on HTTPS: Another Perspective

TLS specifics

- Application layer
- Knows nothing about underlying protocol
- Doesn't protect against destination changing (IP, port)



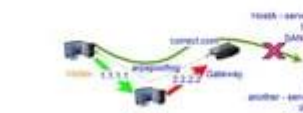

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MITM Attacks on HTTPS: Another Perspective

TLS specifics

- Authentication using x509 certificates
- Client compares server name and SAN field of certificate




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Certificates features and limitations

- Doesn't care about port (many services – 1 certificate)
- For a wide range of domain names:
 - Many names in SAN - Subject Alternative Name (+ CN*)
 - Wildcard certificate
- No SNI
- TLS cache **
- HTTP/2 connection sharing**

*Since IE, Chrome doesn't check CN, only SAN (because of BFC)

** <http://antoine.delamar-leveut.fr/doc/www15.pdf>

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Wildcard names



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A lot of names in SAN

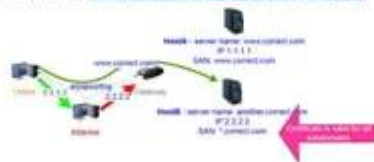


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TLS Redirection

- Group of MitM attacks – misuse of authentication limits and features
- Any protocol
 - Virtual host confusion (<http://antoine.delamar-leveut.fr/doc/www15.pdf>)



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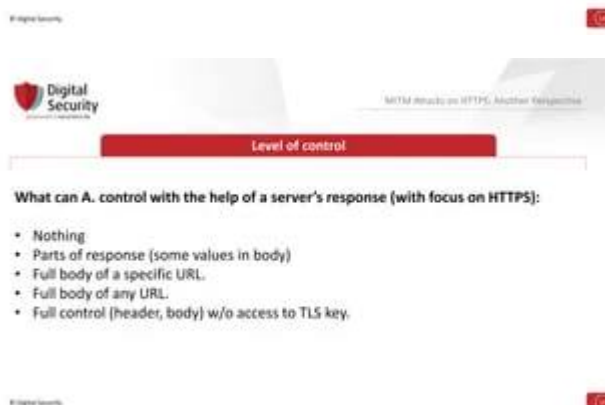
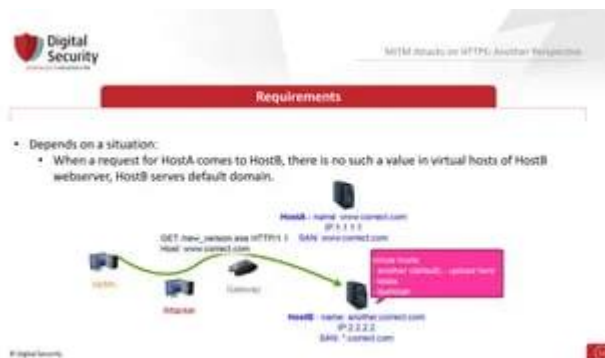
Simplest example

- Attacker (A) controls files on HostB
- A. uploads own new_version.exe on HostB
- Autoupdate on Victim (V) requests a new version of software: https://www.connect.com/new_version.exe
- A. MitMs and redirect to HostB
- Autoupdate downloads and runs A's exe file



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!© Digital Security 16 MITM Attacks on HTTPS: Another Perspective Common example – XSS XSS on HostB (Part of body)

1. V. request to HostA + xss of HostB

https://www.correct.com/xss_of_hostb_here

1. A. MitMs and changes an IP

2. HostB responses with A's JS

3. V. executes JS (context of HostA)

4. A. stops the MitM attack

5. JS can interact with HostA in a usual

way Browser knows nothing about MitM!](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-16-320.jpg>)

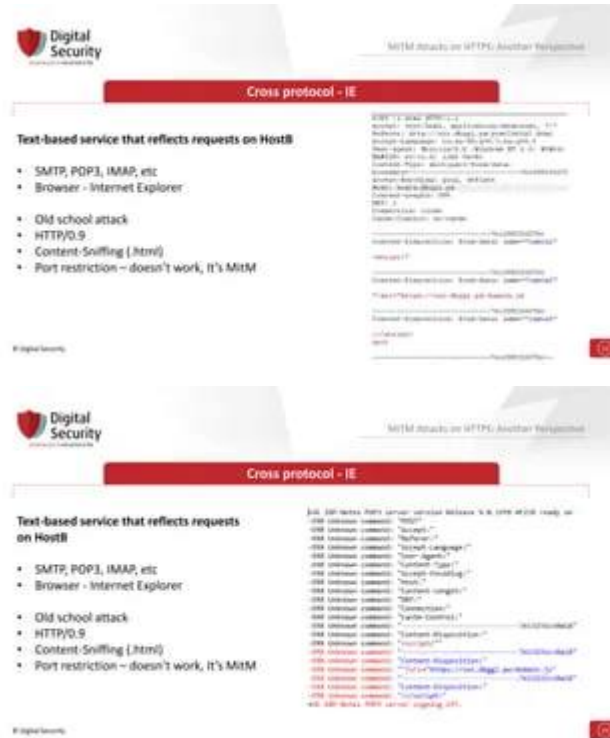


![@ Digital Security 21 MITM Attacks on HTTPS: Another Perspective Flash Crossdomain.xml w/ * on HostB (nothing)

1. V . opens A's swf
2. Swf sends request to HostA
3. Flash checks crossdomain.xml

4. A. MitMs and changes an IP
5. HostB responses w/ crossdomain.xml
6. Swf is allowed to interact w/ HostA
7. A. stops the MitM attack
8. SWF can interact with HostA in a

usual way](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-21-320.jpg>)



![@ Digital Security 24 MITM Attacks on HTTPS: Another Perspective Cross protocol - IE

1. V. sends the POST request w/ JS payload to "any_url.html on" to HostA

1. A. MitMs and changes an IP
2. HostB reflects the request
3. IE interprets it as HTTP/0.9
4. ".html" forces IE to parse as html
5. V. executes JS (in the context of HostA)
6. A. stops the MitM attack
7. JS can interact with HostA in a usual way](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-24-320.jpg>)



![@ Digital Security 26 MITM Attacks on HTTPS: Another Perspective Cross protocol – Other browsers (FF, Chrome) A. wants to steal Basic Auth header or HttpOnly cookie A. has XSS on HostA (can execute JS in it's context) (Nothing)

1. JS sends a request to HostA
2. A. MitMs and changes IP
3. HostB reflects the request

-Browser interprets it as HTTP/0.9, text/plain

- JS is allowed to read response (same origin)](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-26-320.jpg>)

![@ Digital Security 27 MITM Attacks on HTTPS: Another Perspective JavaScript +DOM Web app w/ JQuery uses load() to get content Text-based service that reflects requests on HostB (Nothing) or file uploading is possible

1. A. sets a cookie w/ xss on HostA (cookie forcing)

Set-Cookie: test=<script src="...">

1. V. opens HostA. JQuery is loaded.
2. For other requests load() is used
3. load sends a request to HostA
4. A. MitMs and changes an IP
5. HostB reflects the request

-Browser interprets it as HTTP/0.9, text/plain

- JQuery.load parses it and execute our XSS payload
- Our JS can interact with HostA in a usual way](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-27-320.jpg>)

![@ Digital Security 28 MITM Attacks on HTTPS: Another Perspective REST API V. is a web app that checks auth (for 200 OK) using HostA REST API Text-based service that reflects requests on HostB (Nothing) or it returns 200 OK for any requests

1. A. tries to auth on V
2. V. sends request to HostA to check auth
3. A. MitMs and changes an IP
4. HostB reflects all the request
5. Curl interprets it as HTTP/0.9 *

6. Curl returns CURLE_OK
7. A. is authenticated
8. <https://github.com/curl/curl/issues/467>](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-28-320.jpg>)

MitM Attacks on HTTPS: Another Perspective

Upload anything

A. can upload files on HostB

Too simple:

- Html w/ xss , SWF, PDF ... (SDRF attack)
- Everything is executed in the context of HostA

The same attack as in the example with XSS

MitM Attacks on HTTPS: Another Perspective

Active content substitution

A. can upload files on HostB, but w/ "uninteresting" Content-Type (text/plain, image/png) or Content-Disposition (any path)

Think out of the box:

- Page consists of html, external files – JavaScript and CSS
 - Force downloading JS from another host
 - https://hosta/script.js

```

<script src=javascript:alert('xss!')></script>
<script src=https://www.example.com/js/script.js></script>

```

MitM Attacks on HTTPS: Another Perspective

Active content substitution

- Page consists of html, external files – JavaScript and CSS
 - force downloading JS from another host
 - One TLS for all content?

The diagram illustrates a secure connection between HostA and HostB. HostA sends a request for 'https://index.html' to HostB. HostA also sends a request for 'https://script.js' to HostB. HostB is identified by its name 'another.com' and port '443'. The certificate's Subject Alternative Name (SAN) is '*.another.com'. A red box highlights the text 'Script js (victim's JS)'.

![@ Digital Security 32 MITM Attacks on HTTPS: Another Perspective Browsers behavior <script src="script.js"> and headers:

- no browser cares about Content-Disposition header
- IE doesn't care about Content-Type header (without nosniff)
- FF, Chrome, Edge don't execute script only if Content-Type is from "image" family (without nosniff)
- with X-Content-Type-Options, all the browsers require correct

Content-Type](https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-32-320.jpg)

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MITM Attacks on HTTPS: Another Perspective

Active content substitution

Possible Attacks:

- External files is on another web site (<https://static.correct.com/script.js>).
→ easy for MitM (<https://static.correct.com> → HostB)

```

@ HostA
HostA: http-get http://www.example.com/...
HostA: </GET>
HostA:
@ HostB
HostB: http-get http://static.correct.com/script.js
HostB: </GET>
HostB:
  
```

Protocol attacks

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MITM Attacks on HTTPS: Another Perspective

Active content substitution

Possible Attacks:

- WPAD
 - Automatic proxy detection. Windows, by default
 - Pac file w/ rules
 - For Chrome, Firefox: different proxies for different URLs
 - Chrome – patched, FF – will be patched
 - Windows – partly patched; after BH 2016
 - Now: Useful only for different sites (and tricks)

```

function FindProxyForURL(url, host) {
  if (url === "http://www.example.com") {
    return "DIRECT";
  } else if (url === "http://static.correct.com") {
    return "PROXY 192.168.1.1:8080";
  } else {
    return "DIRECT";
  }
}
  
```

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MITM Attacks on HTTPS: Another Perspective

Active content substitution

Possible Attacks:

- Browser's cache misuse
 - By default, web servers add cache headers to "static" content (javascript, css, etc)
 - Browser cache is URL-based

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!© Digital Security 36 MITM Attacks on HTTPS: Another Perspective Active content substitution A. can upload files on HostB, but w/ “uninteresting” Content-Type or Content-Disposition (any path)

1. V. request to HostA + script.js of HostB
2. A. MitMs and changes IP
3. HostB responses with A's JS
4. V. caches JS for url:

<https://hosta/script.js>

- A. stops mitm attack
- A. forces V. to open HostA
- V. parses html from HostA
- But takes script.js from its cache, cause it's there and still fresh
- V. executes JS (in the context of HostA)
- JS can interact with HostA in a usual way](<https://image.slidesharecdn.com/httpschecked-171120115606/85/MITM-Attacks-on-HTTPS-Another-Perspective-36-320.jpg>)

Active content substitution



Active content substitution - Trick

A. can upload files on HostB, but w/ "uninteresting" Content-Type or Content-Disposition (specific path)

How can we manipulate with a path?
Depends on technologies

- RPO
- Default error page w/ relative scripts
https://HostA/anything_here/falala/ -> anything_here/falala/script.js
- IE HostHeader injection
- ...

What else?

- HTTPS 2 HTTP redirect
- Reverse Proxy misrouting (CDNs)
- Certificate Pinning
- Client Cert auth "bypass"
- CSP bypass
- Crypto attacks
- Another Protocols
- ...

Conclusion

TLS Redirection

- Based on TLS features
- Based on your imagination and circumstances
- For any protocol (but works best for HTTPS)
- Not so hard to exploit
- You can get something from nothing (or misuse safe stuff)

Conclusion

TLS Redirection

- "New" approach of attacking TLS secured protocols
- The security level of web service equals to the security level of the weakest service with common certificate
- Based on the certificate of the weakest service



MITM Attacks on HTTPS: Another Perspective

Conclusion

- Awareness
- Need more research
- There will be a lot of stuff and tricks - <https://github.com/GrrrDog/TLS-Redirection>

Read about Virtual Host Confusion - <https://bh.it-vc/> - AWESOME STUFF THERE!

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Questions



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