Final exam in

Web Security EITF05

Department of Electrical and Information Technology
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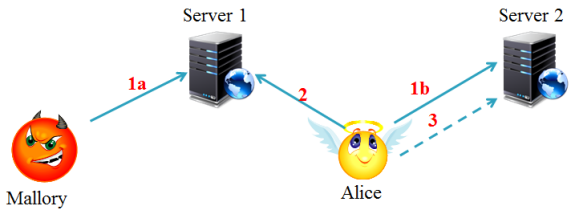
October 28th, 2016

- You may answer in either Swedish or English.
- If any data is lacking, make (and state) reasonable assumptions.
- Use legible hand writing. If your answers cannot be read, you will receive zero points on that problem.
- Grading is done as follows.
  Grade 3 = 20–29 points,
  Grade 4 = 30–39 points,
  Grade 5 = 40–50 points.

Good luck!

Paul

Problem 1. Consider the following illustration of a CSRF attack.



a) Are CSRF attacks possible if Alice has disabled JavaScript in her browser? Motivate.
b) Are CSRF attacks possible if Alice has disabled third-party cookies in her browser? Motivate.
c) Can an XSS attack disable CSRF protection with the synchronizer token pattern? Motivate.

(3 points)

Problem 2. You are creating an image harvester, so you need to design a regular expression for your web crawler. Give a regular expression that matches an HTML image tag with a non-empty source attribute. The following variations should match;

`<img src="pic.jpg" any_name="any_value"/>` (any attribute after src is ok)

`<img alt="Me on vacation" src="pic.jpg"/>` (any attribute before src is ok)

but not

`<img src="pi>c.jpg"/>` (no greater than inside tag)

`<img />` (src attribute must exist)

`<img src=""/>` (src attribute must be non-empty)

(3 points)

Problem 3. Consider Domain Name System Security Extensions (DNSSEC).

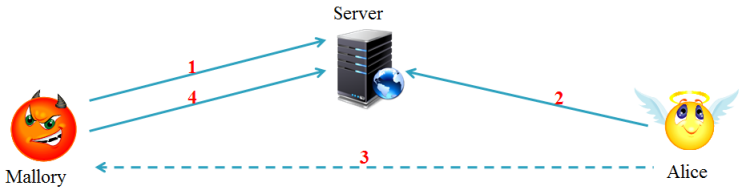
a) What does the DS record contain?

b) All DNSSEC responses are (asymmetrically) signed. How does this affect performance (response time compared to ordinary DNS)? Motivate your answer.

c) Why is zone-walking easy with NSEC but not with NSEC3?

(3 points)

Problem 4. Consider the following illustration of an XSS attack with three involved entities; Mallory, Server and Alice.



a) Does TLS protect against XSS attacks? Motivate.

b) What can Alice do to efficiently prevent XSS attacks? Motivate.

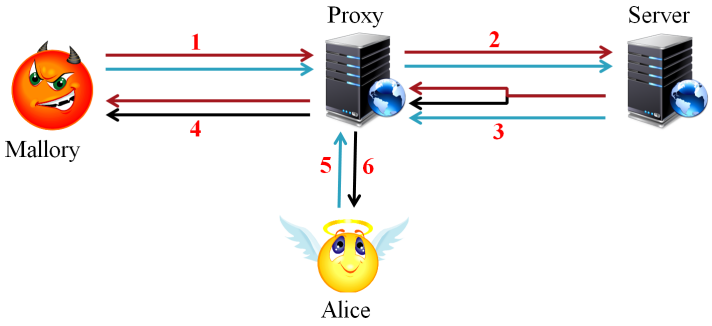
c) What can the Server do to efficiently prevent XSS attacks? Motivate.

(3 points)

Problem 5. Explain the purpose and principal functionality of Domain-based Message Authentication, Reporting and Conformance (DMARC).

(3 points)

Problem 6. Consider the following illustration of an HTTP response splitting attack.



a) Briefly explain how an HTTP response splitting attack works.

b) Does TLS protect Alice against HTTP response splitting attacks? Motivate.

c) Can the first response in step 3 be split into, say, 10 responses (instead of 2)? Motivate.

(3 points)

Problem 7. A DKIM signature header of an email is given below.

```
DKIM-Signature:
v=1;
a=rsa-sha256;
c=simple/relaxed;
d=gmail.com;
s=gamma;
h=received:message-id:date:from:to:subject:mime-version:content-type;
bh=9gicsZnlcLK7yYh6VIrgyAMMRZiWsSbWqSPIhc78RRk=;
b=k4ofvpHPkaQmvuSoGVhRrnCsPK+JEuv9KUrZO7aiypvf/6Y1N2iIatvLvdzwOnZX
  /W6Kxyx6Z4Ybuk8Dqk/vNTIE7Jpy+GQUUHFvM0NFtmZo1CbGRvo8DdHnXRBB/qWw
  lV+Z6wxw/mq7lNuJknVprOAaTLws5mwcZ+AWL8KwHg0=
```

a) How does DKIM provide confidentiality of the message part of the email? (What is encrypted, and how?)

b) How does DKIM provide integrity protection, and for which parts of the email? (What is signed, and how?)

c) How is the DKIM header itself protected?

(3 points)

Problem 8. If the new international version of the Bible were more Base64-inspired, then a paragraph from 1 Samuel 17 might have read:

A champion named `R29saWF0aA==`, who was from `R2F0aA==`, came out of the Philistine camp. His height was six cubits and a span. He had a bronze helmet on his head and wore a coat of scale armor of bronze weighing five thousand shekels; on his legs he wore bronze greaves, and a bronze javelin was slung on his back. His spear shaft was like a weaver's rod, and its iron point weighed six hundred shekels. His shield bearer went ahead of him.

a) Who was this warrior? (decoded name)
b) Where was he from? (decoded name of city)
c) What is his opponent's name in Base64?

Hint: Decimal representation of ASCII characters is given by:

$$\text{A} = 65, \text{B} = 66, \ldots, \text{Z} = 90, \text{a} = 97, \text{b} = 98, \ldots, \text{z} = 122$$

The Base64 alphabet is:

$$0 = \text{A}, \ldots, 25 = \text{Z}, 26 = \text{a}, \ldots, 51 = \text{z}, 52 = 0, 53 = 1, \ldots, 61 = 9, 62 = +, 63 = /$$

(3 points)

Problem 9. Consider a Hashcash solution in which a string

$$ver : bits : date : resource : rand : counter$$

is hashed using SHA-1, where

ver is version number (currently 1),
bits indicates how costly the function is for sender,
date gives current date,
resource is recipients email address,
rand is a random number.

a) How is a proper *counter* value determined?
b) How many times must the hash function be invoked to *generate* a valid HashCash header with $bits = 30$? Exactly or on average?
c) How many times must the hash function be invoked to *verify* a valid HashCash header with $bits = 30$? Exactly or on average?

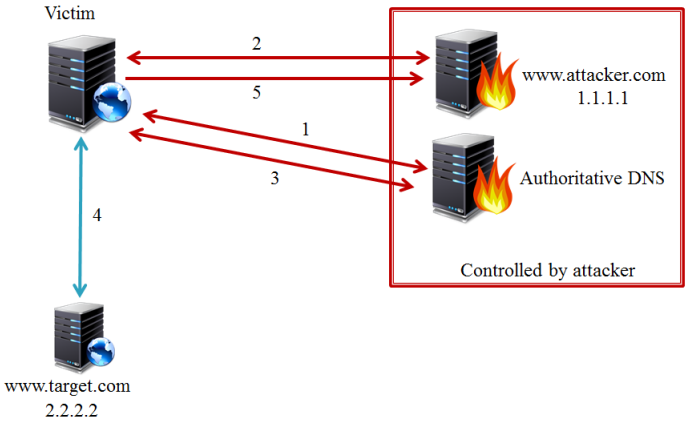
(3 points)

Problem 10. Consider the following illustration of a DNS rebinding attack.

a) Sitting behind a company firewall does not provide the Victim with any protection from DNS rebinding attacks, why is that?

b) Can an XSS exploit be used to trigger a DNS rebinding attack? Motivate.

c) What can the target server (`www.target.com`) do to prevent involvement in DNS rebinding attacks? Motivate.



(3 points)

Problem 11. On October 21st 2016, we saw one of the largest DDoS attacks to date. The attack targeted a major DNS host (Dyn), thus affecting a vast number of sites and services.

On September 30th 2016, the source code for the IoT botnet 'Mirai', that allegedly was used in the attack, was released. The code reveals that IoT devices (IP cameras, routers, ...) with default or hard-coded passwords were harvested for the botnet.

Reports claim traffic loads reaching 1.2Tbps, tens of millions of unique IP addresses being involved and 100,000 physical IoT devices. For comparison, a total of about 6.4 billion IoT devices have been forecast for 2016, and 20.8 billion for 2020.

a) How can DNS amplification be used to maximize the impact of a botnet? (Explain how DNSSEC is involved.)

b) Assuming a worst-case scenario (companies do not care about security, IoT grows exponentially,...), what should you expect in terms of traffic loads from IoT botnets 30 years from now (when you are the seasoned security expert)? Make and state reasonable assumptions and explain your calculations/estimate.

c) How could and should DDoS attacks from IoT botnets be mitigated? (Open question.)

(1+2+2 points)

Problem 12. HTTP digest authentication (RFC2617) is a challenge response protocol in which the client calculates the digest (the response) according to

$$\text{MD5}(\ \text{MD5}(A1) : \mathit{nonce} : \mathit{nc} : \mathit{cnonce} : \mathit{qop} : \text{MD5}(A2)\ ),$$

with

$$\begin{aligned} A1 &= \mathit{username} : \mathit{realm} : \mathit{password}, \\ A2 &= \begin{cases} \mathit{method} : \mathit{URI} & \text{if } \mathit{qop} = \mathit{auth}, \\ \mathit{method} : \mathit{URI} : \text{MD5}(\mathit{entity\text{-}body}) & \text{if } \mathit{qop} = \mathit{auth\text{-}int}. \end{cases} \end{aligned}$$

a) Explain the usage and purpose of the *realm* parameter.

b) In which form are the credentials stored on the server?

c) Follow-up question to a): In what way is this worse than the way operating systems typically store credentials?

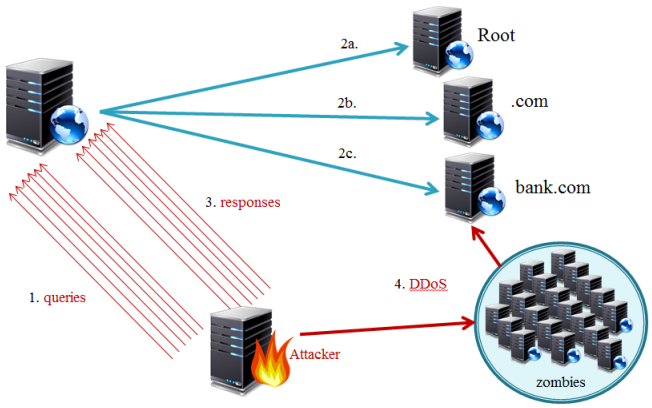
d) Both *nonce* and *cnonce* are random strings. While *cnonce* protects against TMTO attacks, *nonce* does not. Why is that?

Hint for d: How can you attack the authentication system if there is no *cnonce*?

(1+1+1+2 points)

More on next page!

Problem 13. Consider the following illustration of a DNS cache poisoning attack. The success rate of the attack depends on how many queries and responses that can be sent in steps 1 and 3 (before the first response in step 2c has been delivered).



a) Explain why the birthday paradox applies to DNS cache poisoning.

Roughly how many queries and responses need to be sent in steps 1 and 3 if the DNS server randomizes

b) only transaction IDs?

c) both transaction IDs and port numbers?

How is the success probability of the attack affected if

d) transaction IDs in step 3 are generated sequentially rather than uniformly at random?

e) the spoofed responses in step 3 are all sent from different computers (botnet)?

(5 points)

Problem 14. Briefly explain the following terms and acronyms.

a) Remote file inclusion

b) PTR record

c) CSP

d) Reflected (non-persistent) XSS attack

e) First-party cookies

(5 points)
