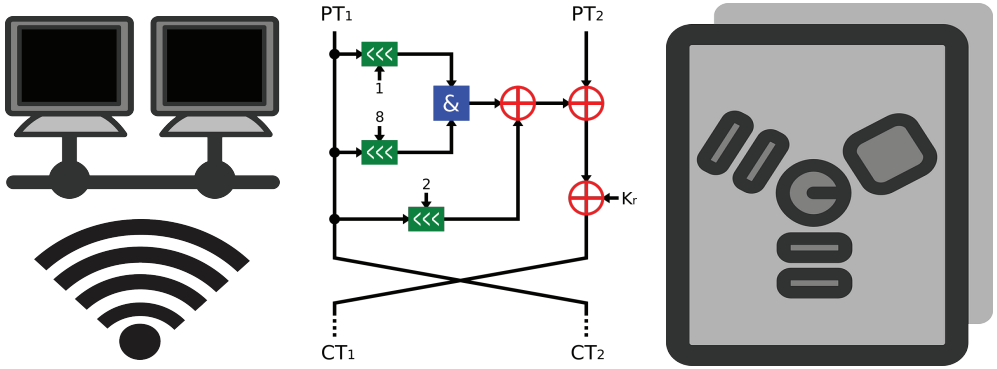
CSE 40567 / 60567: Computer Security



Software Security 5

Changes to the Syllabus:
See Course Website

Changes in Course Logistics:
See my Email and Slack

We are now caught up on grading. If you have questions on where you stand in the class, contact Prof. Scheirer.

Homework #5 has been released. It is due 4/2 at 11:59PM

See **Assignments Page** on the course website for details

Film Response Summary

Format Strings Attack

Another common bug:

```
int func(char *user){
   fprintf(stderr, user);
}
```

Problem: what if `*user = "%s%s%s%s%s%s%s"`?

- Most likely, program will crash: DoS.
- If not, program will print memory contents. Privacy impact?
- Full exploit using `*user = "%n"`

Correct use of `fprintf()`: `fprintf(stdout, "%s", user);`

Vulnerable functions

Any function using a format string:

Printing:

`printf(), fprintf(), sprintf(), …`

`vprintf(), vfprintf(), vsprintf(), …`

Logging:

`syslog(), err(), warn()`

Writing a format strings exploit

- Dumping arbitrary locations in memory:
  - Walk up the stack until desired pointer is found.
  - `printf("%08x.%08x.%08x.%08x|%s|")`
- Write to arbitrary locations in memory:
  - `printf("hello %n", &temp) //` writes ‘6’ into memory
  - `printf("%08x.%08x.%08x.%08x.%n")`

Race Conditions

- General category of bug (not always a security problem)
- Affects systems where the output is dependent on the sequence or timing of other uncontrollable events
- Becomes a bug when events do not happen in the order the programmer intended
- Trouble for authentication:
    - (1) Check for authentication, (2) State changes, (3) Act on authentication

Example: race condition exploit in Starbucks gift cards

- Hole in online gift card purchases surfaced in 2015
- Initiate two identical web store transfers, trick the store into recording both
  - Normal use: Move money from one card with $5 onto another, for a total of $10 on one card
  - With duplicate transfer: end up with $15 on one card!

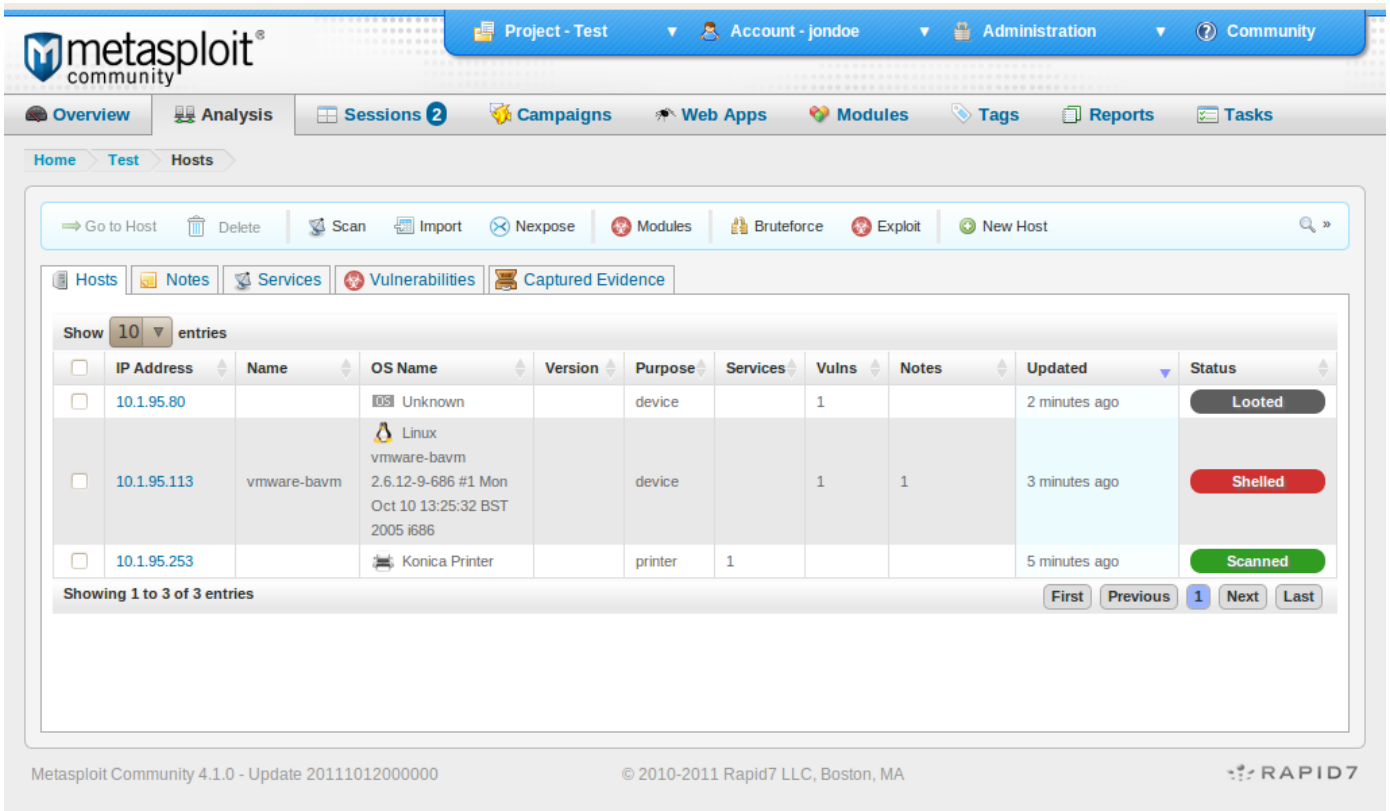
Gift card (cc) BY-SA 2.0 401(K) 2012

https://www.schneier.com/blog/archives/2015/05/race_condition_.html

Helpful Tools for Writing Exploits

Metasploit (www.metasploit.com)

Tool for developing and executing exploit code against a target machine



What does metasploit do?

- Provides tools that make debugging, offset hunting and payload crafting easier
- Basic steps for exploiting a system via the framework:
    1. Choose and configure an exploit (over 900 available in the framework)
    2. Check whether a target system is vulnerable
    3. Choose and configure a payload
    4. Encode payload to evade IDS
    5. Execute the exploit

Disassembling code

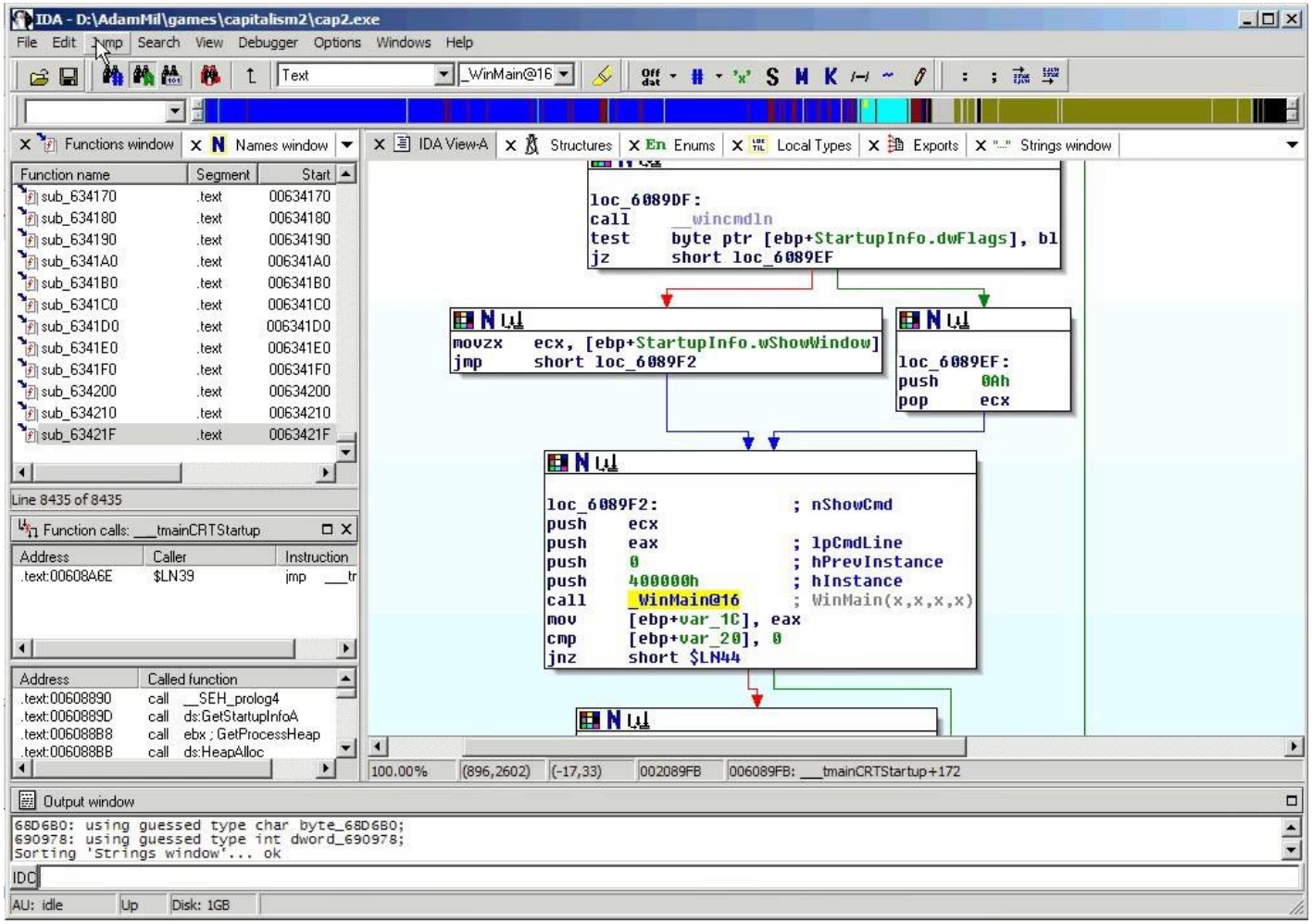
- Broad knowledge of assembly language is essential for writing exploits
  - Need to know where function calls exist in memory, the internal execution flow of the program, and the state of the heap / stack (`eip` / `rip` manipulation)
  - Sometimes source code isn't available; the binary must be examined in these cases

gdb

```
(gdb) disass main
Dump of assembler code for function main:
   0x0000000000400624 <+0>:   push   %rbp
   0x0000000000400625 <+1>:   mov    %rsp,%rbp
   0x0000000000400628 <+4>:   sub    $0x30,%rsp
   0x000000000040062c <+8>:   mov    %edi,-0x24(%rbp)
   0x000000000040062f <+11>:  mov    %rsi,-0x30(%rbp)
   0x0000000000400633 <+15>:  cmpl   $0x4,-0x24(%rbp)
   0x0000000000400637 <+19>:  je     0x40063e <main+26>
   0x0000000000400639 <+21>:  jmpq   0x400731 <main+269>
   0x000000000040063e <+26>:  mov    $0x100,%edi
   0x0000000000400643 <+31>:  callq  0x400520 <malloc@plt>
   0x0000000000400648 <+36>:  mov    %rax,-0x18(%rbp)
   0x000000000040064c <+40>:  mov    $0x40082c,%eax
   0x0000000000400651 <+45>:  mov    -0x18(%rbp),%rdx
```

IDA PRO

https://www.hex-rays.com/index.shtml



https://youtu.be/vb18UVF4a_o

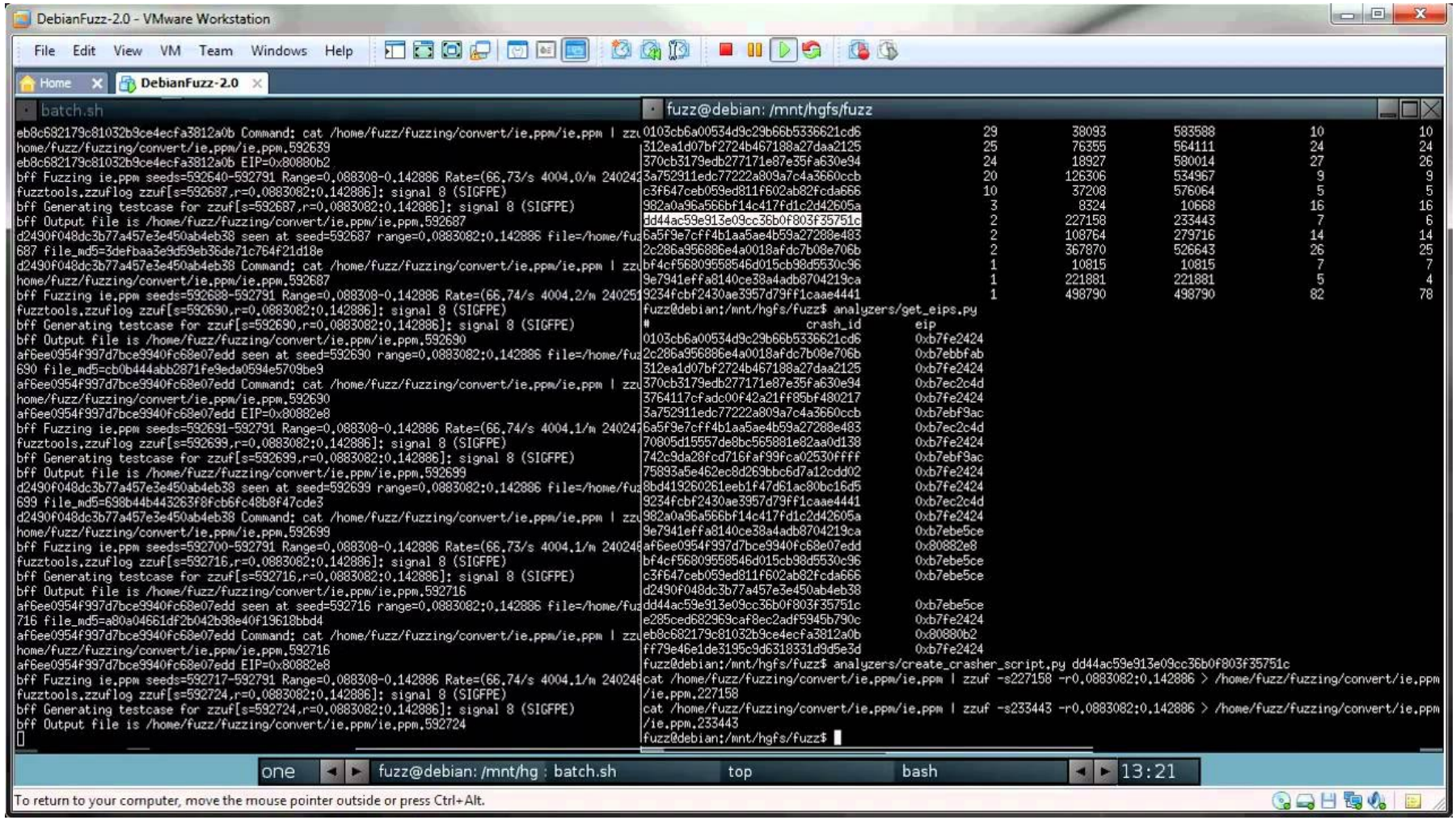
Fuzzing

- Black-box testing methodology
- Checks code modules for vulnerability to overflows
  - Many are not obvious to visual inspection
- Two fuzzing strategies are typically deployed
  1. **Mutation-based fuzzers**
  2. **Generation-based fuzzers**

CERT Basic Fuzzing Framework (BFF)

Mutational fuzzer

https://github.com/CERTCC-Vulnerability-Analysis/certfuzz



https://youtu.be/kSnc7RI5ByA

w3af

http://w3af.org/

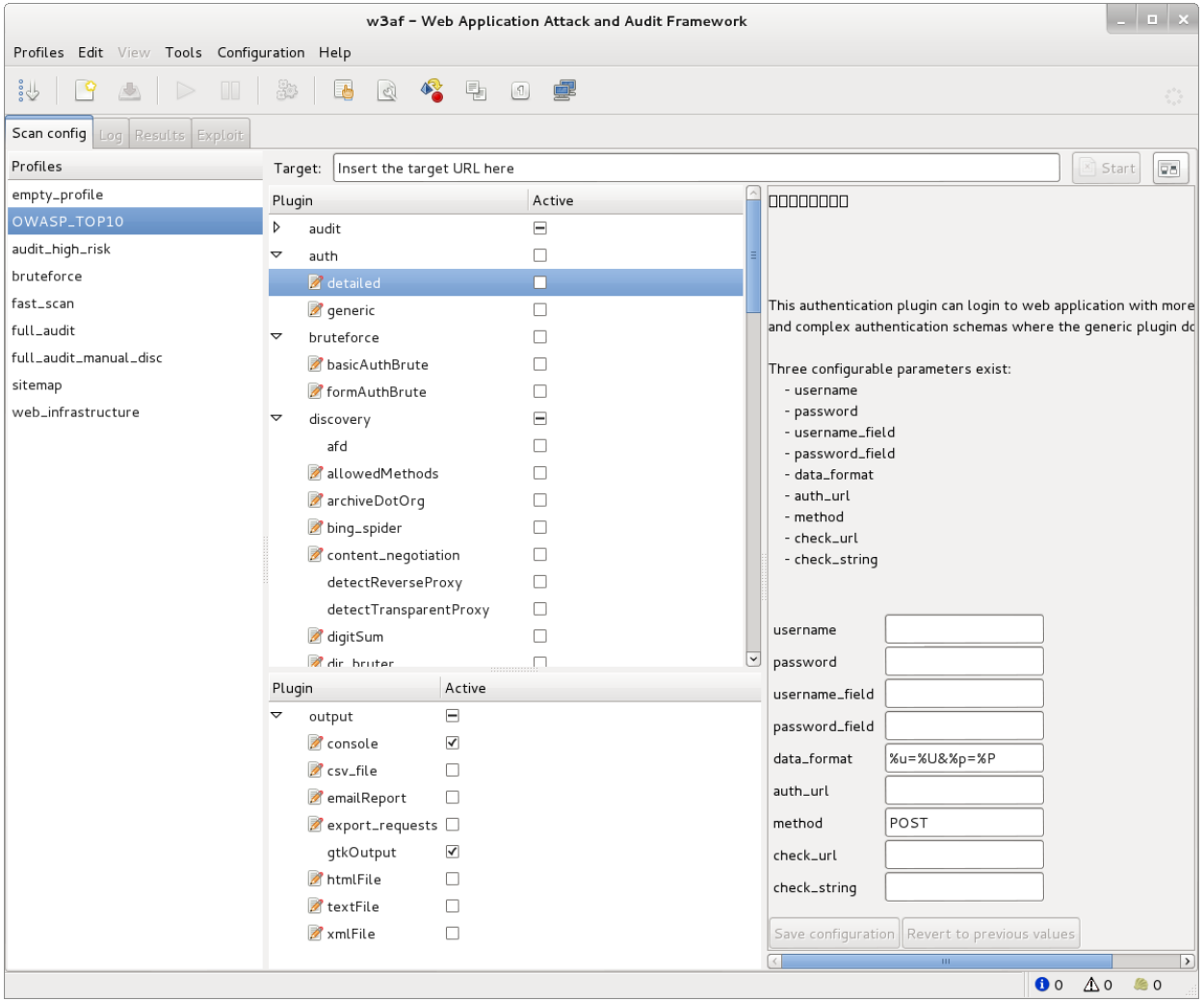


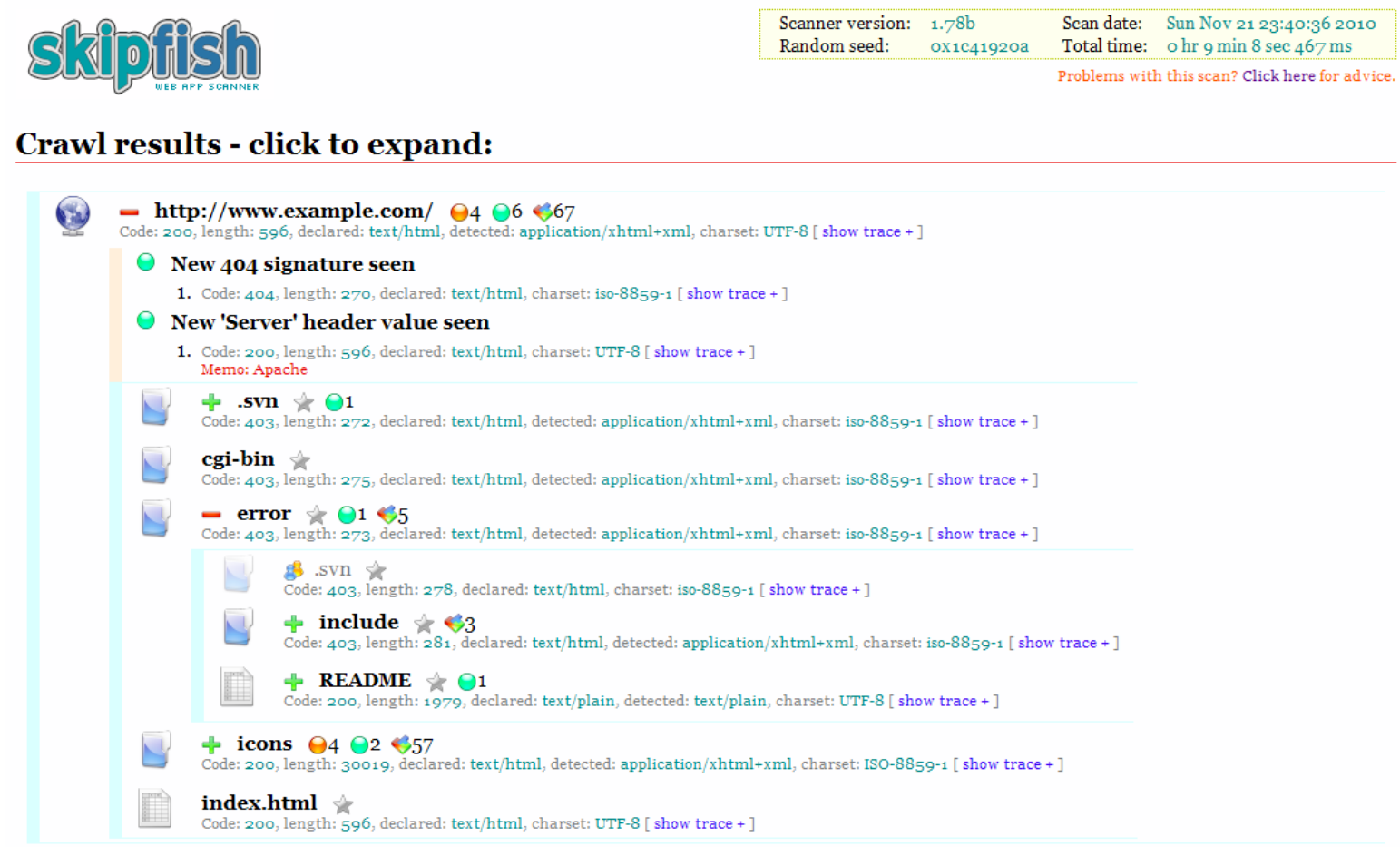
Image Credit: https://binarymist.files.wordpress.com/2014/01/w3af.png

Features:

- Daemons
- Fast HTTP Client
- Output Manager
- Fuzzing Engine
- Knowledge base

skipfish

https://code.google.com/archive/p/skipfish/



https://www.owasp.org/index.php/Automated_Audit_using_SKIPFISH