146 - 68KSWY7B5EIN2ST

FÖRSÄTTSBLAD TENTAMEN/ EXAMINATION COVER

Jag intygar att mobiltelefon och annan otillåten elektronisk utrustning är avstängd och förvaras på anvisad plats. / I hereby confirm that mobile phones and other unauthorized electronic equipment is shut off and placed according to instructions

MARKERA MED "X"/
MARK WITH "X" ☒

IFYLLES AV STUDENT OCH TENTAMENSVAKT/ TO BE FILLED IN BY THE STUDENT AND THE INVIGILATOR:

KURSKOD / COURSE CODE: DD2395	EFTERNAMN / FAMILY NAME: KHOLIA
KURSNAMN / COURSE NAME: Datasäkerhet	FÖRNAMN / FIRST NAME: DHIRENDRA
PROVKOD / TEST CODE: TEN1	NAMNTECKNING / YOUR SIGNATURE: dhk
TENTAMENSDATUM / EXAMINATION DATE Y/Y/Y/Y M/M D/D: 2016-01-16	PERSONNUMMER / PERSONAL NUMBER Y/Y/M/M/D/D: 850227-8255
PROGRAMKOD / PROGRAM CODE:	INLÄMNINGSTID / TIME SUBMITTED: 11:36
SIGNATUR TENTAMENSVAKT / SIGNATURE INVIGILATOR:	ANTAL SIDOR / NO OF PAGES: 12

MARKERA BEHANDLADE UPPGIFTER MED "X "OCH EJ BEHANDLADE UPPGIFTER MED "-" /
MARK WITH "X" PROBLEMS SOLVED. MARK WITH "-" PROBLEMS NOT ATTEMPTED

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
X	X	X	X	X	X	X	X												

IFYLLES AV INSTITUTIONEN / TO BE FILLED IN BY THE DEPARTMENT:

BEDÖMNING / ASSESSMENT

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

BONUSPOÄNG/ BONUS POINTS: ,

SLUTSUMMA / FINAL POINTS: ,

BETYG/ GRADE:

0406186500

Godkänns av examinator / approved by Examiner.....

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	1	1

Sol 1.

Confidentiality loss with low impact → student grades are accidentally revealed.

Confidentiality loss with high impact → classified national security records are revealed (Snowden style)

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	2	2

2a)

RSA algorithm

p, q → primes (private values)

$n = p * q$ → public value (modulus)

$\varphi(n) = (p-1) * (q-1)$

e → co-prime of $\varphi(n)$

$e * d \bmod \varphi(n) = 1$ → compute (d) → private value

Public key → $[n, e]$ → PU

Private key → $[n, d]$ → PR

$C = (M)^e \bmod n$ (M → message)

$D = C^d \bmod n$

(M)

Problem → Given (d, n, e, C, M) find (e) → the private exponent.

$n = p * q$ → the mathematical equation the attacker has to solve.

→ Factorization of very large integers into primes.

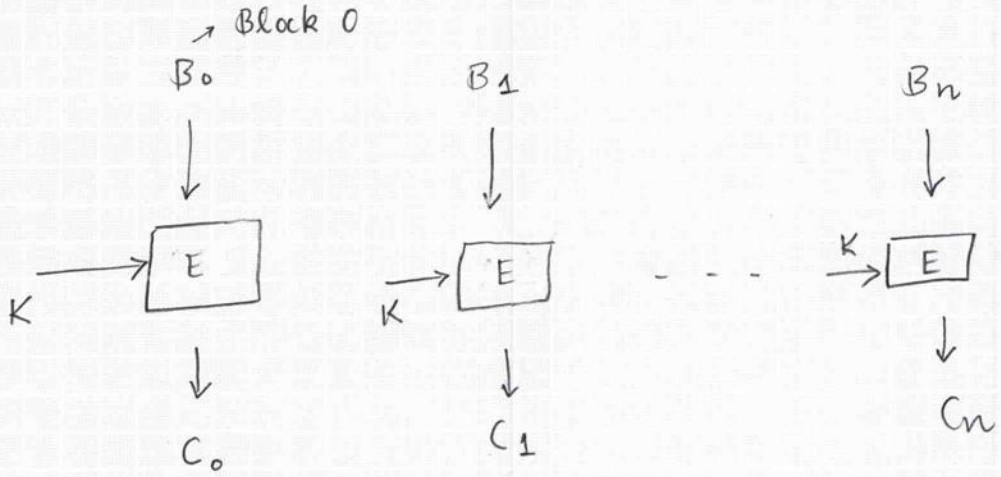
→ computationally this is expensive!

By finding correct (p, q) the attacker can compute (e).

* Continued on the back side * !!

26

In ECB mode, each message block is encrypted independantally.



If the input message has repeated (similar) blocks, then the ciphertext (generated in ECB mode) will reveal the pattern of repetition.

Eg. → On the internet, there is an image of a penguin encryted in ECB mode. The ciphertext clearly reveals the outer shape of the penguin :-)

CBC mode can be used to avoid this particular problem.

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	3	2

2 c)

Requirements for a secure hash function.

① one-way (preimage resistance)
$h = f(x)$, given h, it should be infeasible to find x

② collision resistant
$F(x) = F(y)$ should be infeasible to find for different messages (x, y).

③ Handle variable length messages

④ Fixed size output (called message digest)

⑤ Same input should generate the same hash.

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	4	2

2d

H is not a secure hash function!

H is one-way but it is not collision resistant!

Consider,

$M_1 = B_1, 0, 0, 0, 0_n$

$M_2 = 0, B_1, 0, 0, 0_n$

Both M_1 & M_2 generate same output hash!

$H(M_1) = H(M_2)$

High impact integrity loss → If H is used as a MAC function (message authentication code), then we have the following problem.

A → Alice ——————→ B → Bob

M + E(H(M), K)

↓

encryted hash → MAC

Message signature is essentially stolen, & re-used :)

Since H is not collision resistant, an attacker can create M', such that $H(M) = H(M')$ &

$E(H(M), K) = E(H(M'), K)$

Attacker ——→ B

M' + E(H(M'), K) } → integrity loss!

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	5	3

3

I would use a stateful inspection firewall to block the HTTP traffic that carries files bigger than 5 MB.

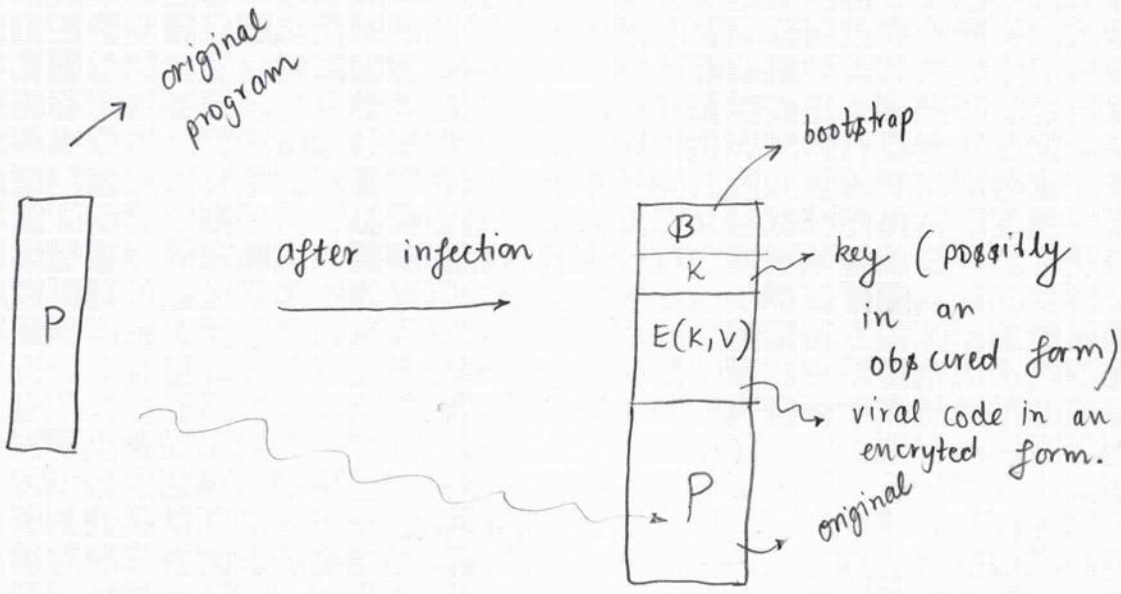
A simple packet filter firewall cannot inspect related HTTP requests (or their fragments) if they are split over multiple packets!

In contrast, a stateful inspection capable firewall can reconstruct the original HTTP request payload, & the corresponding HTTP responses (if required), and then block the non-allowed requests.

— x —

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	6	4

Solution 4



Encryted virus infects the original program. The execution of the infected program begins with the bootstrap code, which decrypts the encryted viral payload by using a key embedded in the infected program itself.

The idea behind such viral constructions is to make static, even dynamic analysis of infected binaries harder. It would also be hard to develop signature-based detection rules against such virus programs.

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	7	5

Solution 5 (DoS)

Example → DNS based amplified reflected DoS attack.

① DNS uses UDP (port 53), which implies that spoofing source IP address works well.

② DNS responses have the potential to be much larger than the corresponding requests. This allows the attacker to amplify his/her traffic.

The resources consumed are →

① Bandwidth

② CPU time, memory (conntrack + iptables)

Possible countermeasures →

① Ingress filtering (hard to do, essentially filter out attacker's traffic)

② Replicate, & distribute your service (servers), capacity planning

③ Incident respone plan & contingency measures → don't panic!

④ SYN cookies (in case of TCP SYN flooding based attacks).

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	8	6

Sol 6

Chinese Wall model is an access control model. It is based on the "conflict of interest" idea, & essentially it prevents information disclosure between competing companies.

dataset

O ∈ DS

↓

object (information)

DS ∈ CI (conflict of interest set)

It is a pretty peculiar access control model because →

① A new employee has access to any data initially.

② Further access is determined by which data set is first accessed by the employee.

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	9	6

Sol 6 (continued) →

Chinese Wall model has following security properties →

SS- security (simple security)

→ A subject can read an object (if it is the subject's initial access). Further access requests are allowed, if they aren't in conflict-of-interest control set.

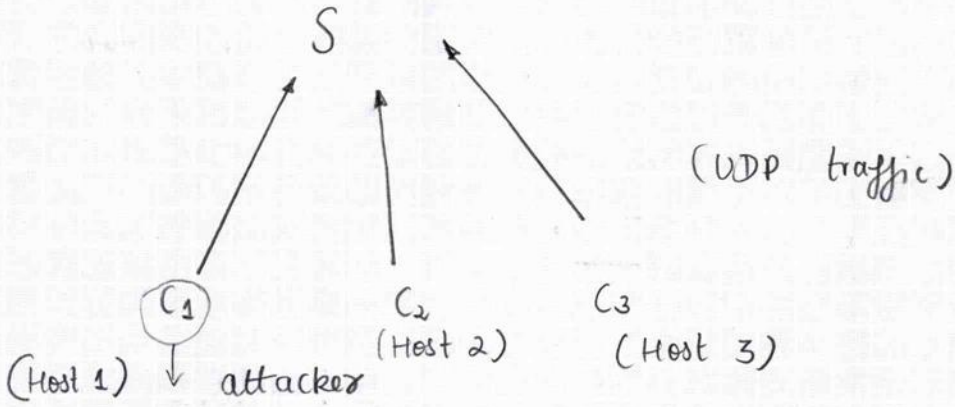
* - property (star property)

→ A subject can write to an object if he/she has read access to the object & he/she can't read outside the object's dataset.

The top level security property guranteed by the Chinese wall model is confidentiality.

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	10	7

Sol. 7 →



7a) Since the protocol is UDP based, we are able to do source IP spoofing attacks easily.

The attack (3) → The attacker (C1, H1) can send forged topic registration requests to the server (S) on behalf of C2 & C3 (Host 2, & 3 respectively). (assuming they have logged on to S before!)

By doing so, the attacker can put a burden on →

a) Server resources (memory, CPU)

b) Hosts resources) (memory, CPU)

c) Bandwidth & latency of the network

d) Users (are faced with spam!)

(1) victim → users (and their corresponding hosts)

(2) resource consumed → user's time! (& server + network resource consumption)

(4) assumptions needed → (C2, H2), (C3, H3) --- have logged on to the server before.

+ IPs are static!

* CONTINUED ON THE BACK SIDE * !

(CONTINUED) ⇒

Additional security threat(s) →

① The server (& the people running it) know about the potentially sensitive interests of the users (based on the topics they subscribe to).

They can potentially sell this information to third-parties. It is very hard to counter this threat!

②

7 6 Counter-measures

① Change the transport protocol from UDP to TCP. (prevent source IP attacks from being effective)

② Change registration payload from E_{PU} (user, pwd) to

E_{PU} (user, pwd, PU_{user})

↓

user's unique public key

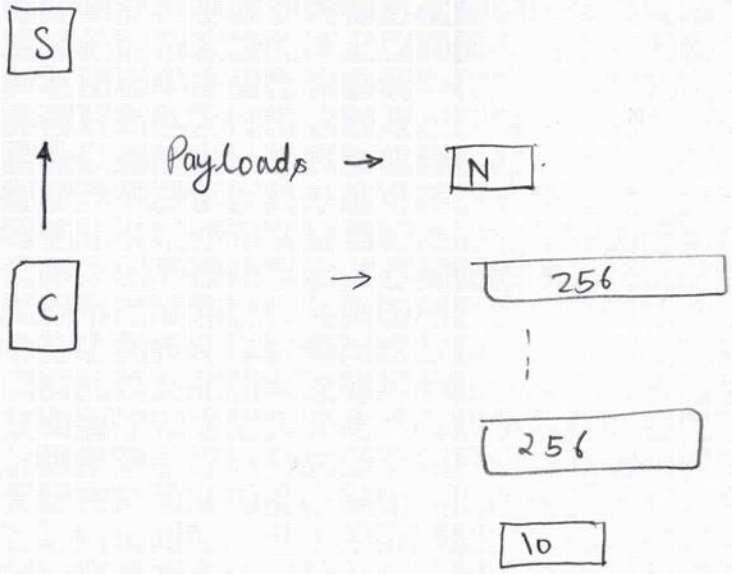
③ Sign the registration request payload from "REGISTER; topic" to "REGISTER; topic; signed hash of the request)

↓

$E(PR_{user}, H(request))$

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	11	8

8 Buffer overflow



8a)

```
Char data [n];   → user controlled!
---
---
read (sockfd, data + (i*256), 256);   // buffer overflow!
```

'n' is user-controlled (attacker-controlled), & by setting n to be smaller-than-required, the attackers can do a stack based buffer overflow attack.

Also, is "unsigned int n" always guaranteed to be at least 4 bytes wide?

If not,

read (sockfd, &n, 4); can be a bit problematic too!

Family name, first name	Personal Registration Number	Programme	Sheet no.	Problem no.
KHOLIA, DHIRENDRA	850227-8255	MS CS	12	8

8b)

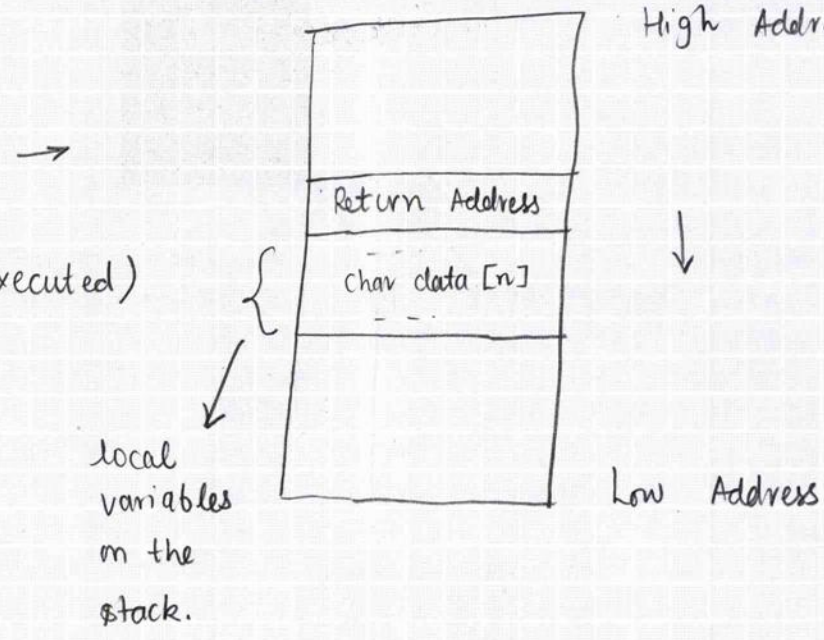
The core idea behind this fix is to make sure that we have enough space in the "data" buffer before we try to write into it.

```
while (1) {
    .
    .
    .
    .
}
```

```
while (1) {
        if (n < 256)
            break;
        n = n - 256;
        read (sockfd, data + (i*256), 256);
        if (data [i*256] == '\0')
            break;
        i++;
    }
    // . . .
}
```

8C

Stack Layout → ("function" is being executed)



The attacker controls "n" (the size of the data buffer).

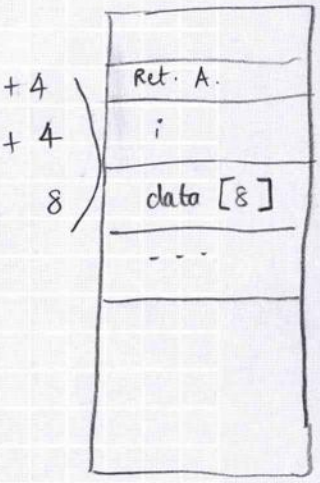
By setting n = 8 (for example), the size of data buffer is 8.

Now the attacker can send a specially crafted message to overwrite the "Return Address" (saved on the stack) to point to the "nuke_world" function.

Possible message to exploit the buffer overflow → for (n = 8)

→ "A" * 12 + Ret. Address of "nuke_world".

(jump over "i")



The additional information that is needed by the attacker is the address of the "nuke_world" function in memory. This is easy to determine if the "server" binary program image is provided & the server doesn't use ASLR (address-space layout randomization)