*Department of Electrical Engineering and Computer Science*

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

**6.858 Fall 2010**

# Quiz II

All problems are open-ended questions. In order to receive credit you must answer the question as precisely as possible. You have 80 minutes to finish this quiz.

Write your name on this cover sheet.

Some questions may be harder than others. Read them all through first and attack them in the order that allows you to make the most progress. If you find a question ambiguous, be sure to write down any assumptions you make. Be neat. If we can't understand your answer, we can't give you credit!

**THIS IS AN OPEN BOOK, OPEN NOTES EXAM.**

*Please do not write in the boxes below.*

| I (xx/32) | II (xx/5) | III (xx/9) | IV (xx/20) | V (xx/8) | VI (xx/6) | Total (xx/80) |
|---|---|---|---|---|---|---|
| | | | | | | |

**Name:**

# I Backtracking Intrusions

Alice finds a suspicious file, `/tmp/mybot`, left behind by an attacker on her computer. Alice decides to use Backtracker to find the initial entry point of the attacker into her computer. In the following scenarios, would Alice be able to use Backtracker, as described in the paper, to find the entry point?

**1. [2 points]:** An attacker exploits a buffer overflow in a web server running as root, gets a root shell, and creates the `/tmp/mybot` file.

**2. [2 points]:** An attacker exploits a buffer overflow in a web server running as root, gets a root shell, and modifies the password file to create an account for himself. The attacker then logs in using the new account, and creates the `/tmp/mybot` file.

**3. [2 points]:** An attacker guesses root's password, logs in, and creates the `/tmp/mybot` file.

Ben Bitdiddle wants to use Backtracker on his web server running the Zoobar web application. Ben is worried about both SQL injection and cross-site scripting attacks, where an attacker might use the vulnerability to modify the profiles of other users.

**4. [6 points]:** Ben runs unmodified Backtracker on his server, and uses a known SQL injection vulnerability to test Backtracker, while other users are actively using the site. Ben finds that he cannot effectively track down the attacker's initial entry point, after he detects that one of the user's profiles has been defaced by the attack. Explain why Backtracker is not working well for Ben as-is.

**5. [10 points]:** Propose a modification of Backtracker that would allow Ben to find the attacker's initial entry point for SQL injection attacks. Be sure to explain how the log, EventLogger, and GraphGen would need to be modified for your design, if at all, and whether you need to add any additional logging components. It's fine if your design does not handle buffer overflow attacks, and only handles SQL injection.

**6. [10 points]:** Ben's modified Backtracker system still cannot catch the attacker's initial entry point for the Zoobar profile worm, which spreads through a cross-site scripting vulnerability. Propose a modified design for Backtracker that can track down the source of a XSS attack like the profile worm.

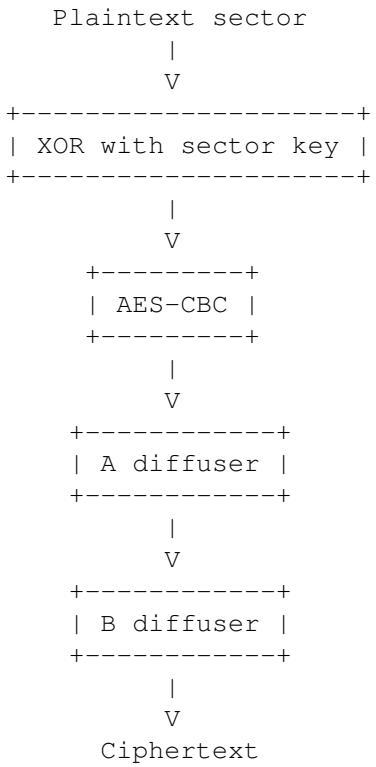
# II TPMs

Suppose Ben implements Sailer's integrity measurement architecture on a Linux server, and a client uses the protocol in Figure 3 to verify the server's integrity (while sending these protocol messages over an SSL connection to Ben's server).

**7. [5 points]:** What, precisely, can a client safely assume about its SSL connection and about Ben's server, if it validates the response (steps 5a, 5b, and 5c)? Assume that no attackers have compromised any TPM chips or certificate authorities.

# III Disk encryption

Ben Bitdiddle decides to optimize BitLocker's encryption mechanism by re-ordering some steps, so that the key-dependent sector key and AES-CBC steps can be combined. In particular, Ben's version of BitLocker looks like the follows (contrast with Figure 1 from the paper):




**8. [9 points]:** How can an adversary extract data from a stolen laptop running Ben's version of BitLocker in TPM-only mode, in a way that he or she could not for the original version of BitLocker? In other words, how is this scheme weaker?

# IV Tor

Alice wants to improve the privacy of Tor, and changes the design slightly. In Alice's design, clients choose an exit node, and instead of building one circuit to the exit node, they build two circuits to the same exit node. Once the client builds both circuits, it sends the same randomly-chosen cookie to the exit node via each of the circuits, to tell the exit node that the two circuits belong to the same client. (After this point, the client and the exit node use the same stream IDs on both circuits interchangeably.) When a client wants to send a packet to the exit node, it sends the packet via one of the two circuits, chosen at random. Similarly, when the exit node wants to send data back to the client, it uses one of the two circuits at random.

**9. [5 points]:** What kinds of attacks against privacy does this scheme make more difficult?

**10. [5 points]:** What kinds of attacks against privacy does this scheme make easier?

**11. [2 points]:** What kinds of attacks against individual exit nodes does this scheme make easier?

**12. [8 points]:** Propose a modified design for Tor's hidden services that would allow a hidden service to require CAPTCHAs before spending resources on a client's request. Explain who generates the CAPTCHA in your design, who is responsible for checking the solution, and how the steps required to connect to a CAPTCHA-enabled hidden service change (along the lines of the list in Section 5.1 of the paper).

# V IP Traceback

Ben Bitdiddle likes the IP Traceback scheme proposed by Stefan Savage, but doesn't like the fact that edge fragments are so small (consisting of just 8 bits of edge fragment data, as shown in Figure 9). Ben decides that he can get rid of the distance field, and expand the edge fragment field to 13 bits. To reconstruct the entire edge, Ben proposes to try all combinations of fragments (since he no longer knows what fragments came from the same distance away), at the cost of requiring more CPU time.

**13. [8 points]:** Describe a specific attack against Ben's scheme that violates the goal of IP Traceback (i.e., that the real path to the attacker is a suffix of the path returned by IP Traceback).

## VI 6.858

We'd like to hear your opinions about 6.858, so please answer the following questions. (Any answer, except no answer, will receive full credit.)

**14. [2 points]:** What security topics did you want to learn more about, either in lectures or in labs?

**15. [2 points]:** What is your favorite paper from 6.858, which we should keep in future years?

**16. [2 points]:** What is your least favorite paper, which we should get rid of in the future?

# End of Quiz