Developing Apps as though Operations Matters

SecAppDev 2010

Quiz

Here's the scenario

- Your software has just suffered a major security breach
- The CEO has called in law enforcement and a Computer Security Incident Response Team (CSIRT) to help clean up the mess

Now what?

What are the CSIRT's top priorities?

How will your software help the CSIRT do its job?

You did plan for this, right?

– Microsoft's SDL spells out planning for crises

Here’s my answer to #1

Highest priority is to determine the business impact

Second highest is situational awareness throughout the incident

Third is to recommend a course of action to take, and then to coordinate execution of that plan

In reality

In my 20+ years of incident response experience:

- The CSIRT is called up after the fact
  - Or they find out about the incident by accident!
- Often, the attackers have come and gone
- CSIRT has to assemble the puzzle from available data
  - There's never enough–or the right–available data

CSIRT needs to…

Determine the who, what, when, where, and how (WWWWH)

- Using existing records of the events
- Disk and network forensics often not terribly useful
    - After the fact may be too late
    - Time consuming and costly
    - Only used to find specific data
- Where do we look?
    - Logs
    - Auditability vs. accountability

Event logging

In a production data processing environment, there can be many sources of log data

- With luck, they're sent to a central log concentrator
- Consider the per-source perspective
    - What did the (router, firewall, web server, Java container, database) see?
    - Now, what did they report?
    - How do they speak to WWWWH?

The trouble with logs

Most are simply extensions of debugging hooks in code
- They are written for the *developer*, not the CSIRT
- Wrong audience and purpose

Let’s take a look at a couple examples

Company background

- Large ISP in Netherlands
  - –Range of services: DSL, VoIP, hosting
- Massive enterprise application infrastructure
  - –Much of it is exposed to the big bad internet
- Security is taken very seriously
  - –Availability is primary concern
  - –Fraud prevention is close second

Examples −1

Does this mean anything (useful) to you?

```
Feb 11 09:09:30 server1 setuid-wrapper[76686]: zzz called "d/usr/bin/setuid/
atmping --monitor LINEIDNUMBER"

Feb 11 09:09:33 server1 setuid-wrapper[76727]: zzz called "d/usr/bin/setuid/
greplog --tail --appstream account=wibble1,"

Feb 11 09:09:34 server1 setuid-wrapper[76736]: zzz called "?^C/usr/bin/setuid/
zoeklog -i 1.2.4.4"

Feb 11 09:09:35 server1 greplog[76727]: zzz searches with TRACE for
account=wibble1,
```

Examples −2

How about this one?

```
Feb  6 10:28:08 service8 ServiceCentre-1.36.24[9231]: [STATS] {Service:217} servicecentre_login:
username_mangled=54894ef40dca18a5

Feb  6 10:28:27 service6 ServiceCentre-1.36.24[2919]: [STATS] {Service:217} servicecentre_login:
username_mangled=bf2808e01aeb8deb

Feb  6 10:28:35 service6 ServiceCentre-1.36.24[2923]: [STATS] {Service:217} servicecentre_login:
username_mangled=8ec5c711d167964d

Feb  6 10:29:27 service6 ServiceCentre-1.36.24[2934]: [STATS] {Service:217} servicecentre_login:
username_mangled=2b82db4bbf54f7aa

Feb  6 10:29:41 service8 ServiceCentre-1.36.24[9258]: [STATS] {Service:217} servicecentre_login:
username_mangled=64aa378b8f32905c

Feb  6 10:29:55 service2 ServiceCentre-1.36.24[98842]: [STATS] {Service:217} servicecentre_login:
username_mangled=aa9e261c1f797bc5

Feb  6 10:29:57 service8 ServiceCentre-1.36.24[9263]: [STATS] {Service:217} servicecentre_login:
username_mangled=54894ef40dca18a5
```

Examples −3

And what does this one tell you?

```
64.4.8.137 - - [24/Jan/2007:06:15:09 -0500] "GET /robots.txt HTTP/1.0" 200 0 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:06:15:09 -0500] "GET /rss.xml HTTP/1.0" 200 8613 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:06:38:41 -0500] "GET /robots.txt HTTP/1.0" 200 0 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:06:38:41 -0500] "GET /about.php HTTP/1.0" 200 9770 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:06:42:21 -0500] "GET /index.php HTTP/1.0" 200 5080 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:06:42:38 -0500] "GET /courses.php HTTP/1.0" 200 7509 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:06:50:07 -0500] "GET /whats_new.php HTTP/1.0" 200 12404
"-" "msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:10:09:30 -0500] "GET /contact.php HTTP/1.0" 200 3526 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:10:09:34 -0500] "GET /consulting.php HTTP/1.0" 200 4936
"-" "msnbot/1.0 (+http://search.msn.com/msnbot.htm)"

64.4.8.137 - - [24/Jan/2007:10:09:34 -0500] "GET /sclist.php HTTP/1.0" 200 3139 "-"
"msnbot/1.0 (+http://search.msn.com/msnbot.htm)"
```

Wow, those were ugly

So, what is missing from our logging?

- Meaningful data about the software
- Pretty much all of WWWWH

So let’s see what can be done to improve things

- Let’s start by looking at some case studies

Case study 1: ISP Provisioning

Web-based ISP provisioning application

–Used to open/close/modify customer accounts

Logs used to look like this

```
1.2.4.4 - - [17/Jun/2009:12:00:30 +0200] oms "GET /adsl/?
postcode=1234ZZ&housenumber=21&floor=&dsl_type=&abo=ADSLEntryPackage&PartnerID=w
ibble HTTP/1.1" 302 5 "http://www/g/adsl/check.php" "Mozilla/5.0 (Windows; U;
Windows NT 5.1; nl; rv:1.8.1.7) Gecko/20070914 Firefox/2.0.0.7 (.NET CLR
3.5.30729)" TLSv1 DHE-RSA-AES256-SHA
```

What can we learn here?

–See the problems?

–Finding fraudulent requests is not easy

And then the CSO stepped in to improve things

Provisioning, cont'd

Version 1.1 looked like this

```
Jan 12 17:46:57 oms[INFO] 22.20.16.130 Order 911956 created with userid vdhmople custid 1231560

Jan 12 19:23:43 oms [INFO] 14.10.2.120 Order 911970 created with userid kpmople custid 125518
inpersonated by adsfalsvaso

Jan 12 19:40:16 oms [INFO] 9.21.162.178 Order 911978 created with userid hthmople custid 1232450

Jan 12 19:49:30 oms [INFO] 8.11.3.60 Order 911979 created with userid spemople custid 417793

Jan 12 19:52:23 oms [INFO] 8.95.14.86 Order 911982 created with userid gimople custid 291704

Jan 12 20:28:14 oms [INFO] 8.131.0.104 Order 911987 created with userid fammavoople custid 1138152

Jan 12 20:36:38 oms [INFO] 6.221.17.65 Order 911989 created with userid hartjmople custid 702782

Jan 12 20:57:24 oms [INFO] 8.80.113.101 Order 911996 created with userid jadvmple custid 1232451
```

A little better, but we're not there yet

Provisioning, cont'd

Third attempt, showing improvements

```
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_new order 942963 created with userid murfle klantid 1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_new order 942963 created with userid murfle klantid 1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_modem order 942964 created with userid murfle klantid
1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 bns_ship order 942965 created with userid murfle klantid
1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_modem order 942964 created with userid murfle klantid
1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_engineer order 942966 created with userid murfle klantid
1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_engineer order 942966 created with userid murfle klantid
1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_q4mobile order 942967 created with userid murfle klantid
1240655
Feb 11 19:14:06 oms : [audit][INFO] 1.195 xso_q4mobile order 942967 created with userid murfle klantid
1240655
```

Provisioning, cont'd

Last (and current) version

```
Feb  5 06:57:58 oms : [audit][INFO] 1.2.3.4 voip_new order 937282 created with userid blah custid
286010

Feb  5 10:00:32 oms : [audit][INFO] 5.6.7.8 voip_new order 937402 created with userid basdflah custid
1222877 inpersonated by savdskalf

Feb  5 10:16:46 oms : [audit][INFO] 83.13.55.220 voip_new order 937418 created with userid bzavalah
custid 1216223

Feb  5 11:12:57 oms : [audit][INFO] 8.9.253.36 voip_new order 937528 created with userid xblah custid
453088

Feb  5 11:31:58 oms : [audit][INFO] 83.11.19.154 voip_new order 937543 created with userid brblah
custid 1230761

Feb  5 11:42:59 oms : [audit][INFO] 3.61.18.91 voip_new order 937555 created with userid hecblah custid
1231818

Feb  5 11:52:13 oms : [audit][INFO] 15.22.61.13 voip_new order 937567 created with userid eblah custid
441733

Feb  5 12:42:59 oms : [audit][INFO] 8.13.241.249 voip_new order 937636 created with userid jmblah
custid 1228739
```

Now we have all the WWWWH data we need

Provisioning, cont'd

- See how the end result has improved things?
- Security team can now find business-relevant data in the logs
  - The logs are now written for the right audience
- The log formats (syslog using log4j) are unchanged

Code considerations

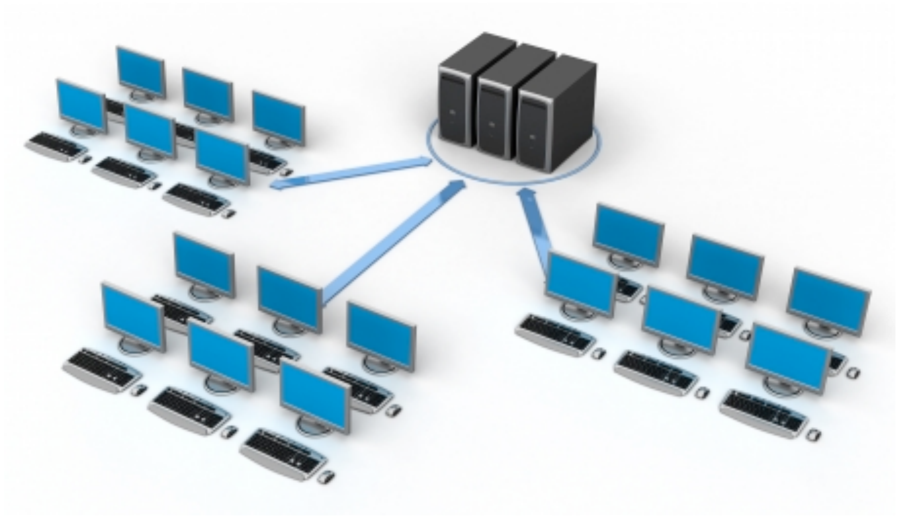
What do we need to take care of in our code?

- It's NOT sufficient to change those debug statements to log4j
- Some issues require careful planning

Infrastructure first

Be sure your logging architecture is solid

- Centralized log server
  - Monitored by security team
- Secure protocols
- Non-repudiation of logged data
- Mutual authentication
  - How do you know you're talking to the logger
- What's the performance impact?
  - Separate admin data from production



Case study: Servlet

We'll step through some code issues using a Java EE servlet

- Code excerpts are meant for illustrative purposes only
- Not meant to be compilable per se

Scenario

You're the dev team leader for some enterprise code

- Boss has asked to add some functionality

New function

- Users can view their account settings

Assumptions

- Only authenticated users have access to the servlet
  - Enforced by Java EE container in presentation layer
- No input validation takes place on the client

Servlet excerpt: first attempt

```
String Lastname = request.getParameter("LASTNAME");

String Query = "SELECT Accounts FROM CUSTOMERS WHERE LASTNAME = '" + Lastname + "'";

// Query will be:   SELECT Accounts FROM CUSTOMERS WHERE LASTNAME = '_lastname_'

Statement selectStatement = connection.createStatement ();
ResultSet resultSet = selectStatement.executeQuery(Query);
```

Servlet excerpt: added SQLi

```
String Lastname = request.getParameter("LASTNAME"); // From HTTP request

String Query = "SELECT Accounts FROM CUSTOMERS WHERE LASTNAME = ?";

PreparedStatement pstmt = connection.preparedStatement(Query);
pstmt.setString(1, Lastname);
try
       {
              ResultSet results = pstmt.execute();
       }
```

Servlet excerpt: added XSS

```
Protected final static String LEGITNAMECHARS = "^[a-zA-Z\s.\-]+$";
boolean validated = false;
String Lastname = request.getParameter("LASTNAME"); // From HTTP request

if (Lastname != null)
   {
         pattern = Pattern.compile(LEGITNAMECHARS);
         validated = pattern.matcher(Lastname).matches();
  }

if (validated) {
   String Query = "SELECT Accounts FROM CUSTOMERS WHERE LASTNAME = ?";

   PreparedStatement pstmt = connection.preparedStatement(Query);
   pstmt.setString(1, FilteredLastname);
   try
         {
                     ResultSet results = pstmt.execute();
         }

   Statement selectStatement = connection.createStatement ();
   ResultSet resultSet = selectStatement.executeQuery(sel);
}
```

Definition: Security tiers

Levels of app security

- Tier 1
  - Block the bad stuff from happening
- Tier 2
  - Block the bad, and log
- Tier 3
  - Block, log, and take evasive actions

Servlet excerpt: towards tier 2

```
// We assume Log4J is already initialized and available to our code.
// (See  http://www.devdaily.com/blog/post/java/simple-log4j-example

Protected final static String LEGITNAMECHARS = "^[a-zA-Z\s.\-]+$";
String Lastname = request.getParameter("LASTNAME"); // From HTTP request
if (Lastname != null)
   {
       pattern = Pattern.compile(LEGITNAMECHARS);
       validated = pattern.matcher(Lastname).matches();
  }
if (validated)
   {
       /* Do business function */
   }
else
  {
       log.info("Attack detected!");
 }
```

Servlet excerpt: closer to tier 2

```
if (validated)
   {
       /* Do business function */
   }
else
  {
       String RawLastname = Lastname;
       Lastname = RawLastname.toLowerCase();
       if Lastname.indexOf("<script>") != 0 {
          log.info("XSS attack detected!")
       }
       /* and so on */
  }
```

Servlet excerpt: tier 2ish

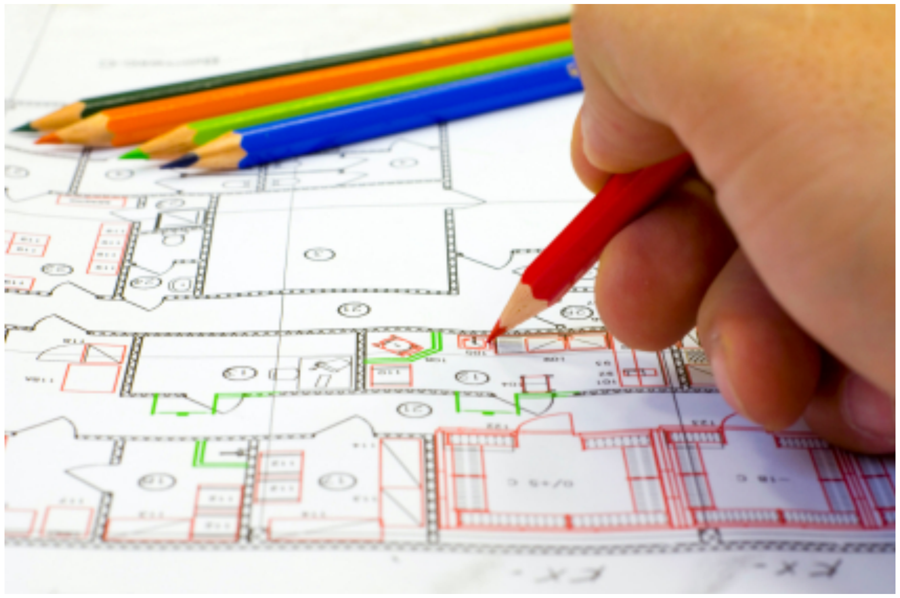
```
/*      OK, so let's consider what we log in more detail:

        Who -- We need to log the caller here.  That should come from
        somewhere outside the direct control of the user.  We'll grab
        that from the Session object.  Also src/dst IP and other
        packet-layer detail.

        What -- What did the attacker do?  Known attack vs. unknown.
        Raw data or quarantine of malicious data?

        When -- basic time/date stamp.

        Where -- See src/dst data above. */
```

Servlet excerpt: tier 3 stuff

```
/*     Possibilities, in ascending order, include (in addition to Tier two steps above):

                    Turn up logging of offending user

                    Kill session and force reauthentication

                    Quarantine the attack data

                    Null out any PII in the account

                    Kill/disable the account

                    Store attack in "evidence bag" with
                    tamper-evident seal

                    Put attacker in a "walled garden" where he can
                    do no harm (but thinks he can). */
```

Design issues

- Do we include this sort of thing everywhere, in every servlet or input?
  - Centralization can make sense
  - What about context?
- Building some primitive functions can make sense



Candidates

Primitives to consider building

- Quarantine data (with evidentiary support)
- Common input validation attack recognition
- Evasive actions

Legacy apps

How do you improve the auditability of your legacy apps?

- Application firewalls can help to a degree
  - Most are exclusively for web apps
- Must have intimate knowledge of how the app works in order to be useful
- Event logging is a trivial and natural add-on this way

Getting started

Don't wait for "them" to come to you

- Seek out the CSIRT at earliest stage of the dev process
  - Coordinate features, logging, etc.
  - Inventory of what gets logged is vital
  - Interface with IDS data/team to ensure compatibility with app logging data
- Seek out General Counsel or privacy officer
  - Ensure logging is in compliance
  - May need to be different by region

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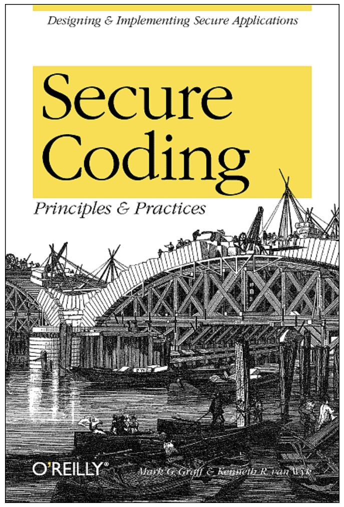
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