Velkommen til

Security Tools in Software Development

FOSS Aalborg

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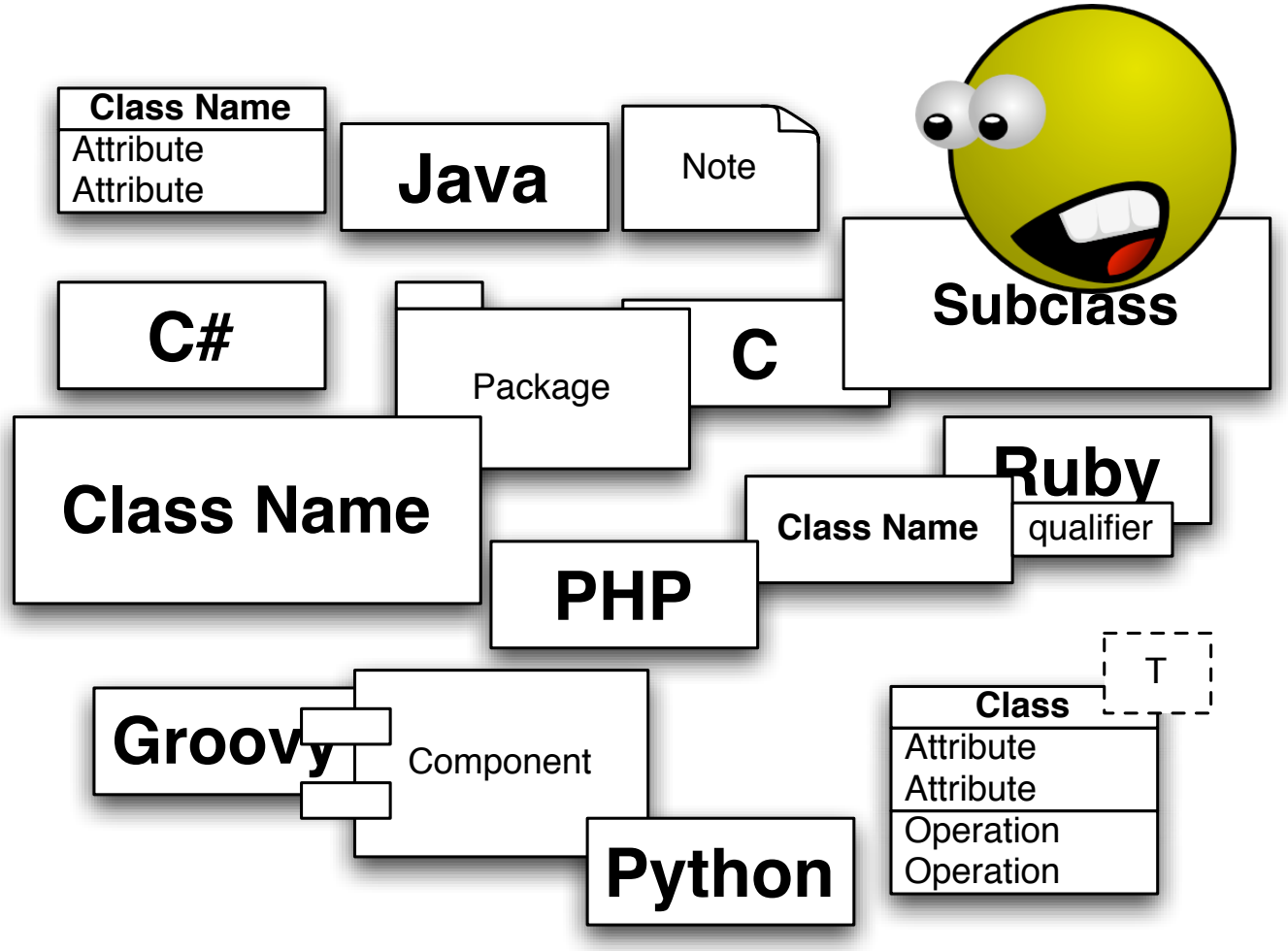
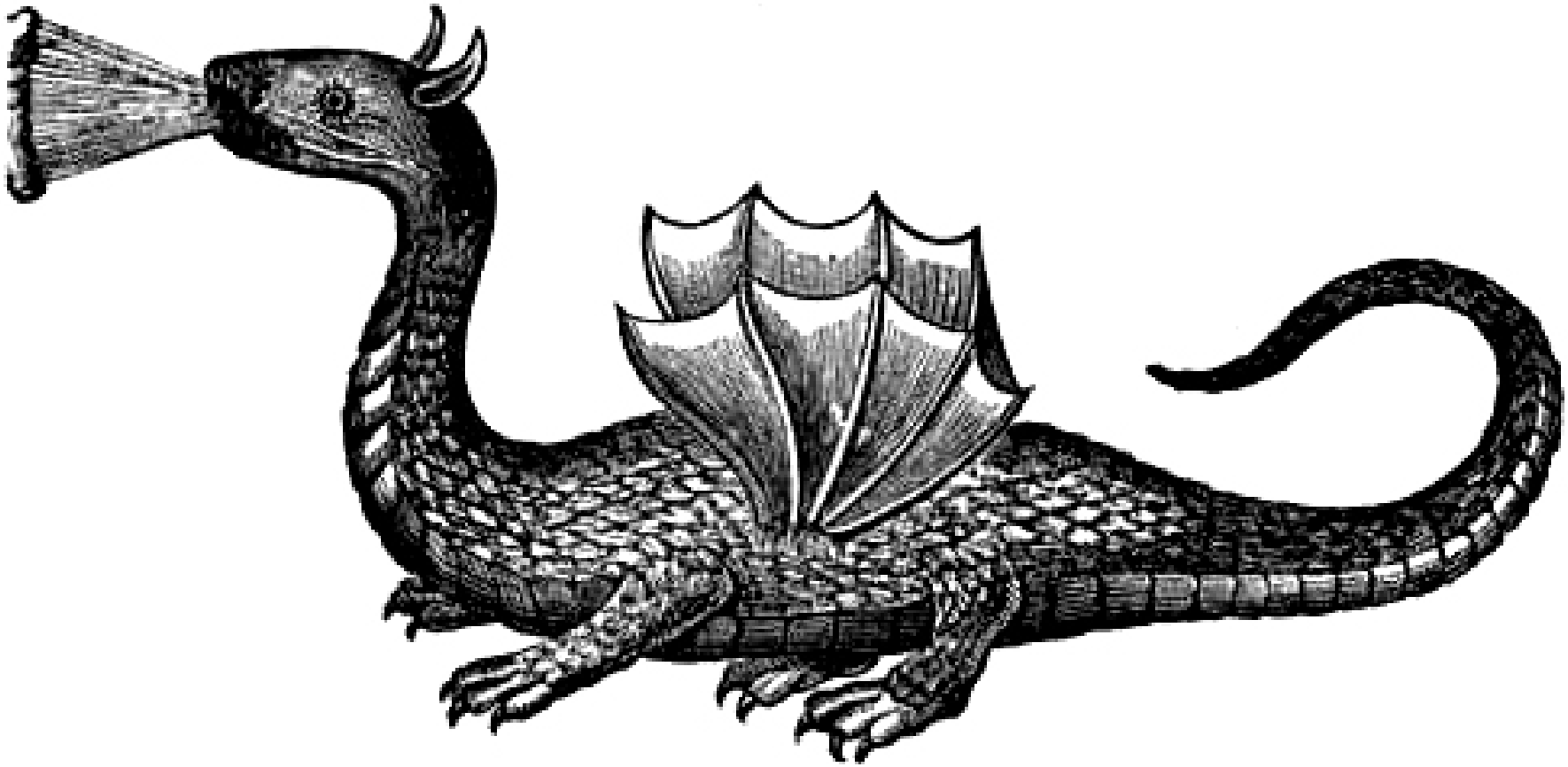
Slides are available as PDF and are in Danish only, sorry

Forml



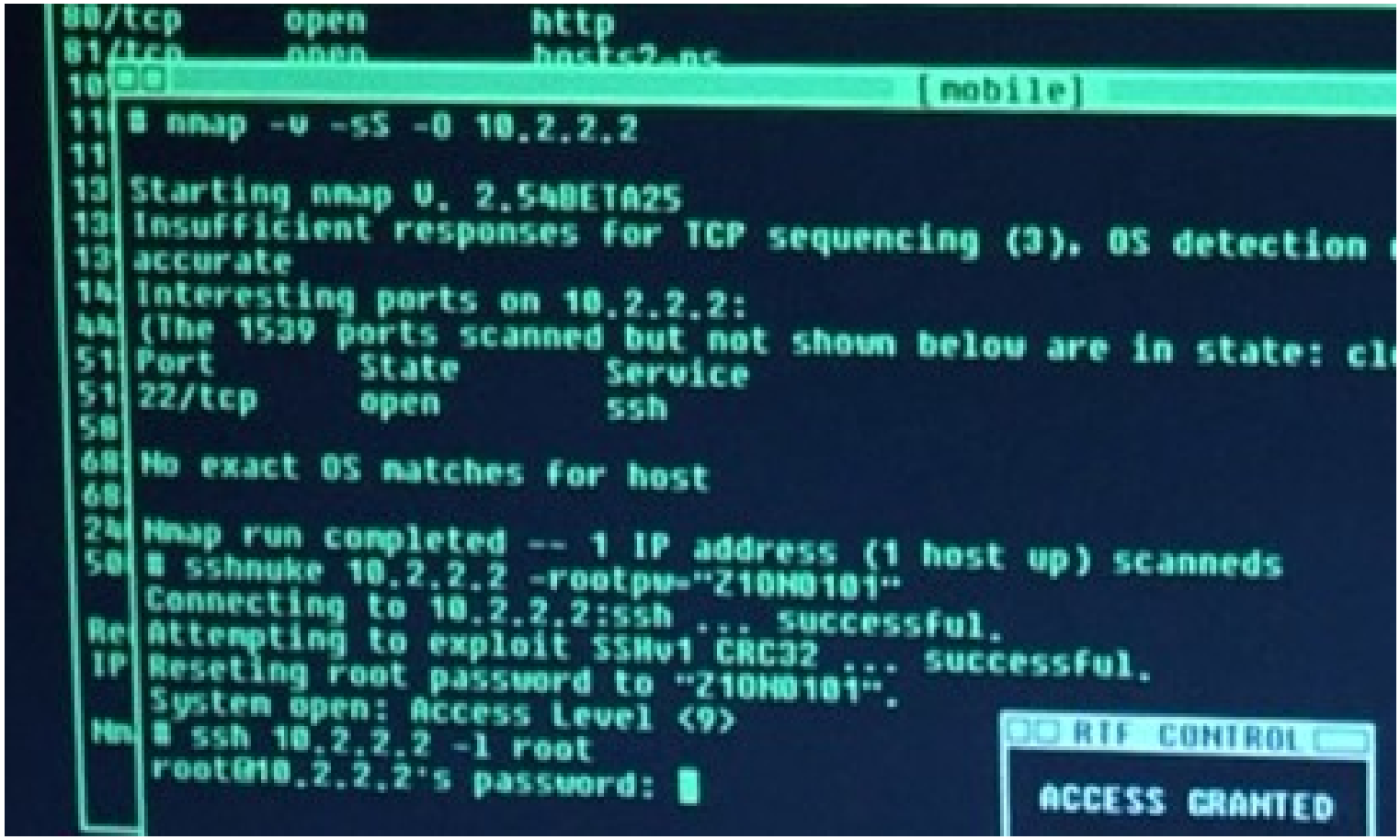
Lre om vrktjer der kan forbedre sikkerhed for produktionssystemer

Internet - Here be dragons



Matrix style hacking anno 2003

Trinity breaking in



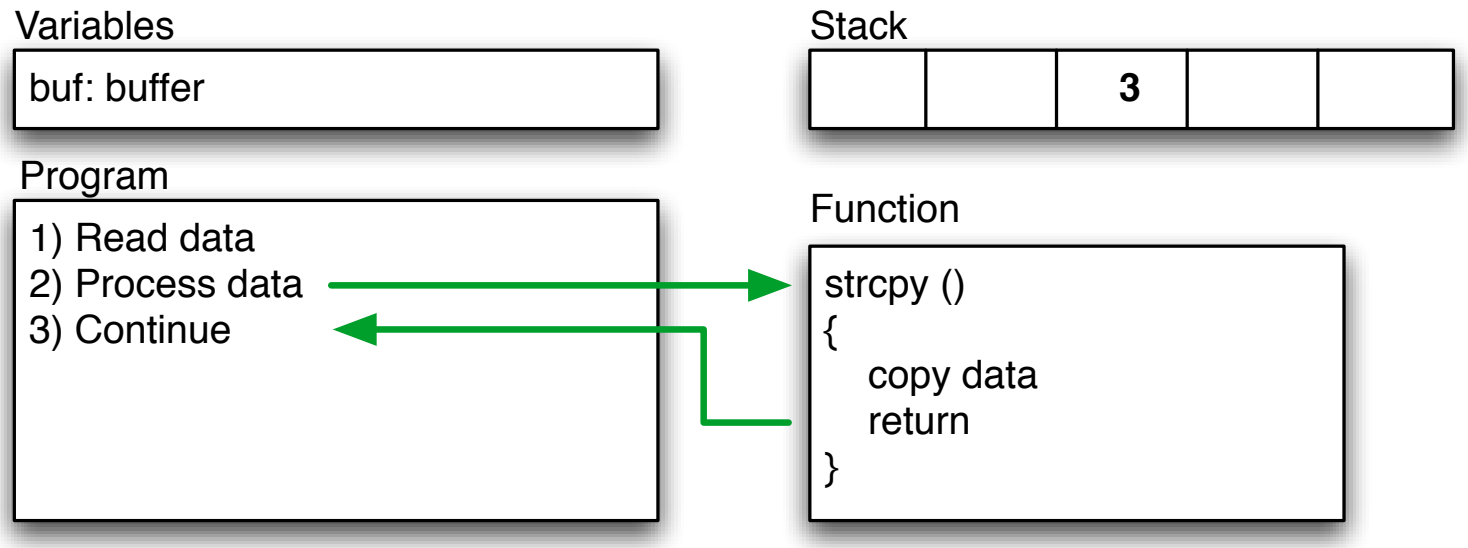
http://nmap.org/movies.html
Meget realistisk http://www.youtube.com/watch?v=Zy5$_gYu_isg$

buffer overflows et C problem

Et buffer overflow er det der sker nr man skriver flere data end der er afsat plads til i en buffer, et dataomrde. Typisk vil programmet g ned, men i visse tilflde kan en angriber overskrive returadresser for funktionskald og overtage kontrollen.

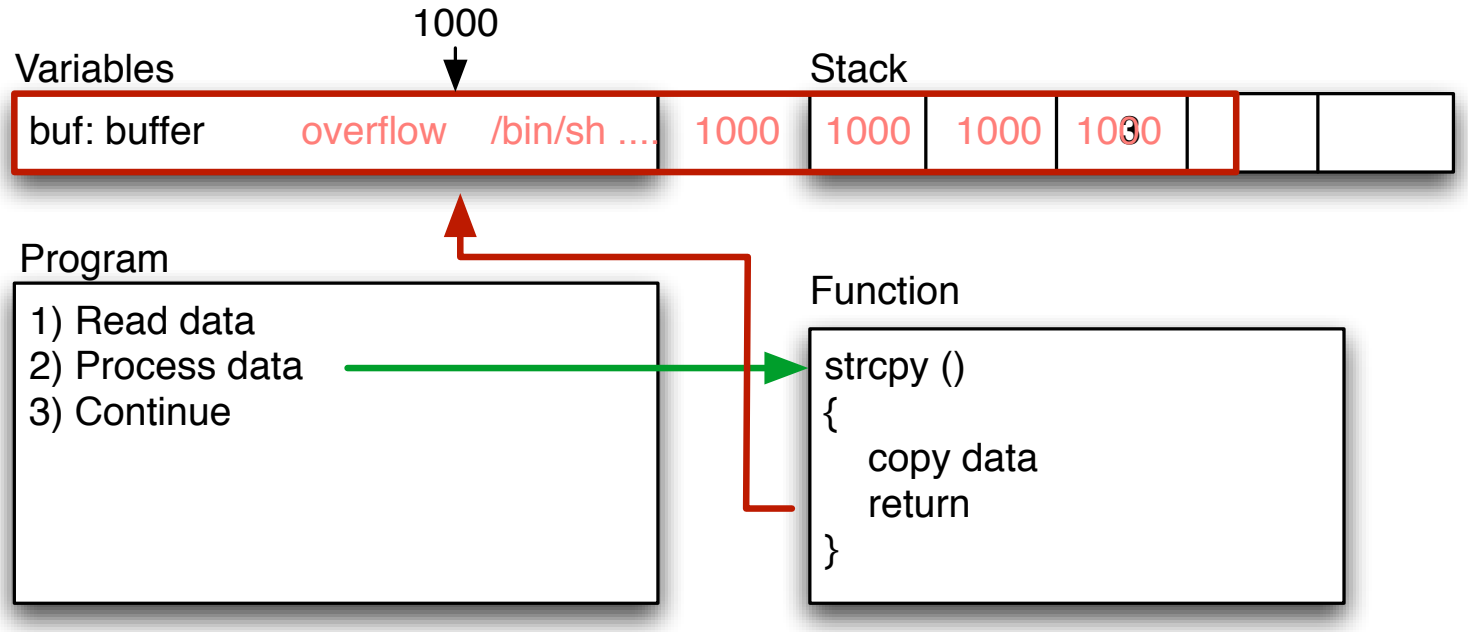
Stack protection er et udtryk for de systemer der ved hjlp af operativsystemer, programbiblioteker og lign. beskytter stakken med returadresser og andre variable mod overskrivning gennem buffer overflows. StackGuard og Propolice er nogle af de mest kendte.

Buffer og stacks




```
main(int argc, char **argv)
{       char buf[200];
         strcpy(buf, argv[1]);
         printf("%s\n",buf);
}
```

Overflow - segmentation fault



Bad function overwrites return value!

Control return address

Run shellcode from buffer, or from other place

Exploits


```
$buffer = "";
$null = "\x00";
$nop = "\x90";
$nopsize = 1;
$len = 201; // what is needed to overflow, maybe 201, maybe more!
$the_shell_pointer = 0xdeadbeef; // address where shellcode is
# Fill buffer
for ($i = 1; $i < $len;$i += $nopsize) {
    $buffer .= $nop;
}
$address = pack('l', $the_shell_pointer);
$buffer .= $address;
exec "$program", "$buffer";
```

Demo exploit in Perl

Hvordan finder man buffer overflow, og andre fejl

Black box testing

Closed source reverse engineering

White box testing

Open source betyder man kan lse og analysere koden

Source code review - automatisk eller manuelt

Fejl kan findes ved at prve sig frem - fuzzing

Exploits virker typisk mod specifikke versioner af software

Forudstninger

Bemrk: alle angreb har forudstninger for at virke

Et angreb mod Telnet virker kun hvis du bruger Telnet

Et angreb mod Apache HTTPD virker ikke mod Microsoft IIS

Kan du bryde kden af forudstninger har du vundet!

Eksempler p forudstninger

Computeren skal vre tndt

Funktionen der misbruges skal vre slet til

Executable stack

Executable heap

Fejl i programmet

alle programmer har fejl

Software udvikling er nemt

Du skal blot skrive perfekt kode frste gang :-)

Sikkerhed er svrt

Det er svrt at skrive perfekt kode, om ikke umuligt

S nu vil vi snakke om vrktjer til at forbedre situationen

Part 1 Low hanging fruits - easy

Hjere kvalitet er mere sikkert

Coding standards - style

This file specifies the preferred style for kernel source files in the OpenBSD source tree. It is also a guide for preferred user land code style. These guidelines should be followed for all new code. In general, code can be considered “new code” when it makes up about 50more of the file(s) involved. ...
Use queue(3) macros rather than rolling your own lists, whenever possible. Thus, the previous example would be better written:

```
#include <sys/queue.h>
struct  foo {
LIST_ENTRY(foo) link;  /* Queue macro glue for foo lists */
            struct  mumble amumble; /* Comment for mumble */
            int     bar;
};
LIST_HEAD(, foo) foohead;       /* Head of global foo list */
```

OpenBSD style(9)

Coding standards functions

The following copies as many characters from input to buf as will fit and NUL terminates the result. Because strncpy() does not guarantee to NUL terminate the string itself, it must be done by hand.

```
char buf[BUFSIZ];

(void)strncpy(buf, input, sizeof(buf) - 1);
buf[sizeof(buf) - 1] = '\0';
```

Note that strlcpy(3) is a better choice for this kind of operation. The equivalent using strlcpy(3) is simply:

```
(void)strlcpy(buf, input, sizeof(buf));
```

OpenBSD strcpy(9)

Compiler warnings - gcc -Wall


```
$ gcc -o demo demo.c
demo.c: In function main:
demo.c:4: warning: incompatible implicit declaration of built-in
function strcpy

$ gcc -Wall -o demo demo.c
demo.c:2: warning: return type defaults to int
demo.c: In function main:
demo.c:4: warning: implicit declaration of function strcpy
demo.c:4: warning: incompatible implicit declaration of built-in
function strcpy
demo.c:5: warning: control reaches end of non-void function
```

Easy to do!

No warnings = no errors?


```
$ cat demo2.c
#include <strings.h>
int main(int argc, char **argv)
{
    char buf[200];
    strcpy(buf, argv[1]);
    return 0;
}
$ gcc -Wall -o demo2 demo2.c
```

Der er stadig alvorlige fejl!

Version control

Versionsstyring og configuration management har mange fordele

Hvem ndrede, hvornr og hvad

Hvorfor blev der foretaget en ndring

Med versionsstyring kan pre-commit hooks implementeres

Subversion sample hooks scripts

pre-commit - check

- case-insensitive.py
- check-mime-type.pl
- commit-access-control.pl
- commit-block-joke.py
- detect-merge-conflicts.sh
- enforcer
- log-police.py
- pre-commit-check.py
- svnperms.py
- verify-po.py

http://subversion.tigris.org/tools$_{c}ontrib.htmlhttp://svn.collab.net/repos/svn/trunk/cont$
$scripts/$

Eksempel Enforcer

In a Java project I work on, we use log4j extensively. Use of System.out.println() bypasses the control that we get from log4j, so we would like to discourage the addition of println calls in our code.

We want to deny any commits that add a println into the code. The world being full of exceptions, we do need a way to allow some uses of println, so we will allow it if the line of code that calls println ends in a comment that says it is ok:

```
System.out.println("No log4j here"); // (authorized)
```

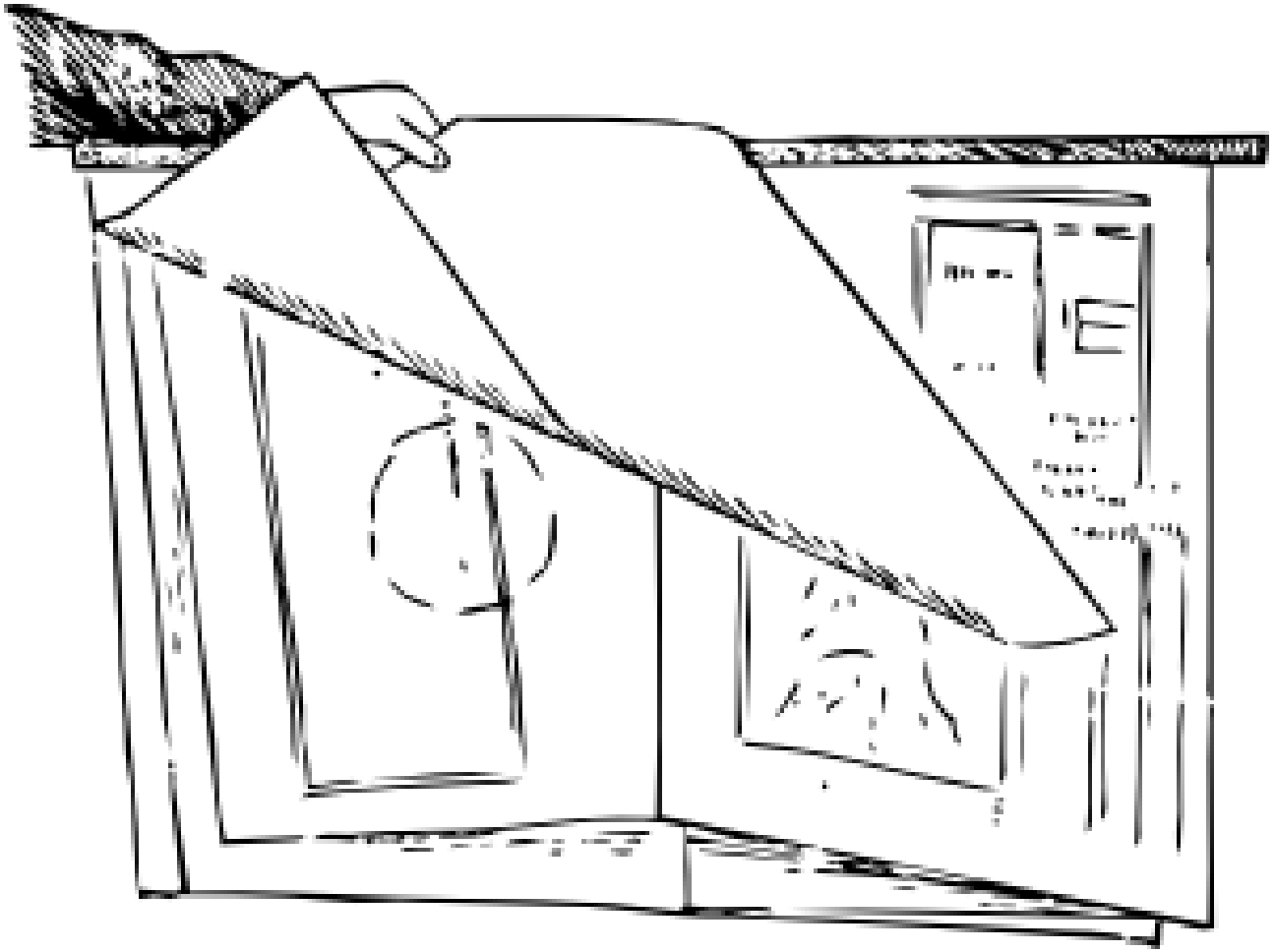
http://svn.collab.net/repos/svn/trunk/contrib/hook-scripts/enforcer/enforcer

Eksempel verify-po.py


```
#!/usr/bin/env python
"""This is a pre-commit hook that checks whether the contents
of PO files committed to the repository are encoded in UTF-8.
"""
```

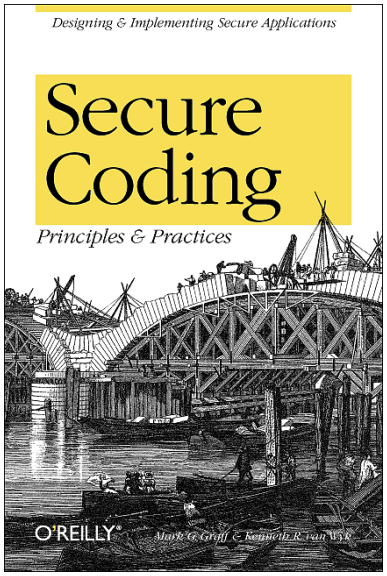
http://svn.collab.net/repos/svn/trunk/tools/hook-scripts/verify-po.py

Part 2 Design for security - more work



Sikkerhed er kun effektivt hvis det tnkes ind i design

Secure Coding begynder med design



5cm *Secure Coding: Principles and Practices* af Mark G. Graff, Kenneth R. Van Wyk 2003

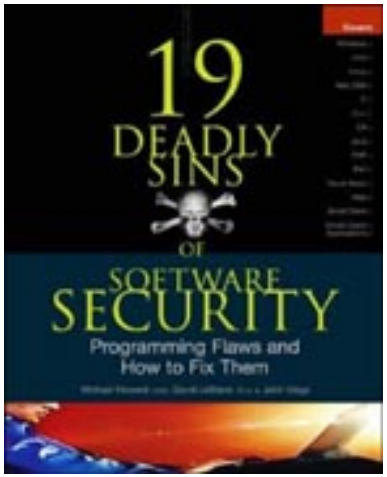
Architecture/design while you are thinking about the application

Implementation while you are writing the application

Operations After the application is in production

Ca. 200 sider, men ttpakket med information.

Sins in Software Security



5cm *19 Deadly Sins of Software Security* af Michael Howard, David Leblanc, John Viega 2005

Obligatorisk lsning for alle udviklere

Forfatterne har skrevet mange gode bger bde fr og efter

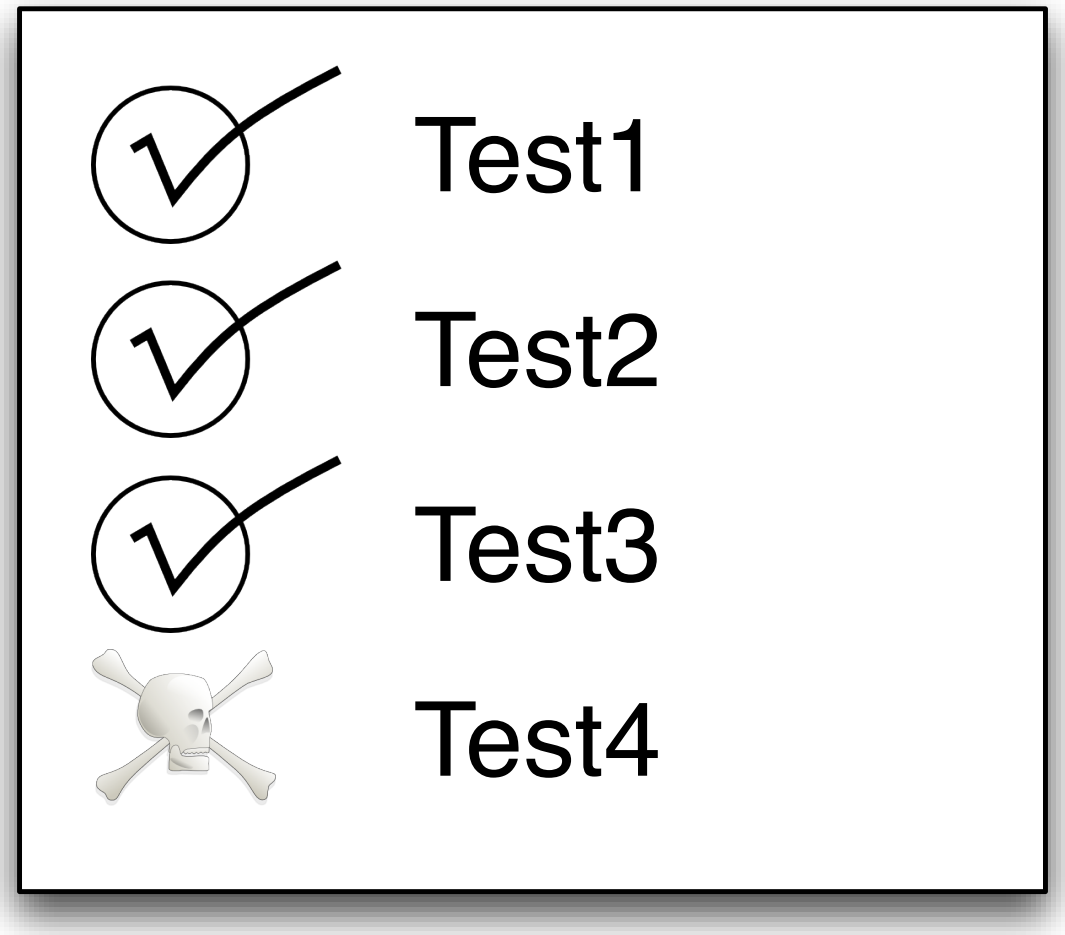
Denne bog er prcis og giver overblik

Ca. 270 sider, let at lse.

Buffer Overruns, Format String Problems, Integer Overflows, SQL Injection, Command

Injection, Failing to Handle Errors, Cross-Site Scripting, Failing to Protect Network Traffic, Magic URLs Hidden Form Fields, Improper Use of SSL and TLS, Weak Password-Based Systems, Failing to Store and Protect Data Securely, Information Leakage, Improper File Access, Trusting Network Name Resolution, Race Conditions, Unauthenticated Key Exchange, Cryptographically Strong Random Numbers, Poor Usability

Part 3 Testing - more work now, less work in the long run



Hjere kvalitet er mere sikkert

Hvorfor teste

Finde fejl under udviklingen af software

Sikre at software overholder krav til kvalitet

Finde fejl senere!

Undg at gamle fejl optrder igen!

Test ofte

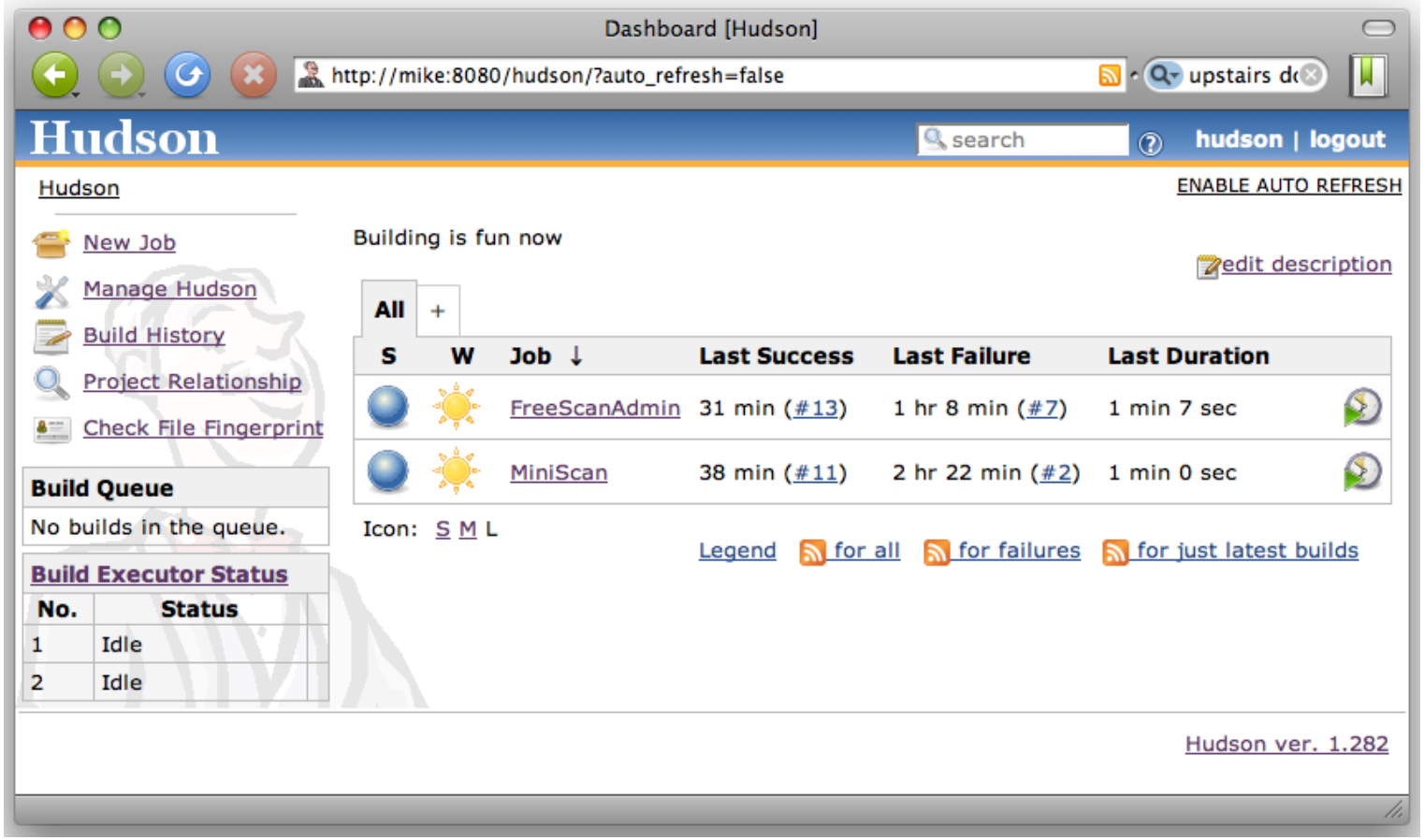
Unit testing - laveste niveau

```
public class TestAdder {
    public void testSum() {
        Adder adder = new AdderImpl();
        assert(adder.add(1, 1) == 2);
        assert(adder.add(1, 2) == 3);
        assert(adder.add(2, 2) == 4);
        assert(adder.add(0, 0) == 0);
        assert(adder.add(-1, -2) == -3);
        assert(adder.add(-1, 1) == 0);
        assert(adder.add(1234, 988) == 2222);
    }
}
```

Kan bruges til at teste enkelte dele af en applikation

Eksempel fra http://en.wikipedia.org/wiki/Unit$_testing$

Hudson and friends



Continous building and testing

Finder lbende fejl - hurtig feedback

Part 4 Analysis

Brug al den hjlp du kan til at finde fejl

Typer af analyse

statisk analyse

finder fejl uden at kre programmet
typisk findes konstruktioner som indeholder fejl, brug af forkerte funktioner m.v.

dynamisk analyse

findes ved at kre programmet, typisk i et specielt milj

Statiske analysevrktjer

Flawfinder http://www.dwheeler.com/flawfinder/

RATS Rough Auditing Tool for Security, C, C++, Perl, PHP and Python

PMD static ruleset based Java

http://en.wikipedia.org/wiki/List$_{o}f_{t}ools_{f}or_{s}tatic_{c}ode_{a}nalysis$

A Fool with a Tool is still a Fool

1. Run tool
2. Fix problems
3. Rinse repeat

Fixing problems?

```
char tmp[256]; /* Flawfinder: ignore */
strcpy(tmp, pScreenSize); /* Flawfinder: ignore */
```

Eksempel fra http://www.dwheeler.com/flawfinder/

PMD static ruleset based Java source code analyzer

PMD

PMD scans Java source code and looks for potential problems like:

- Possible bugs - empty try/catch/finally/switch statements
- Dead code - unused local variables, parameters and private methods
- Suboptimal code - wasteful String/StringBuffer usage
- Overcomplicated expressions - unnecessary if statements, for loops that could be while loops
- Duplicate code - copied/pasted code means copied/pasted bugs

You can **download everything from here**, and you can get an overview of all the rules at the rulesets index page.

PMD is integrated with JDeveloper, Eclipse, JEdit, JBuilder, BlueJ, CodeGuide, NetBeans/Sun Java Studio Enterprise/Creator, IntelliJ IDEA, TextPad, Maven, Ant, Gel, JCreator, and Emacs.

http://pmd.sourceforge.net/

Spjs note: 2009-02-08 PMD 4.2.5: bug fixes, new rule, new Android ruleset

Hard to do - manual analysis

Hvorfor ikke bare programmere sikkert?

Der er mange ressourcer tilgngelige:

Websites: *Secure Programming for Linux and Unix HOWTO*
http://www.dwheeler.com/secure-programs/

Bger: *19 Deadly Sins of Software Security: Programming Flaws and How to Fix Them*
Michael Howard, David LeBlanc, John Viega + deres andre bger

Det er for svrt, tager for lang tid!

Feedback

Srg for feedback i jeres processer

Mske nr I kun til denne del, s srg for at erfaringer opsamles for hvert projekt

Ls ressourcer og lav design s det bliver nemmere at sikre

F antagelser = frre fejl

Dynamic analysis

compile time vs. at run time nogle fejl kan ikke findes p compile-time

Er du doven s overst og kr programmet p OpenBSD ;-)

Part 5 Break it

Use fuzzers, hackertools, improve security by breaking it

Simple fuzzer

```
$ for i in 10 20 30 40 50
>> do
>> ./demo `perl -e "print 'A'x$i"`
>> done
AAAAAAAAAA
AAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAA
Memory fault
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Memory fault
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Memory fault
```

Memory fault/segmentation fault - juicy!

Fuzz Revisited

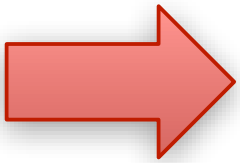
Fuzz Revisited: A Re-examination of the Reliability of UNIX Utilities and Services

> We have tested the reliability of a large collection of basic UNIX utility programs, X-Window applications and servers, and networkservices. We used a simple testing method of subjecting these programs to a random inputstream.
> ...
> The result of our testing is that we can crash (with coredump) or hang (infiniteloop) over 40% (in the worst case) of the basic programs and over 25% of the X-Window applications.
> ...
> We also tested how utility programs checked their return codes from the memory allocation library routines by simulating the unavailability of virtual memory. We could crash almost half of the programs that we tested in this way.

october 1995

Fuzzers

cat /dev/random



```
main(int argc, char **argv)
{       char buf[200];
        strcpy(buf, argv[1]);
        printf("%s\n",buf);
}
```

Et program der kan give forskelligt fejlbehftet input som mske kan identificere fejl

Jeg anbefaler bogen *Fuzzing: Brute Force Vulnerability Discovery* Michael Sutton, Adam Greene, Pedram Amini og tilhrende website

Se: http://www.fuzzing.org/fuzzing-software

Fri adgang til hackervrktjer

I 1993 skrev Dan Farmer og Wietse Venema artiklen
Improving the Security of Your Site by Breaking Into it

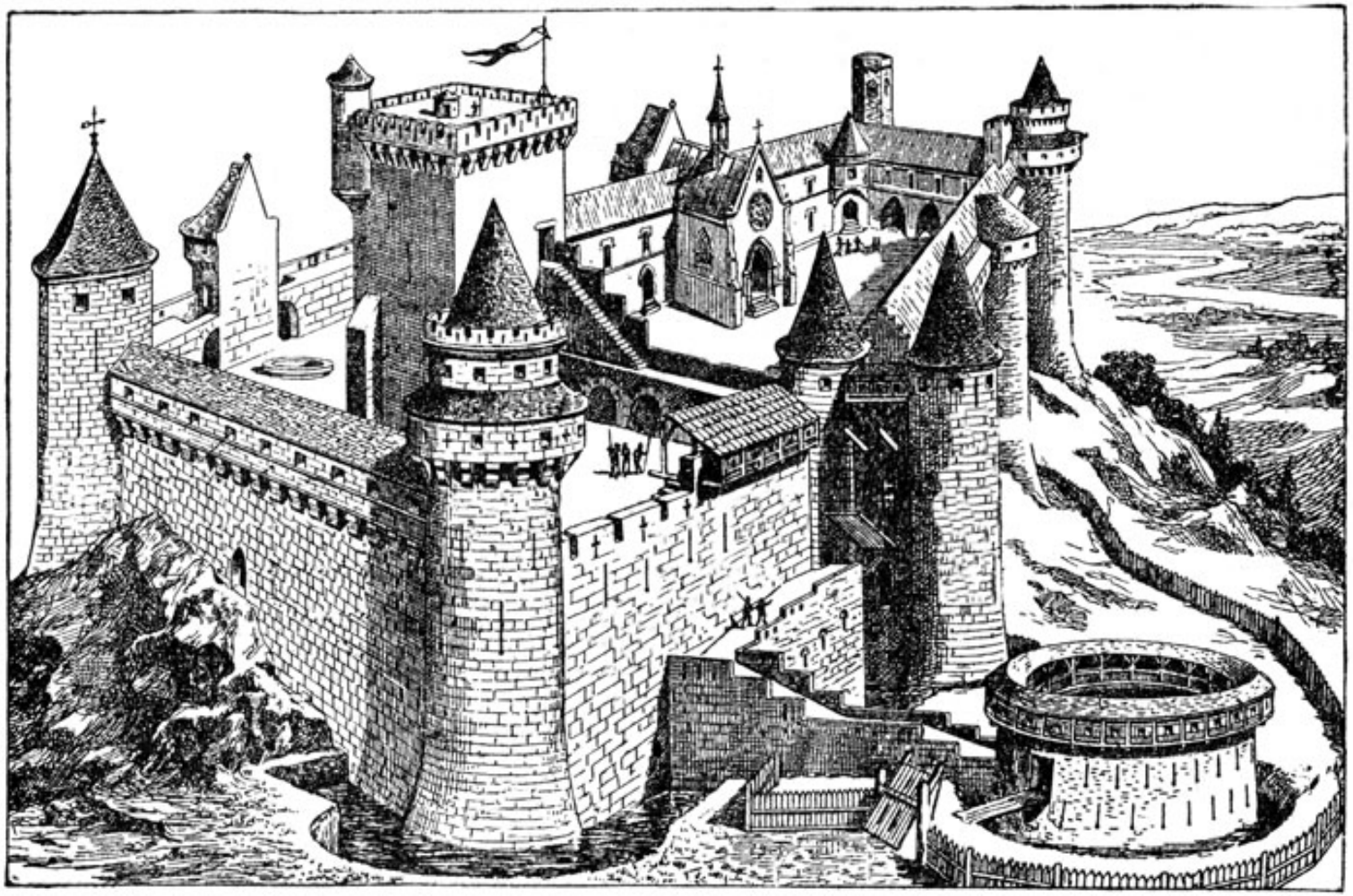
I 1995 udgav de softwarepakken SATAN
Security Administrator Tool for Analyzing Networks

> We realize that SATAN is a two-edged sword - like many tools, it can be used for good and for evil purposes. We also realize that intruders (including wannabees) have much more capable (read intrusive) tools than offered with SATAN.

Traditionen med benhed er frt videre helt til idag

Se http://sectools.org og http://www.packetstormsecurity.org/

Part 6 Enhance and secure runtime environment



Sidste chance er p afviklingstidspunktet

Chroot, Jails and

Der findes mange typer *jails* p Unix

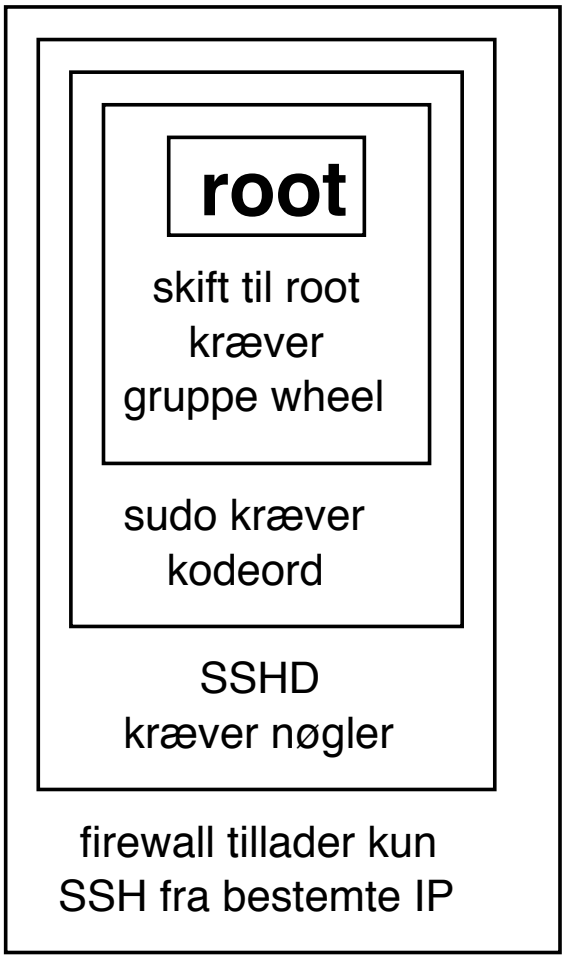
Ideer fra Unix chroot som ikke er en egentlig sikkerhedsfeature

- Unix chroot - bruges stadig, ofte i daemoner som OpenSSH
- FreeBSD Jails
- SELinux
- Solaris Containers og Zones - *jails p steroider*
- VMware virtuelle maskiner, er det et jail?

Hertil kommer et antal andre mder at adskille processer - sandkasser

Husk ogs de simple, database som `_postgresql`, Tomcat som `tomcat`, Postfix post-system som `_postfix`, SSHD som `sshd` osv. - simple brugere, f rettigheder

Defense in depth - flere lag af sikkerhed



Forsvar dig selv med flere lag af sikkerhed!

JVM security policies

Udviklet sammen med Java

Meget kendt

Bde Silverlight og JavaFX lner fra denne type model

Apache 6.0.18 catalina.policy (uddrag)


```
// ========== WEB APPLICATION PERMISSIONS ===================================
// These permissions are granted by default to all web applications
// In addition, a web application will be given a read FilePermission
// and JndiPermission for all files and directories in its document root.
grant {
    // Required for JNDI lookup of named JDBC DataSource's and
    // javamail named MimePart DataSource used to send mail
    permission java.util.PropertyPermission "java.home", "read";
    permission java.util.PropertyPermission "java.naming.*", "read";
    permission java.util.PropertyPermission "javax.sql.*", "read";
...
};
// The permission granted to your JDBC driver
// grant codeBase "jar:file:$catalina.home/webapps/examples/WEB-INF/lib/driver.jar!/-" {
//      permission java.net.SocketPermission "dbhost.mycompany.com:5432", "connect";
// };
```

Eksempel fra `apache-tomcat-6.0.18/conf/catalina.policy`

Apple sandbox named generic rules


```
;; named - sandbox profile
;; Copyright (c) 2006-2007 Apple Inc.  All Rights reserved.
;;
;; WARNING: The sandbox rules in this file currently constitute
;; Apple System Private Interface and are subject to change at any time and
;; without notice. The contents of this file are also auto-generated and not
;; user editable; it may be overwritten at any time.
;;
(version 1)
(debug deny)

(import "bsd.sb")

(deny default)
(allow process*)
(deny signal)
(allow sysctl-read)
(allow network*)
```

Apple sandbox named specific rules

```
;; Allow named-specific files
(allow file-write* file-read-data file-read-metadata
  (regex "^(/private)?/var/run/named\\.pid$"
         "^/Library/Logs/named\\.log$"))

(allow file-read-data file-read-metadata
  (regex "^(/private)?/etc/rndc\\.key$"
         "^(/private)?/etc/resolv\\.conf$"
         "^(/private)?/etc/named\\.conf$"
         "^(/private)?/var/named/"))
```

Eksempel fra `/usr/share/sandbox` p Mac OS X

Gode operativsystemer

Nyere versioner af Microsoft Windows, Mac OS X og Linux distributionerne inkluderer:

- Buffer overflow protection
- Stack protection, non-executable stack
- Heap protection, non-executable heap
- *Randomization of parameters* stack gap m.v.

OpenBSD er nok net lngst og et godt eksempel
http://www.openbsd.org/papers/

NB: meget af dette krver relativt ny CPU og Memory Management Unit

NB: meget f embedded systemer eller operativsystemer til samme har beskyttelse!

Informationssikkerhed

Husk flgende:

Sikkerhed kommer fra langsigtede intiativer

Hvad er informationssikkerhed?

Data p elektronisk form

Data p fysisk form

Social engineering - *The Art of Deception: Controlling the Human Element of Security* af Kevin D. Mitnick, William L. Simon, Steve Wozniak

Informationssikkerhed er en proces

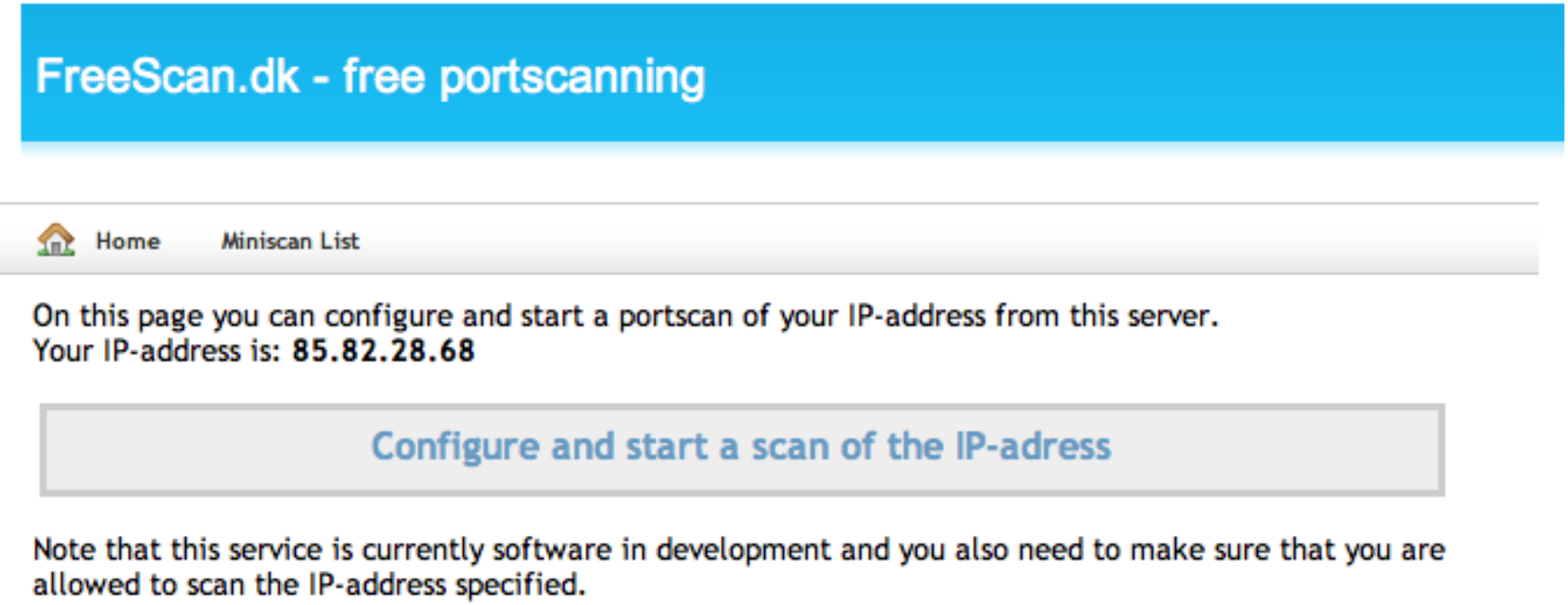
Sprgsml?

Henrik Lund Kramshj
hlk@security6.net

http://www.security6.net

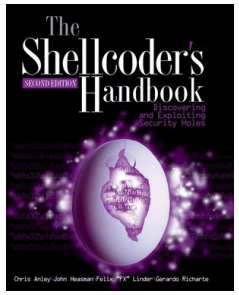
I er altid velkomne til at sende sprgsml p e-mail

FreeScan.dk - gratis portscanning



http://www.freescan.dk

Buffer overflows



Hvis man vil lre at lave buffer overflows og exploit programmer er flgende dokumenter et godt sted at starte

Smashing The Stack For Fun And Profit Aleph One

Writing Buffer Overflow Exploits with Perl - anno 2000

Flgende bog kan ligeledes anbefales: *The Shellcoder's Handbook : Discovering and Exploiting Security Holes* af Chris Anley, John Heasman, Felix Lindner, Gerardo Richarte 2nd Edition , John Wiley & Sons, august 2007

NB: bogen er avanceret og sledes IKKE for begyndere!

milw0rm - dagens buffer overflow

http://milw0rm.com/

Metasploit

What is it?

The Metasploit Framework is a development platform for creating security tools and exploits. The framework is used by network security professionals to perform penetration tests, system administrators to verify patch installations, product vendors to perform regression testing, and security researchers world-wide. The framework is written in the Ruby programming language and includes components written in C and assembler.

Trinity brugte et exploit program ☺

Idag findes der samlinger af exploits som milw0rm

Udviklingsvrktjerne til exploits er idag meget raffinerede!

http://www.metasploit.com/

Reklamer: kursusafholdelse

Flgende kurser afholdes med mig som underviser

- IPv6 workshop - 1 dag
  Introduktion til Internetprotokollerne og forberedelse til implementering i egne netvrk.
- Wireless teknologier og sikkerhed workshop - 2 dage
  En dag med fokus p netvrksdesign og fornuftig implementation af trdlse netvrk, samt integration med hjemmepc og wirksomhedsnetvrk.
- Hacker workshop 2 dage
  Workshop med detaljeret gennemgang af hackermetoderne angreb over netvrk, exploitprogrammer, portscanning, Nessus m.fl.
- Forensics workshop 2 dage
  Med fokus p tilgngelige open source vrktjer gennemgs metoder og praksis af undersgelse af diskimages og spor p computer systemer
- Moderne Firewalls og Internetsikkerhed 2 dage
  Informere om trusler og aktivitet p Internet, samt give et bud p hvorledes en avanceret moderne firewall idag kunne konfigureres.

Se mere p http://www.security6.net/courses.html