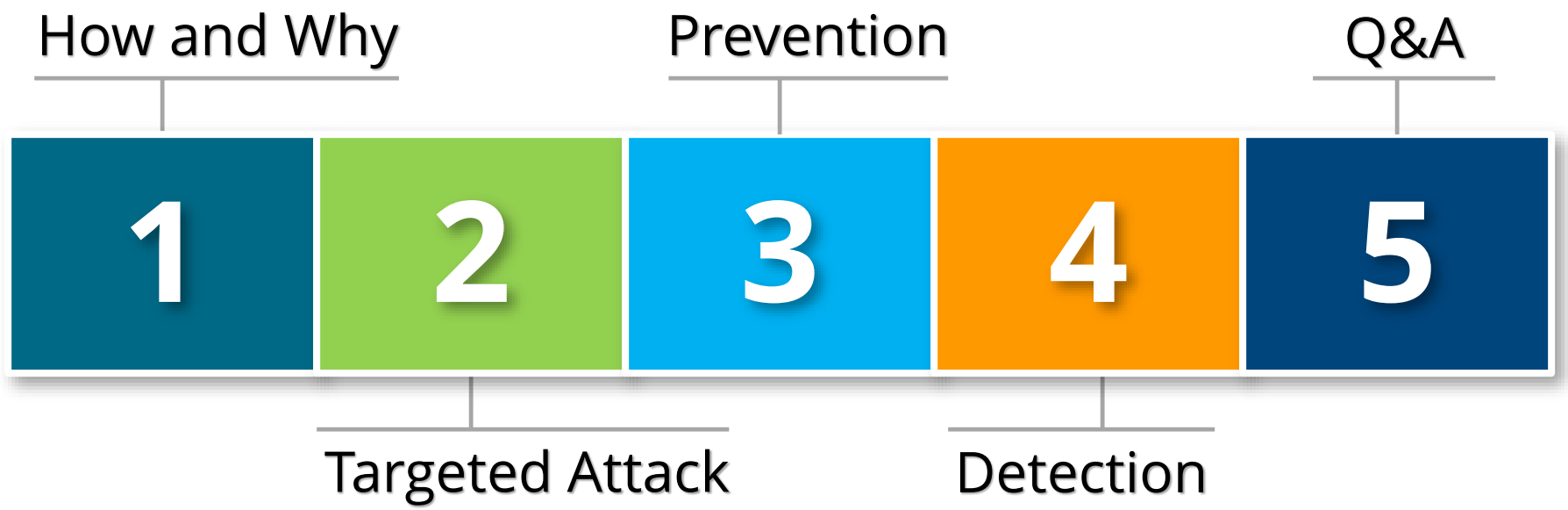
Detecting and Stopping Cyber Attacks
Against Oracle Databases

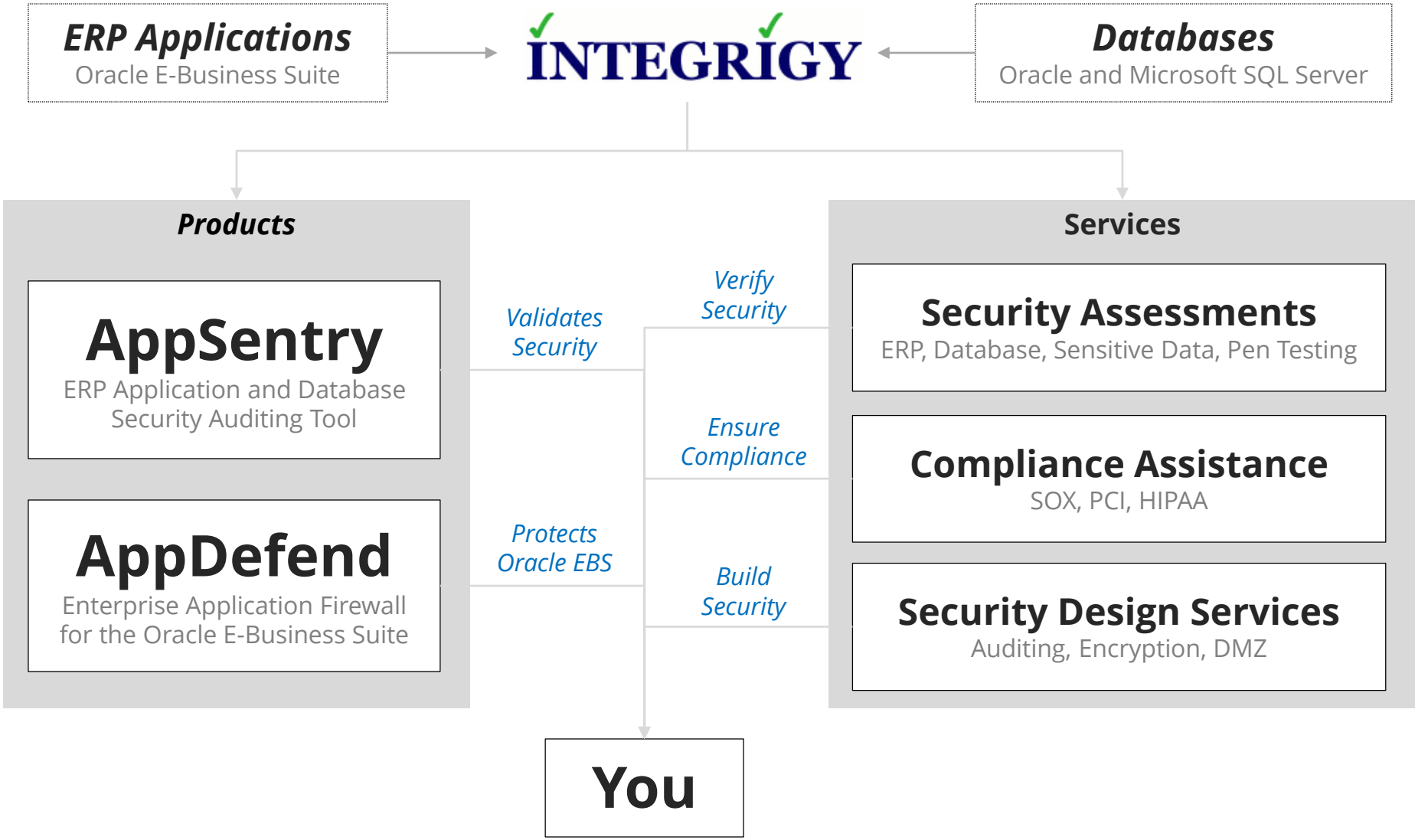
June 25, 2015

Stephen Kost
Chief Technology Officer
Integrigy Corporation

Agenda



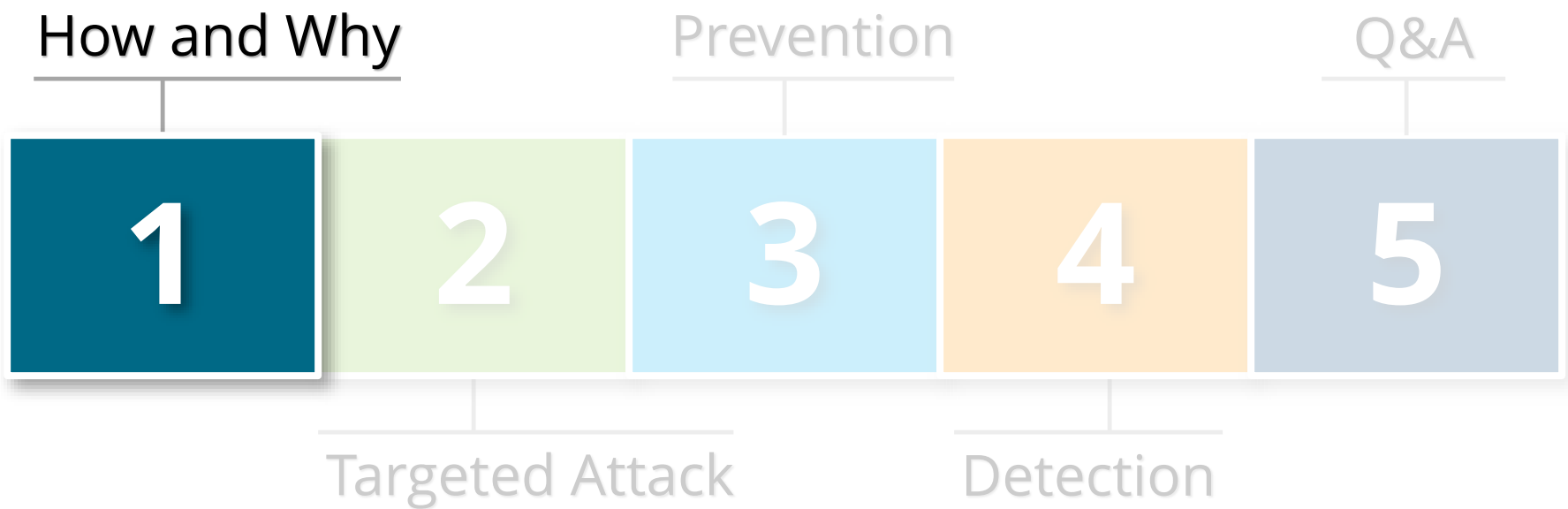
About Integrigy



Integrigy Published Security Alerts

Security Alert	Versions	Security Vulnerabilities
Critical Patch Update April 2012	11.5.10 – 12.1.x	▪ Oracle E-Business Suite security architecture issue
Critical Patch Update July 2011	11.5.10 – 12.1.x	▪ Oracle E-Business Suite security configuration issue
Critical Patch Update October 2010	11.5.10 – 12.1.x	▪ 2 Oracle E-Business Suite security weaknesses
Critical Patch Update July 2008	Oracle 11g 11.5.8 – 12.0.x	▪ 2 Issues in Oracle RDBMS Authentication ▪ 2 Oracle E-Business Suite vulnerabilities
Critical Patch Update April 2008	12.0.x 11.5.7 – 11.5.10	▪ 8 vulnerabilities, SQL injection, XSS, information disclosure, etc.
Critical Patch Update July 2007	12.0.x 11.5.1 – 11.5.10	▪ 11 vulnerabilities, SQL injection, XSS, information disclosure, etc.
Critical Patch Update October 2005	11.0.x, 11.5.1 – 11.5.10	▪ Default configuration issues
Critical Patch Update July 2005	11.0.x, 11.5.1 – 11.5.10	▪ SQL injection vulnerabilities and Information disclosure
Critical Patch Update April 2005	11.0.x, 11.5.1 – 11.5.10	▪ SQL injection vulnerabilities and Information disclosure
Critical Patch Update Jan 2005	11.0.x, 11.5.1 – 11.5.10	▪ SQL injection vulnerabilities
Oracle Security Alert #68	Oracle 8i, 9i, 10g	▪ Buffer overflows ▪ Listener information leakage
Oracle Security Alert #67	11.0.x, 11.5.1 – 11.5.8	▪ 10 SQL injection vulnerabilities
Oracle Security Alert #56	11.0.x, 11.5.1 – 11.5.8	▪ Buffer overflow in FNDWRR.exe
Oracle Security Alert #55	11.5.1 – 11.5.8	▪ Multiple vulnerabilities in AOL/J Setup Test ▪ Obtain sensitive information (valid session)
Oracle Security Alert #53	10.7, 11.0.x 11.5.1 – 11.5.8	▪ No authentication in FNDFS program ▪ Retrieve any file from O/S

Agenda



Targeted Attack

Targeted Attack

Advanced Persistent Threat (APT)

Organized Crime

State Sponsored

Anonymous, LulzSec, Legion of Doom, ...

With more than 317 million new pieces of malware created in 2014, or close to 1 million new pieces of unique malware each day, the overall total number of malware is now 1.7 billion.

- Symantec Internet Security Threat Report April 2015

What are they after?

Credit Card Fraud
 	
Credit Card Data
	▪ Credit Card Number
	  ▪ *Primary Account Number (PAN)*
	▪ CVV/CV2/CID
	  ▪ *3 digits on the back for Visa/MC*
	  ▪ *4 digits on the front for AMEX*
	▪ Magnetic Stripe Data

Identify Theft/Tax Fraud
 	
Personally Identifiable Information (PII)
	▪ First and last name
	▪ Date of Birth
	▪ Plus one of the following:
	  ▪ **Social security number**
	  ▪ Bank account number
	  ▪ Financial account number
	  ▪ Driver license or state ID number

Health Insurance Fraud
 	
Health Information
	▪ First and last name
	▪ Plus one of the following (Protected Health Information)
	  ▪ "the past, present, or future physical or mental health, or condition of an individual"
	  ▪ "provision of health care to an individual"
	  ▪ "payment for the provision of health care to an individual"

In 2013, the health care industry accounted for 44% of all breaches

- Identity Theft Resource Center

What is your data worth? Credit Cards

Credit Card Price	*Black Market Circumstances*
$20 – $45	**Freshly acquired**
$10 – $12	**Flooded**
$2 – $7	**Clearance (“stale” data)**

Source: Krebs on Security

What is your data worth? Identify Theft

$1 – $5	▪ First and last name ▪ Social Security number	**Tax information (e.g., 1099)**
$20 – $40	▪ First and last name ▪ Social Security number ▪ Current address ▪ Date of birth	**Health care** **Human Resources**
$30 – $100	▪ First and last name ▪ Social Security number ▪ Current address ▪ Date of birth ▪ Bank account number or credit card number ▪ Salary	**Payroll**

- **FY 2013 – 1 million fraudulent tax returns**
- **FY 2013 – $5.8 billion in fraudulent tax refunds**
- **3,000 IRS employees dedicated to tax Fraud**

- General Accounting Office (GAO) Report

Database Valuation

Calculate the black market value of the data contained in your database to help evaluate risk.

Data Type	*Formula*
Credit Cards	**(number of unique, unexpired cards) * $10**
Social Security Numbers	**(number of unique SSN + Name + DoB) * $20** **or (number of unique SSN + Bank) * $50**

Agenda

Anatomy of the Targeted Attack

1 **Point of Entry**	Breach the perimeter network through a network compromise, phishing attack, or social engineering.
2 **Persistence**	Once inside, establish a “beach-head” and maintain the compromise over time (days, months, years).
3 **Lateral Movement**	Expand the compromise to more devices and systems.
4 **Asset and Data Discovery**	The **Targeted Attack** has already identified “data of interest” and will being searching for it. *How to do this without detection?*
5 **Data Exfiltration**	Once the “data of interest” has been gathered, it must be transferred externally without being detected. *How do you quietly steal gigabytes or terabytes of data?*

Asset and Data Discovery Techniques

Passive	▪ Search internal knowledge repositories for architecture diagrams, design documents, code repositories, etc. ▪ Find TNSNAMES.ORA files
Active	▪ Compromise DBA credentials through phishing or social engineering attacks ▪ Install malware on DBA machines and steal credentials, such as saved in SQL Developer ▪ Use Nmap to scan internal network for Oracle Databases on default port 1521 – very noisy

Demo

Findings tnsnames.ora files using internal search engines

www.google.com

search: tnsnames filetype:ora site:.edu

Demo

Obtaining passwords from internal source code repositories

www.github.com

search: “alter user” “identified by”

Demo

Decrypt SQL Developer passwords

https://github.com/tomecode/show-me-password-sqldev-jdev

Use extension in SQL Developer

Demo

Using Nmap to find Oracle databases

www.nmap.com

```
nmap -sT -sV -p 1521-1529 -T4 -v -n -Pn –open 192.168.2.11-50
```

Demo

Using Nmap to brute force SID

www.nmap.com

```
nmap -p 1521 -v --script oracle-sid-brute 192.168.56.10
```

Default Oracle Password Statistics

Database Account	Default Password	Exists in Database %	Default Password %
SYS	CHANGE_ON_INSTALL	100%	3%
SYSTEM	MANAGER	100%	4%
DBSNMP	**DBSNMP**	**99%**	**52%**
OUTLN	**OUTLN**	**98%**	**43%**
MDSYS	MDSYS	77%	18%
ORDPLUGINS	ORDPLUGINS	77%	16%
ORDSYS	ORDSYS	77%	16%
XDB	CHANGE_ON_INSTALL	75%	15%
DIP	DIP	63%	19%
WMSYS	WMSYS	63%	12%
CTXSYS	**CTXSYS**	**54%**	**32%**

* Sample of 120 production databases

Demo

Brute forcing Oracle Database Passwords

Integrigy internal tool

google: oracle password cracker

free tools: woraauthbf, orabf

Demo

Using Nmap for Database Password Guessing

www.nmap.com

```
nmap -p 1521 -v --script oracle-brute
--script-args oracle-brute.sid=ORCL 192.168.56.10
```

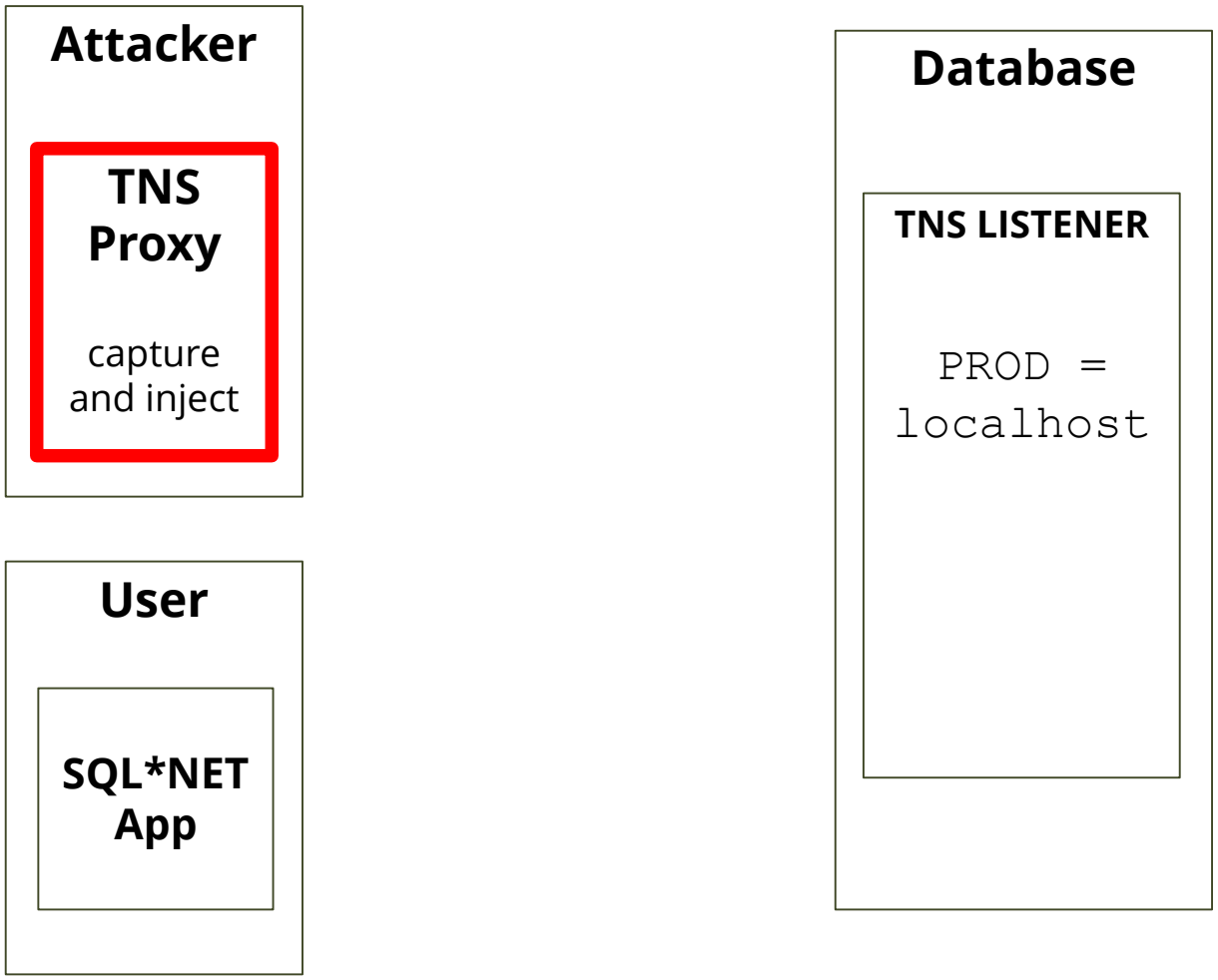
TNS Poisoning Attack – One-off – April 30, 2012

Vuln #	Component	Protocol	Package and/or Privilege Required	Remote Exploit without Auth.?
CVE-2012-1675	**Listener**	**Oracle Net**	**None**	**Yes**

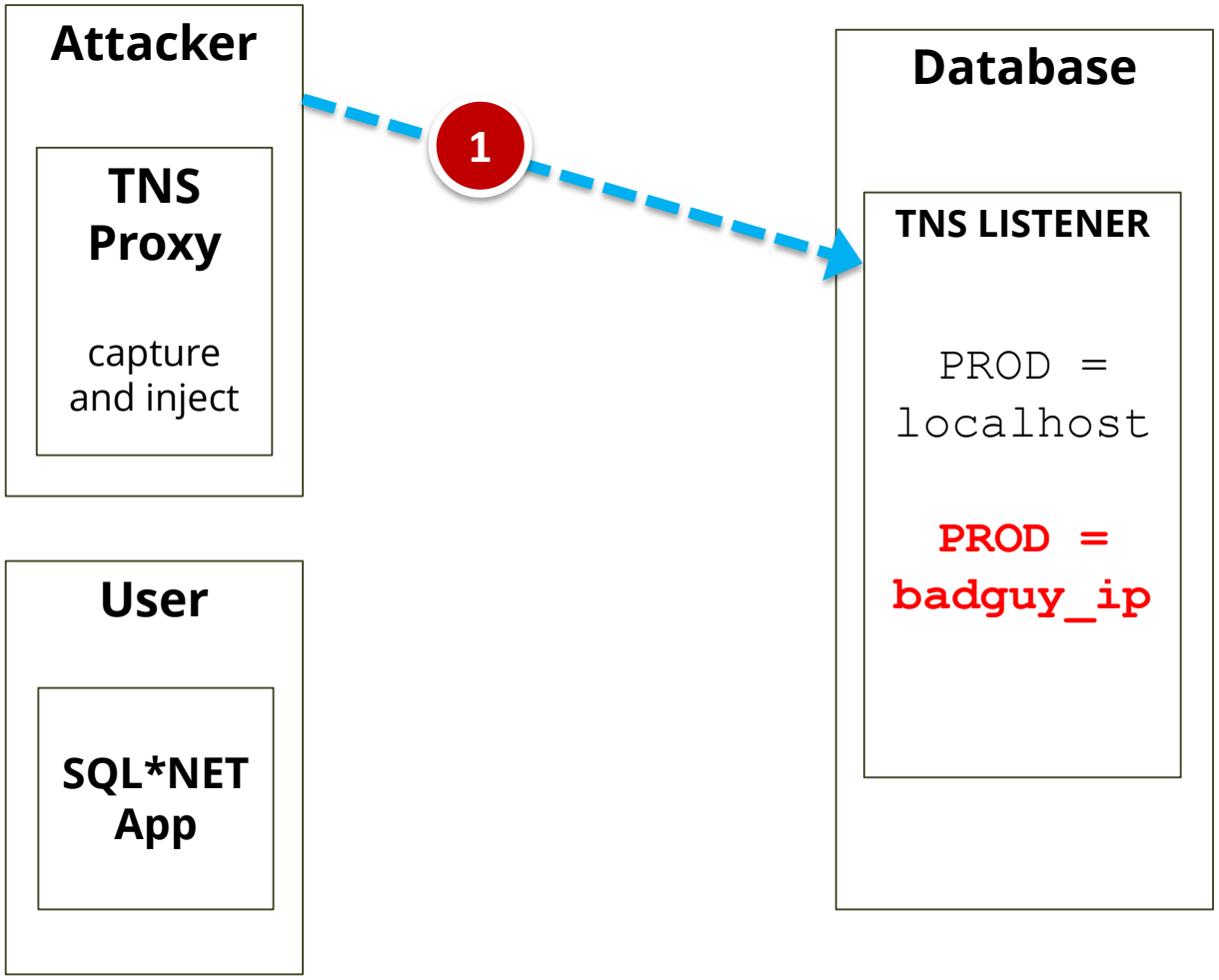
CVSS VERSION 2.0 RISK							Last Affected Patch set (per Supported Release)
Base Score	Access Vector	Access Complexity	Authentication	Confidentiality	Integrity	Availability	
7.5	**Network**	**Low**	**None**	**Partial+**	**Partial+**	**Partial**	**ALL VERSIONS**

- **This vulnerability is not patched by a SPU or PSU.** The TNS Listener configuration must be secured.
- **ALL VERSIONS** of the Oracle Database are affected.
- 12c and 11.2.0.4 protected by default, but vulnerable when Valid Node Checking Registration (VNCR) is disabled.

TNS Poisoning Attack Illustrated

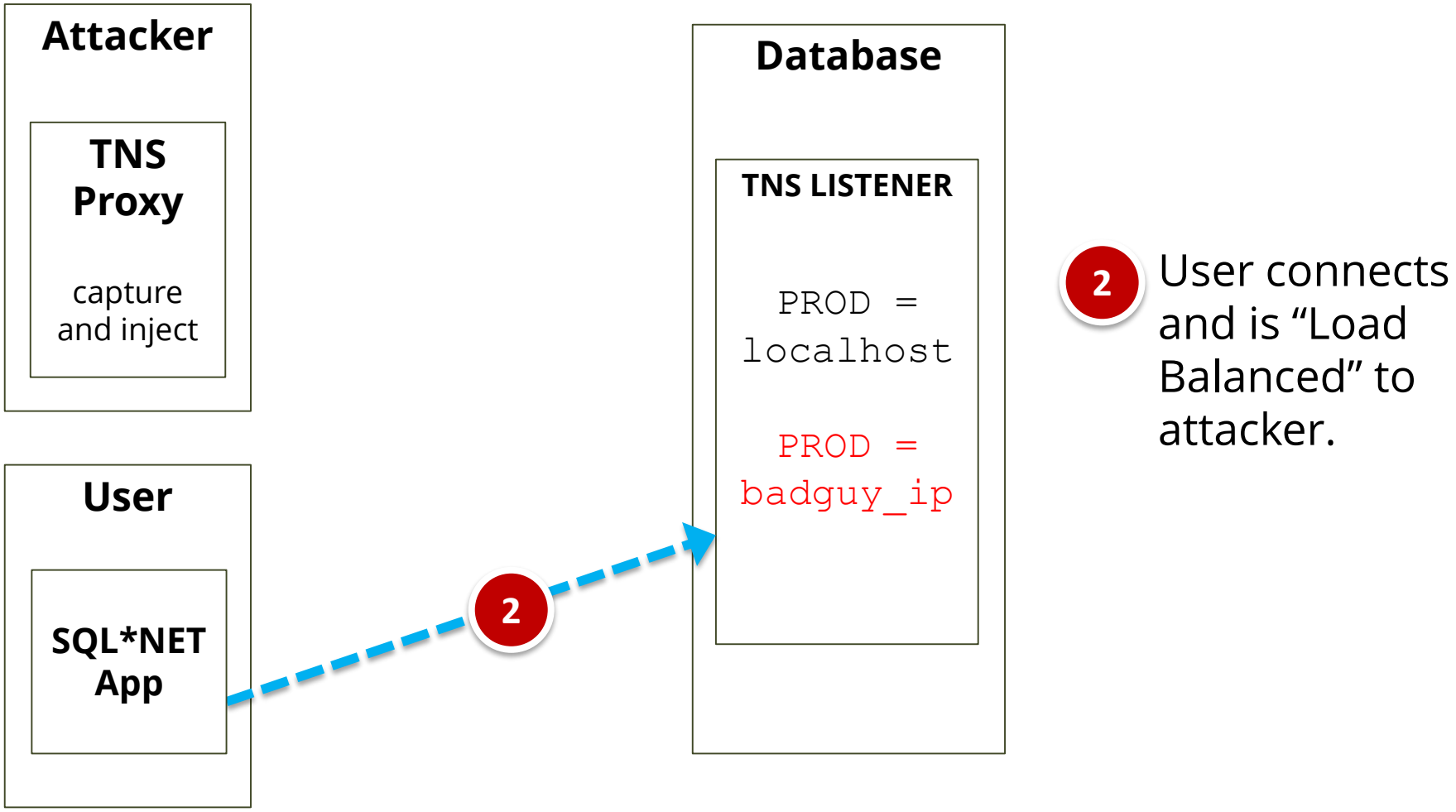


TNS Poisoning Attack Illustrated

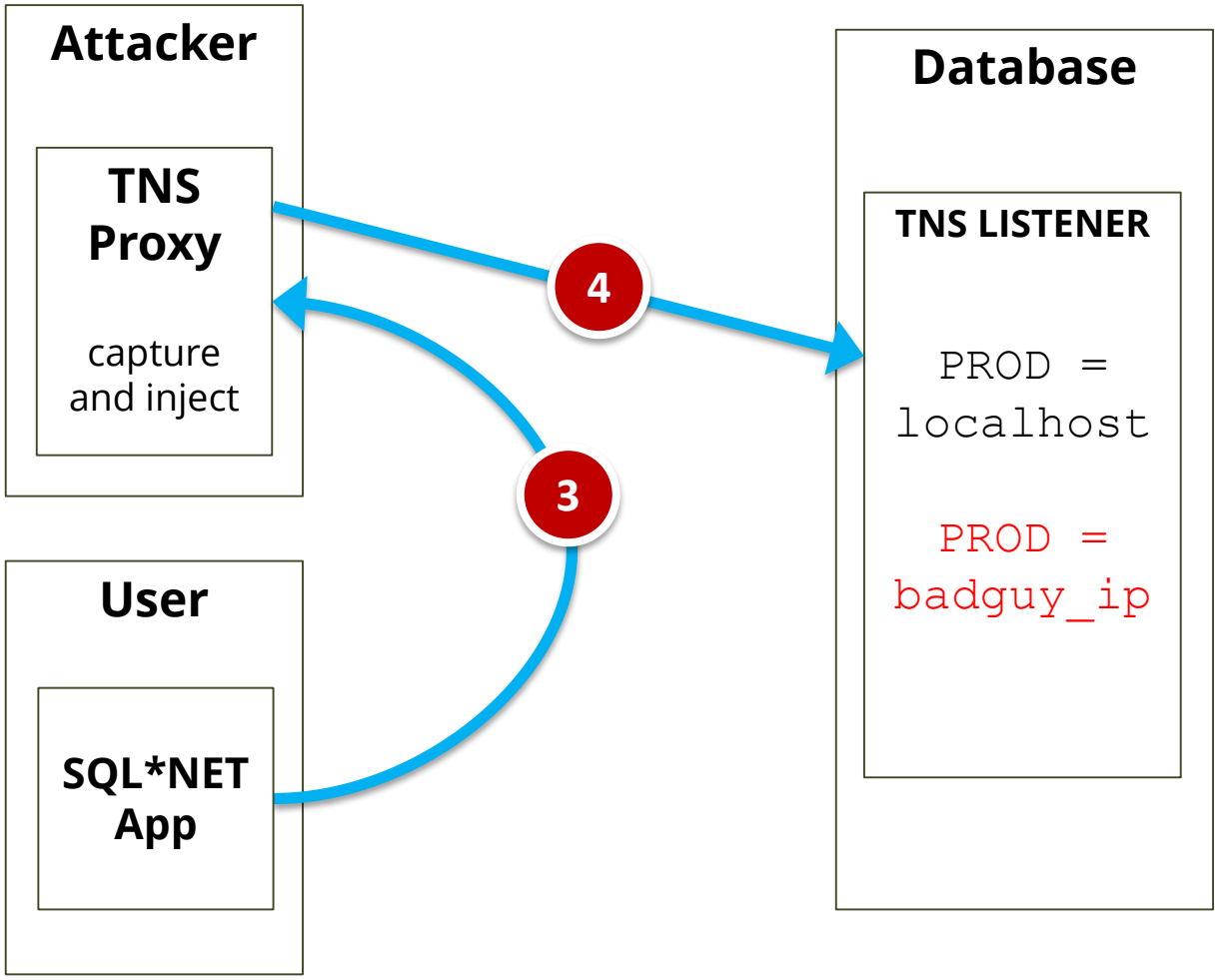


1 Attacker dynamically registers Service with database.

TNS Poisoning Attack Illustrated



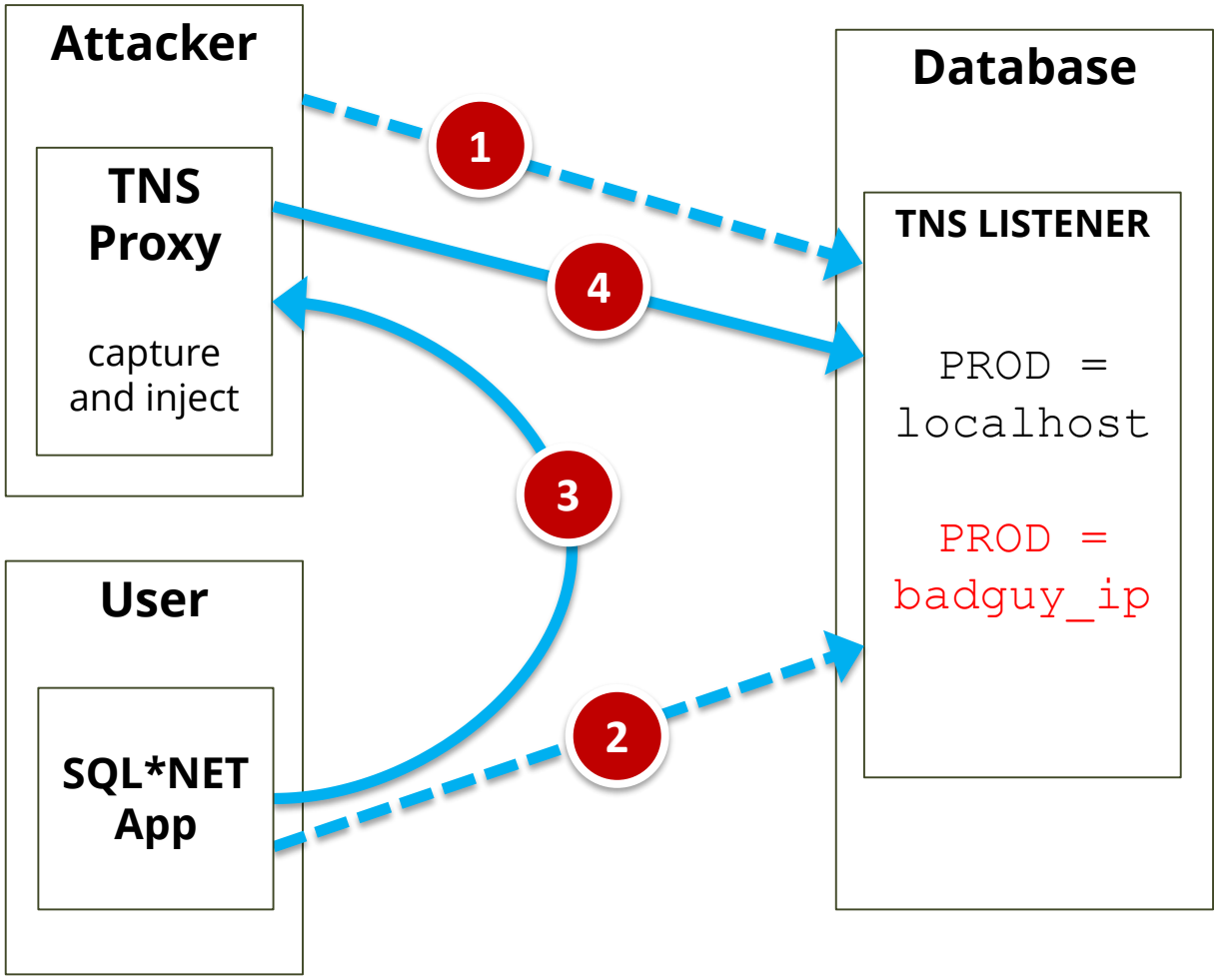
TNS Poisoning Attack Illustrated



3 User connect to attacker rather than database.

4 Attacker forwards to database.

TNS Poisoning Attack Illustrated



1. Attacker dynamically registers Service with database.
2. User connects and is “Load Balanced” to attacker.
3. User connect to attacker rather than database.
4. Attacker forwards to database.

TNS Poisoning Mitigation

Database Version	***SSL Encrypt with Cert***	***COST*** *class of secure transport*	***VNCR*** *Valid node checking registration*
References	See ASO	1453883.1 1340831.1 (RAC)	1600630.1
8.1.7.x – 10.2.0.3	✓		
10.2.0.3 – 10.2.0.5	✓	✓	
11.1.0.x	✓	✓	
11.2.0.1 – 11.2.0.3	✓	✓	
11.2.0.4*	✓	✓	✓ (Enabled by default)
12.1.0.x*	✓	✓	✓ (Enabled by default)

* 11.2.0.4 and 12c does not allow remote registration by default.

Demo

TNS Poisoning Attack

http://joxeankoret.com/research.html

Exploit Information

- **Joxean Koret**
  - http://joxeankoret.com/research.html
  - Oracle TNS Poison un-auth proof on concept (Oracle 9i, 10g and 11g)
- **tnspoisonv1.py**
  - Used to poison the remote database listener
- **proxy.py**
  - Proxy on attacker machine to accept client connections and forward to database server

Stealth Password Cracking Bug – October 2012

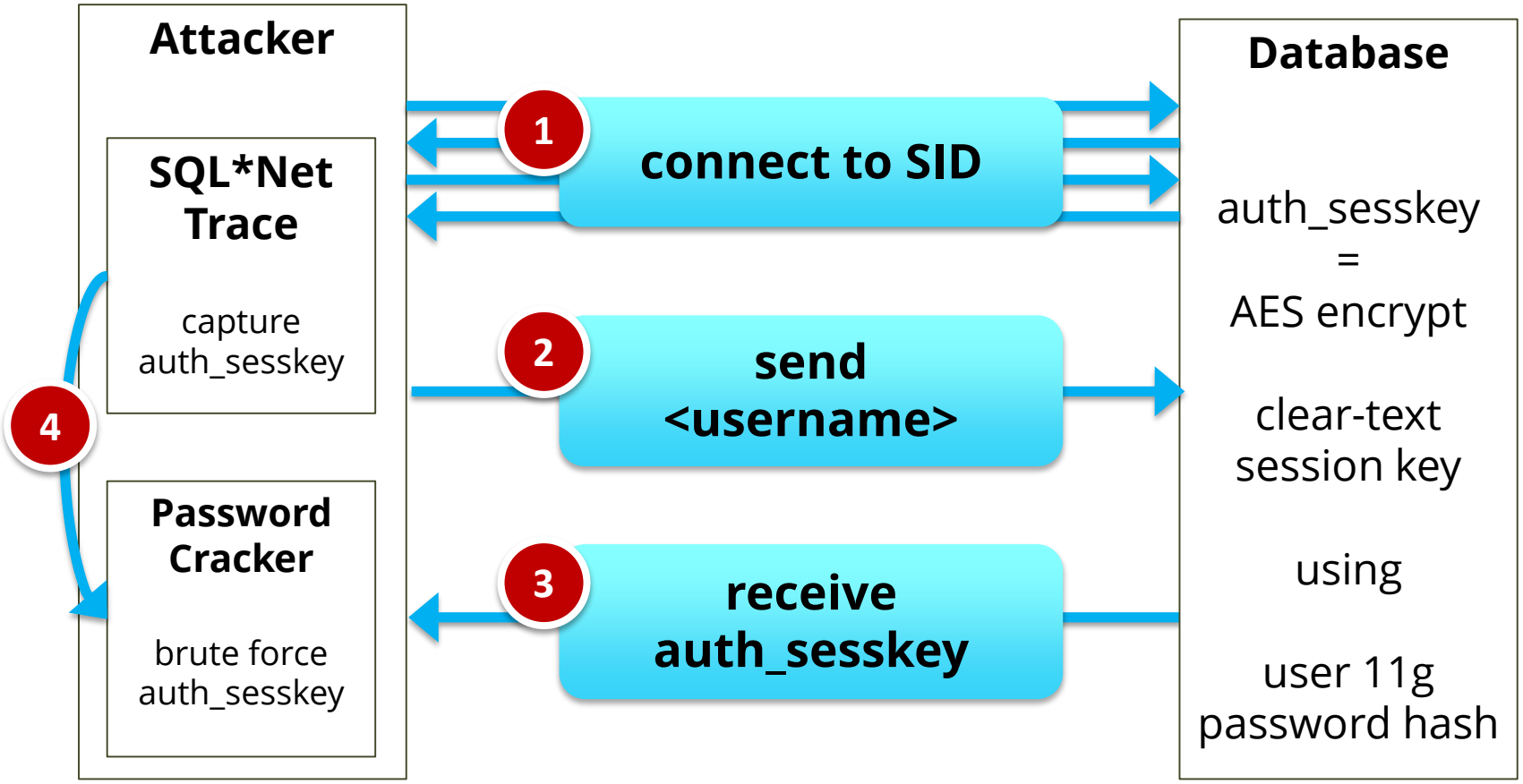
Vuln #	Component	Protocol	Package and/or Privilege Required	Remote Exploit without Auth.?
CVE-2012-3137	**Oracle RDBMS**	**Oracle Net**	**None**	**Yes**

CVSS VERSION 2.0 RISK							Last Affected Patch set (per Supported Release)
Base Score	Access Vector	Access Complexity	Authentication	Confidentiality	Integrity	Availability	
10.0	**Network**	**Low**	**None**	**Complete**	**Complete**	**Complete**	**11.1.0.x 11.2.0.1 11.2.0.2 11.2.0.3**

Vulnerable if using "11G" passwords (see USER$). 10.2.0.x is also vulnerable if using Enterprise User Security (EUS) with an SHA-1 password verifier.

Stealth Password Attack Illustrated

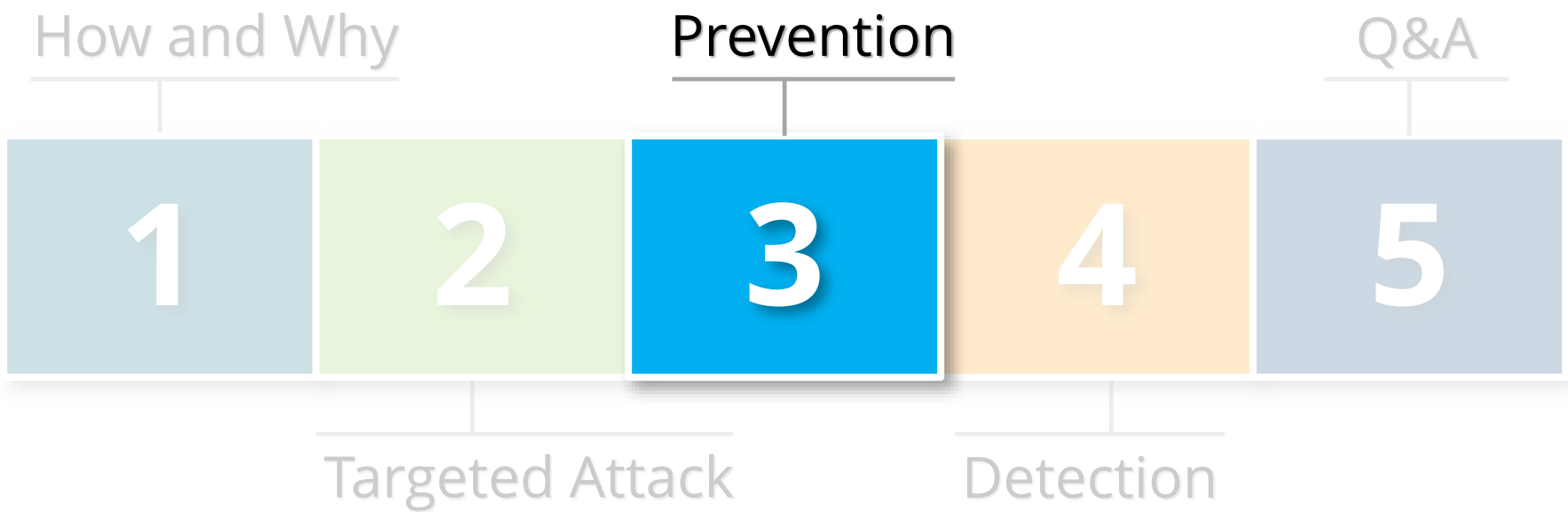
Flaw in the 11g O5Logon protocol allows for brute forcing of the password using the authsess_key.



Exploit Information

- **SQL*Net Trace on client**
  - Capture SQL*Net connection and auth_sesskey
  - TRACE_LEVEL_CLIENT = SUPPORT
- **nmap**
  - Legendary network scanning tool
  - oracle-brute-stealth script
  - Retrieves auth_sesskey for selected users
- **John the Ripper**
  - Legendary password cracking tool
  - Use o5logon

Agenda



Integrigy #1 Security Recommendation

- **Limit direct database access whenever possible**
  - Much harder to hack database if an attacker can not connect to it
  - Would have to use another avenue such as a web application or reporting tool (e.g., OBIEE)
- **Use firewalls in front of data center, network ACLs, TNS invited nodes, Oracle Connection Manager, Oracle Database Firewall, etc.**
  - DBAs should use bastion hosts to manage databases

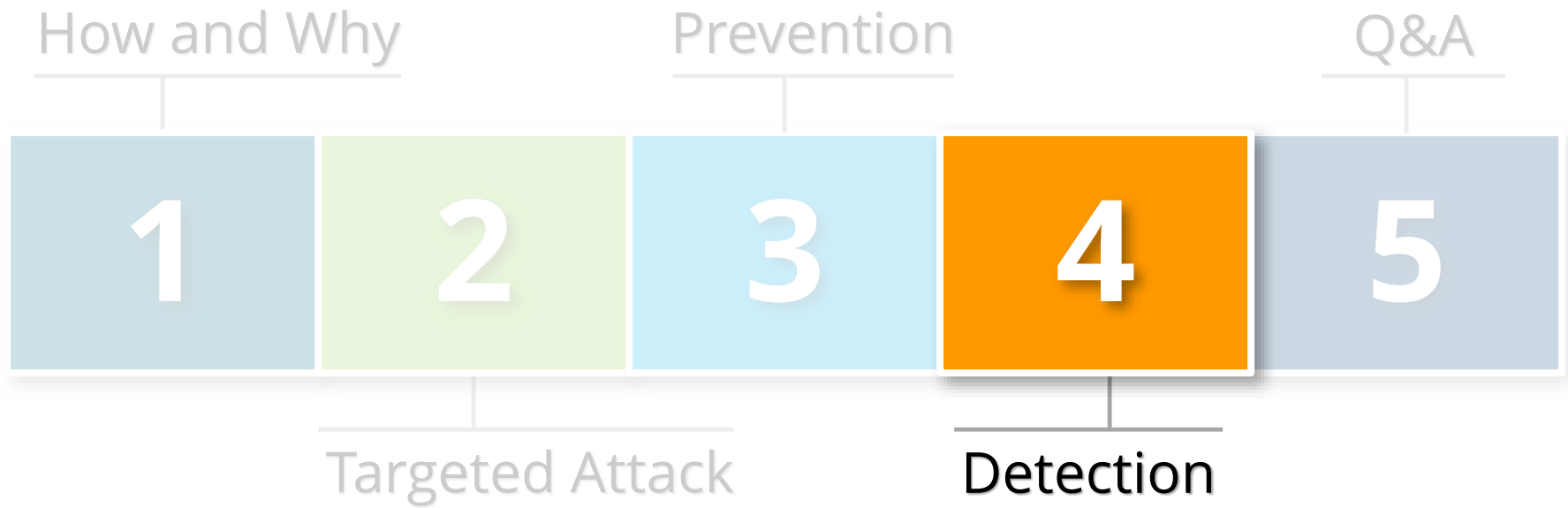
Database Security Preventative Controls

- **Apply Oracle Critical Patch Updates on a regular basis on all databases**
  - Reduce risk of compromise and escalation of privileges
- **Check for default and weak passwords constantly**
  - Use multiple tools to check passwords
  - Install database profiles to enforce strong passwords
- **Harden database configurations**
  - Validate configurations on regular basis

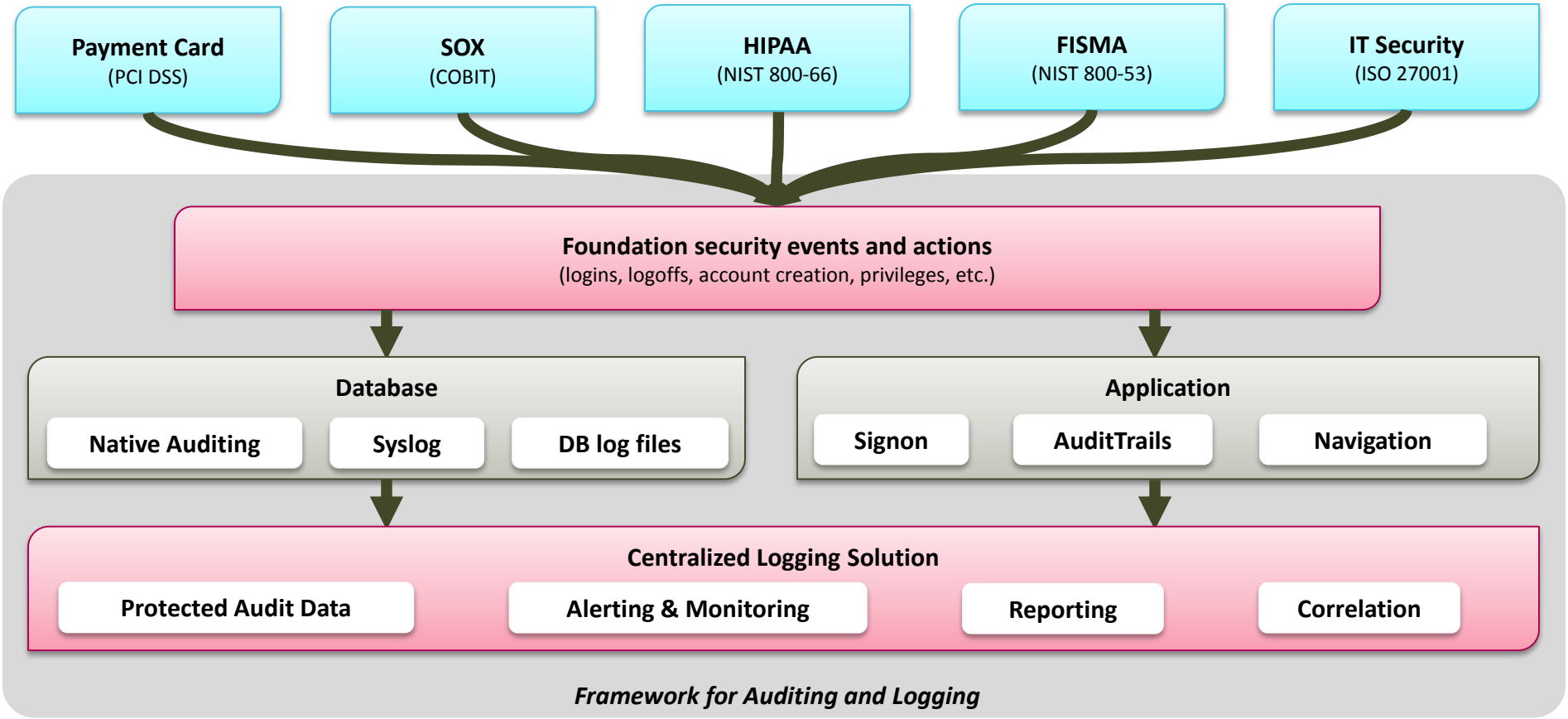
How to Check Database Passwords

- **Use Oracle's DBA_USERS_WITH_DEFPWD**
  - Limited set of accounts
  - Single password for each account
- **Command line tools (orabf, etc.)**
  - Difficult to run – command line only
- **AppSentry**
  - Checks all database accounts
  - Uses passwords lists - > 1 million passwords
  - Allows custom passwords

Agenda



Framework for Auditing and Logging



Framework for Auditing and Logging

Foundation Security Events and Actions

The foundation of the framework is a set of key security events and actions derived from and mapped to compliance and security requirements that are critical for all organizations.

E1 - **Login**	*E8* - **Modify role**
E2 - **Logoff**	*E9* - **Grant/revoke user privileges**
E3 - **Unsuccessful login**	*E10* - **Grant/revoke role privileges**
E4 - **Modify auth mechanisms**	*E11* - **Privileged commands**
E5 - **Create user account**	*E12* - **Modify audit and logging**
E6 - **Modify user account**	*E13* - **Create, Modify or Delete object**
E7 - **Create role**	*E14* - **Modify configuration settings**

Foundation Security Events Mapping

Security Events and Actions	PCI DSS 10.2	SOX (COBIT)	HIPAA (NIST 800-66)	IT Security (ISO 27001)	FISMA (NIST 800-53)
E1 - Login	10.2.5	A12.3	164.312(c)(2)	A 10.10.1	AU-2
E2 - Logoff	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E3 - Unsuccessful login	10.2.4	DS5.5	164.312(c)(2)	A 10.10.1 A.11.5.1	AC-7
E4 - Modify authentication mechanisms	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E5 – Create user account	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E6 - Modify user account	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E7 - Create role	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E8 - Modify role	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E9 - Grant/revoke user privileges	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E10 - Grant/revoke role privileges	10.2.5	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E11 - Privileged commands	10.2.2	DS5.5	164.312(c)(2)	A 10.10.1	AU-2
E12 - Modify audit and logging	10.2.6	DS5.5	164.312(c)(2)	A 10.10.1	AU-2 AU-9
E13 - Objects Create/Modify/Delete	10.2.7	DS5.5	164.312(c)(2)	A 10.10.1	AU-2 AU-14
E14 - Modify configuration settings	10.2.2	DS5.5	164.312(c)(2)	A 10.10.1	AU-2

Foundation Database Logging

Object	Oracle Audit Statement	Resulting Audited SQL Statements
Session	session	Database logons and failed logons
Users	user	create user alter user drop user
Roles	role	create role alter role drop role
Database Links **Public Database Links**	database link public database link	create database link drop database link create public database link drop public database link
System	alter system	alter system
Database	alter database	alter database
Grants **(system privileges and roles)**	system grant	grant revoke
Profiles	profile	create profile alter profile drop profile
SYSDBA and SYSOPER	sysdba sysoper	All SQL executed with sysdba and sysoper privileges

Agenda

Contact Information

Stephen Kost

Chief Technology Officer

Integrigy Corporation

web: **www.integrigy.com**

e-mail: **info@integrigy.com**

blog: **integrigy.com/oracle-security-blog**

youtube: **youtube.com/integrigy**