INTEGRIGY

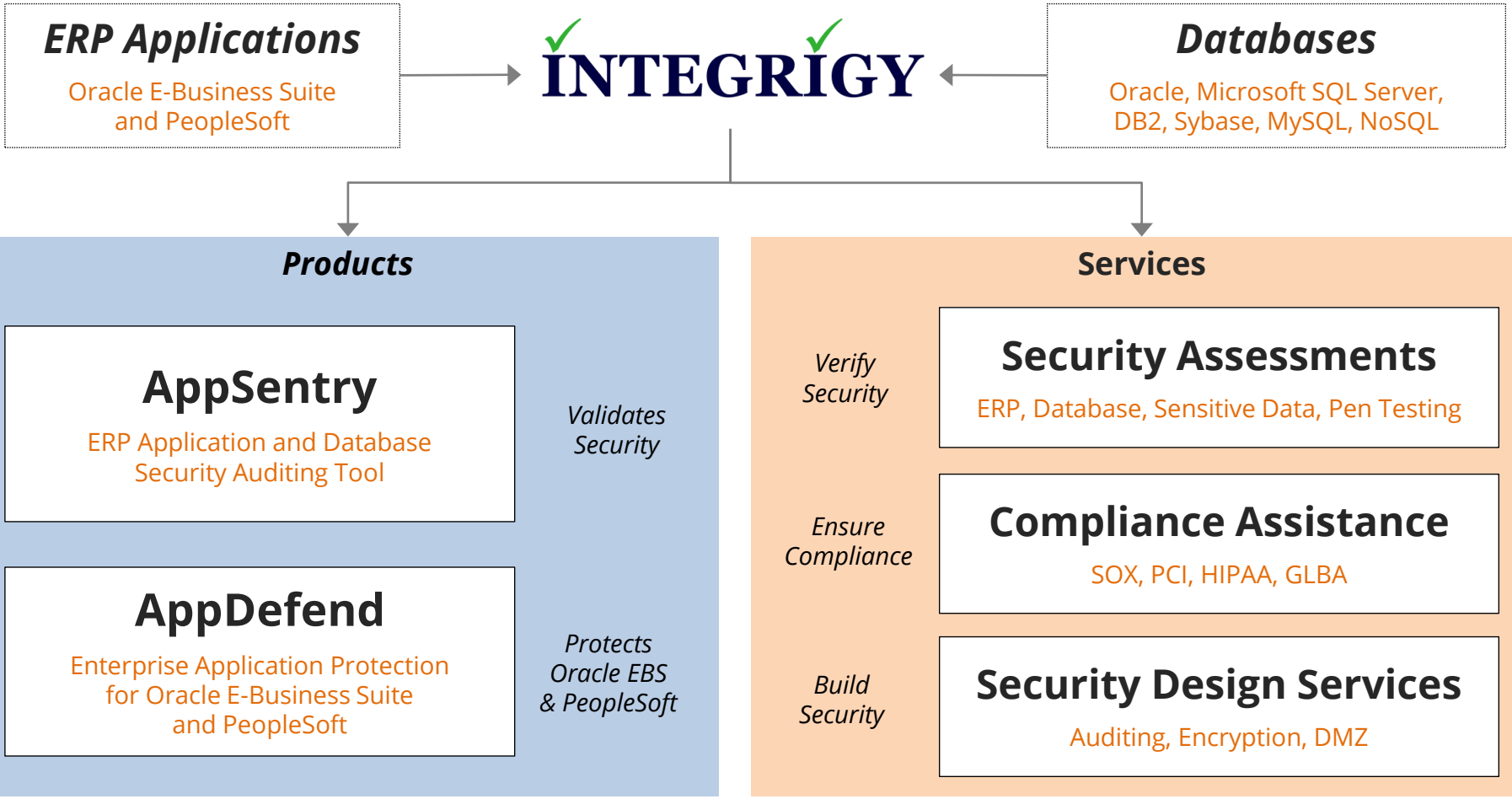
AppDefend

Oracle E-Business Suite
Enterprise Application Protection

June 2021

mission critical applications ...
... mission critical security

About Integrigy



Integrigy Research Team

ERP Application and Database Security Research

ORACLE Gold Partner

Agenda

1. Web Application Security
2. Oracle E-Business Suite Web Architecture
3. AppDefend Overview
4. AppDefend Benefits
5. Q & A

Safe Harbor Statement

The following is intended to outline our general product direction. It is intended for information purposes only and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions. The development, release, and timing of any features or functionality described for Integrigy's products remains at the sole discretion of Integrigy.

Integrigy's Products

AppSentry	**Security scanner for databases, application servers, and ERP packages** ▪ Performs advanced penetration testing and in-depth security and controls auditing ▪ Performs over 1,000+ audits and checks on Oracle products ▪ Requires no software to be installed on the target servers
AppDefend	**Application firewall and protection system for ERP packages** ▪ Blocks common attacks like SQL injection, session hijacking, cross site scripting, and Java deserialization ▪ Blocks access to unimplemented application modules and pages ▪ Scans all incoming web requests and outbound responses

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SQL Injection Explained

Attacker modifies URL with extra SQL

```
http://<server>/pls/VIS/fnd_gfm.dispatch?p_path=fnd_help.get/US/fnd/@search');%20fnd_user_pkg.updateUser('operations',%20'SEED',%20'welcome1
```

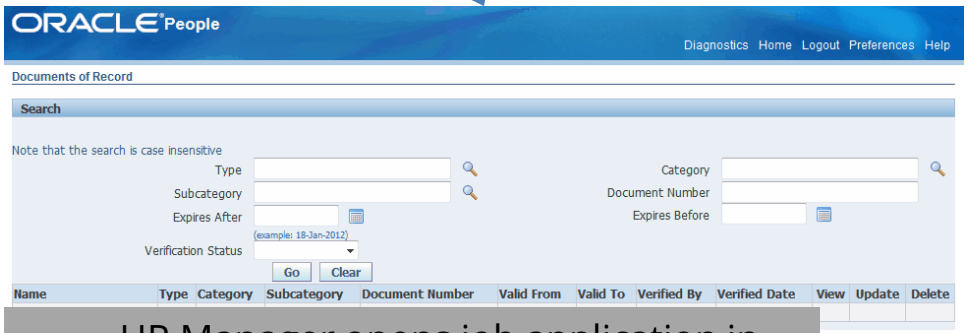
Oracle EBS executes appends SQL to the SQL statement being executed

- SQL executed as APPS database account
- Example changes any application account password

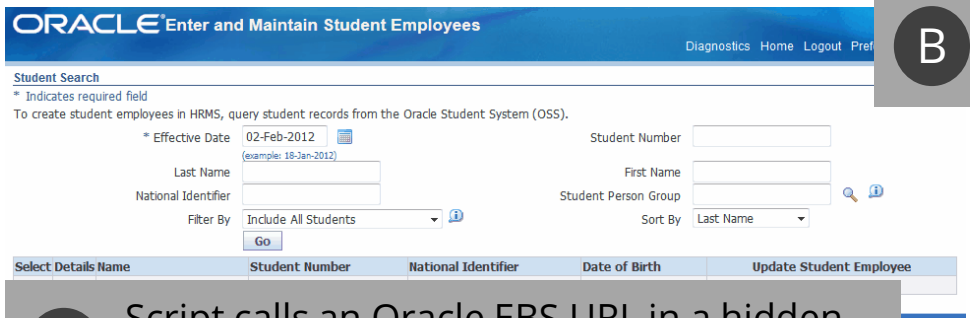
This vulnerability was patched as part of Oracle Security Alert #32

Cross Site Scripting (XSS) Illustrated

A Attacker enters malicious JavaScript into job application description field to for example automatically approve resume



B HR Manager opens job application in Oracle and script executes in browser



C Script calls an Oracle EBS URL in a hidden frame to execute some EBS functionality

Cross Site Scripting – Sample Attacks

```
<script>alert(0)</script>

<img src="x:x" onerror="alert(0)">

<iframe src="javascript:alert(0)">

<object data="javascript:alert(0)">

<isindex type=image src=1 onerror=alert(0)>

<img src=x:alert(alt) onerror=eval(src) alt=0>

with(document)alert(cookie)

eval(document.referrer.slice(10));

(É=[Å=[],µ=!Å+Å][µ[È=-~-~++Å]+({}+Å) [Ç=!!Å+µ,ª=Ç[Å]+Ç[+!Å],Å]+ª])() [µ[Å]+µ[Å+Å]+Ç[È]+ª](Å)

</a onmousemove="alert(1)">

data:text/html,<script>alert(0)</script>

%C0%BCscript%C0%BEalert(1)%C0%BC/script%C0%BE

<ScRIPT x src=//0x.lv?
```

Cross Site Scripting References

XSS Cheat Sheet

http://ha.ckers.org/xss.html

WSC Script Mapping Project

http://www.webappsec.org/projects/scriptmapping

OWASP XSS Reference

https://www.owasp.org/index.php/Cross-Site_Scripting

Oracle EBS Security Vulnerabilities

Oracle E-Business Suite security vulnerabilities
fixed between
January 2005 and April 2021

956

Oracle EBS Web Vulnerabilities Fixed

~130	SQL Injection in web pages
~540	Cross Site Scripting
~90	Authorization/Authentication
~60	Business Logic Issues
~7	Non-EBS Vulnerabilities

OWASP Top 10 – Oracle E-Business Suite Mapping

Ten top security risks commonly found in web applications listed by level of risk

A1: Injection	**A2: Broken Authentication**	**A3: Sensitive Data Exposure**	**A4: XML External Entities (XXE)**
A5: Broken Access Control	**A6: Security Misconfiguration**	**A7: Cross-Site Scripting (XSS)**	**A8: Insecure Deserialization**
	A9: Components with Known Vulnerabilities	**A10: Insufficient Logging and Monitoring**	

High Risk

Medium Risk

Low Risk

http://www.owasp.org/index.php/Top_10

WASC Threat Classification

Web Application Security Consortium

Comprehensive list of threats to the security of a web site – attacks and weaknesses

Attacks

- **Abuse of Functionality**
- **Brute Force**
- Buffer Overflow
- **Content Spoofing**
- Credential/Session Prediction
- **Cross-Site Scripting**
- **Cross-Site Request Forgery**
- **Denial of Service**
- **Fingerprinting**
- Format String
- **HTTP Response Smuggling**
- **HTTP Response Splitting**
- **HTTP Request Smuggling**
- **HTTP Request Splitting**
- **Integer Overflows**
- LDAP Injection
- **Mail Command Injection**
- **Null Byte Injection**
- OS Commanding
- Path Traversal
- **Predictable Resource Location**
- **Remote File Inclusion (RFI)**
- Routing Detour
- Session Fixation
- **SOAP Array Abuse**
- SSI Injection
- **SQL Injection**
- **URL Redirector Abuse**
- **XPath Injection**
- **XML Attribute Blowup**
- **XML External Entities**
- **XML Entity Expansion**
- **XML Injection**
- **XQuery Injection**

Weaknesses

- **Application Misconfiguration**
- **Directory Indexing**
- Improper File System Permissions
- **Improper Input Handling**
- **Improper Output Handling**
- **Information Leakage**
- Insecure Indexing
- **Insufficient Anti-automation**
- Insufficient Authentication
- **Insufficient Authorization**
- **Insufficient Password Recovery**
- **Insufficient Process Validation**
- **Insufficient Session Expiration**
- **Insufficient Transport Layer Protection**
- **Server Misconfiguration**

http://www.webappsec.org

High Risk * **Medium Risk** * **Low Risk** * No Risk

Inherent Risks with Package Software

Structure and vulnerabilities within the application are well known and documented

- **An attacker knows exactly what to expect and how the application is structured**
- **No probing or reconnaissance of the application is required**
- **Fatal attack can be one URL**
- **Allows for easy automated attacks**

Another Layer of Security

Web Application Firewalls (WAF) are specialized firewalls designed to detect and prevent web application attacks by analyzing the HTTP web requests.

- **Prevents common web application attacks**
  Detects and blocks SQL injection, XSS, and known vulnerabilities in widely used web applications

- **Often implemented as an appliance**
  Dedicated appliance used to protect all web applications in an organization

- **May be required for compliance such as PCI-DSS**
  PCI-DSS 2.0 requirement 6.6 requires use of a WAF or periodic reviews

Web Application Firewall (WAF) Shortcomings

- **Must be heavily customized for Oracle EBS**
  - No out of the box rules for Oracle EBS – no CPU specific rules
  - Unaware for the unique web application architecture of OA Framework
  - Rules, application profiles, and learning must be developed, tuned, and tested by you
  - Oracle EBS is multiple web architectures resulting in additional tuning

- **Unable to block unused Oracle EBS modules**
  - Due to the complexity of the Oracle naming and design, very difficult to implement blocking of EBS modules with WAF rules

- **Significant cost, effort, and skill required to deploy**
  - WAFs are usually an appliance that must be deployed and the learning curve for configuring and operating an enterprise WAF is steep

- **AppDefend is complementary with an enterprise WAF solution**
  - AppDefend can be stand-alone or combined with an existing WAF
  - Multiple layers of defense
  - Enterprise WAF provides general protection and eliminates “noise”
  - AppDefend provides Oracle EBS specific layer of protection

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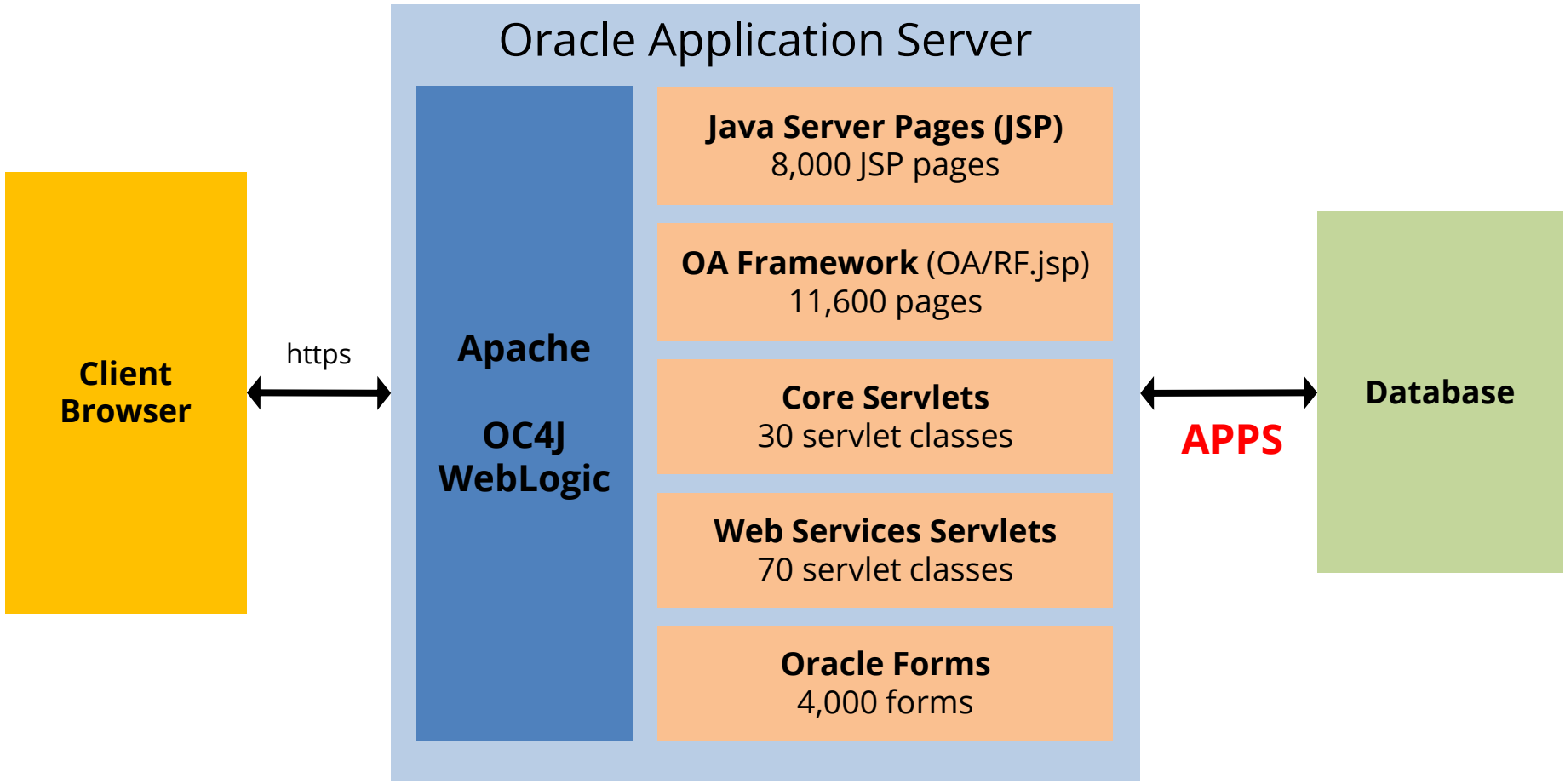
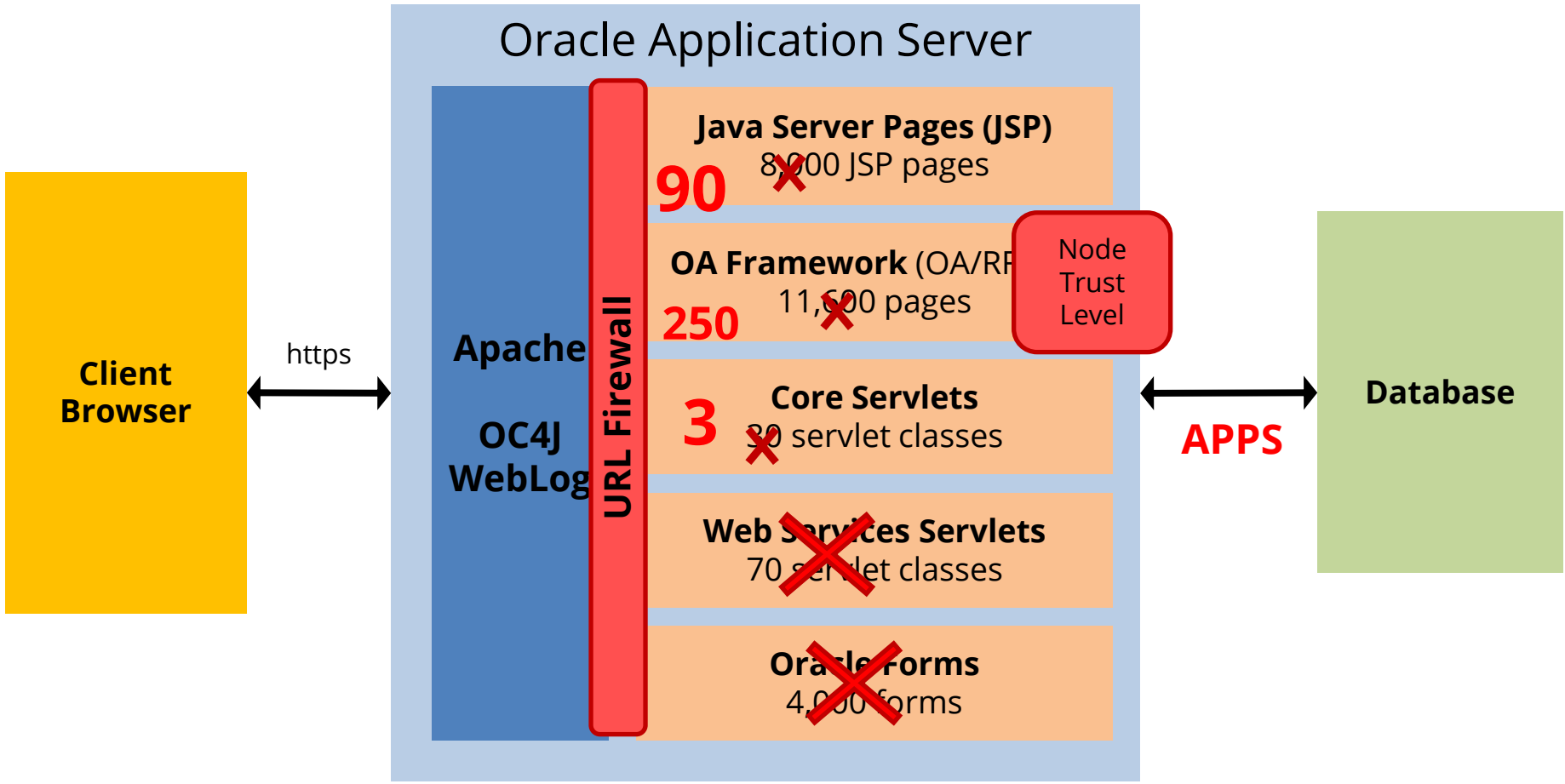
2. **Oracle EBS Web Architecture**
3. AppDefend Overview
4. AppDefend Benefits
5. Q & A

Oracle EBS R12 DMZ Configuration



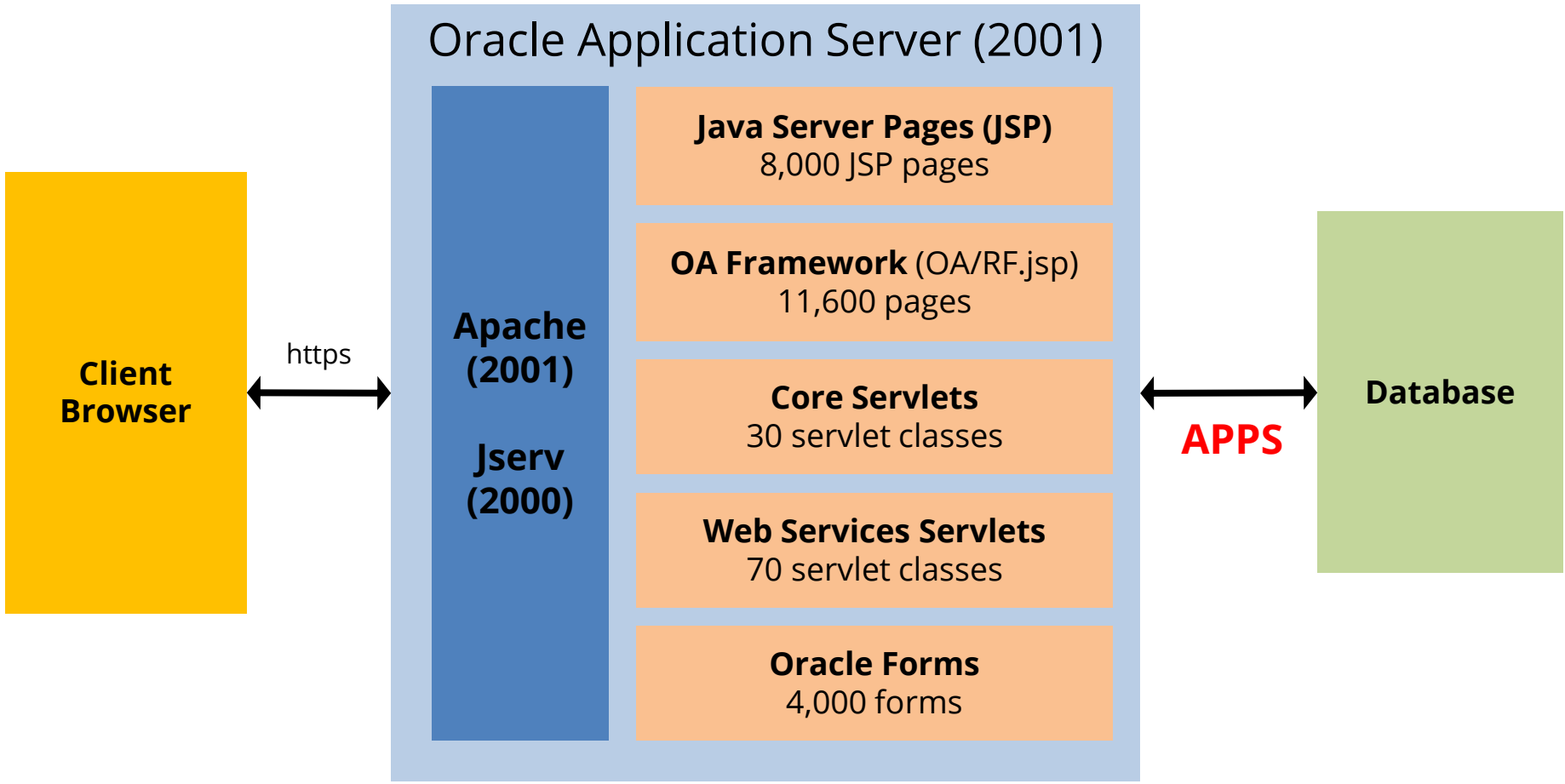
- All Oracle E-Business Suite environments include ALL modules (250+) and ALL web pages (20,000+) even if modules are not installed, licensed, or configured. Many security vulnerabilities exist in unused modules.

Oracle EBS R12 DMZ Configuration



- Proper **DMZ configuration** reduces accessible pages and responsibilities to only those required for external access. Reducing the application surface area eliminates possible exploiting of vulnerabilities in non-external modules. (See MOS Note ID 380490.1)

Oracle EBS 11i DMZ Configuration



- All Oracle E-Business Suite environments include ALL modules (250+) and ALL web pages (20,000+) even if modules are not installed, licensed, or configured. Many security vulnerabilities exist in unused modules.

Oracle EBS 11i Web Components

Component	11i Version	Release Date	Non-EBS Desupport[1]
Oracle Application Server[3]	1.0.2.2.2	Dec 2001	June 2004
Apache[3]	1.3.19	Feb 2001	Feb 2010
Jserv	1.1.2	June 2000	June 2006
mod_security	1.8.4	July 2004	May 2006
OpenSSL	0.9.5a	Sept 2000	March 2004
	0.9.8zh[2]	Dec 2015	Dec 2016

1. Oracle EBS 11i web components are desupported but had support exceptions for 11i environments through January 2016. As of January 2016, all support for 11i and associated technology stack components has ended.
2. OpenSSL updated from 0.9.5a to 0.9.8zh with July 2015 Critical Patch Update for OAS 1.0.2.2.2.
3. Security vulnerabilities are patched but version is not upgraded.

OWASP Top 10– Oracle DMZ Config

The Oracle EBS DMZ configuration (380490.1) does not address any of the OWASP Top 10 vulnerabilities in Oracle EBS.

A1: Injection	**A2: Broken Authentication**	**A3: Sensitive Data Exposure**	**A4: XML External Entities (XXE)**
A5: Broken Access Control	**A6: Security Misconfiguration**	**A7: Cross-Site Scripting (XSS)**	**A8: Insecure Deserialization**
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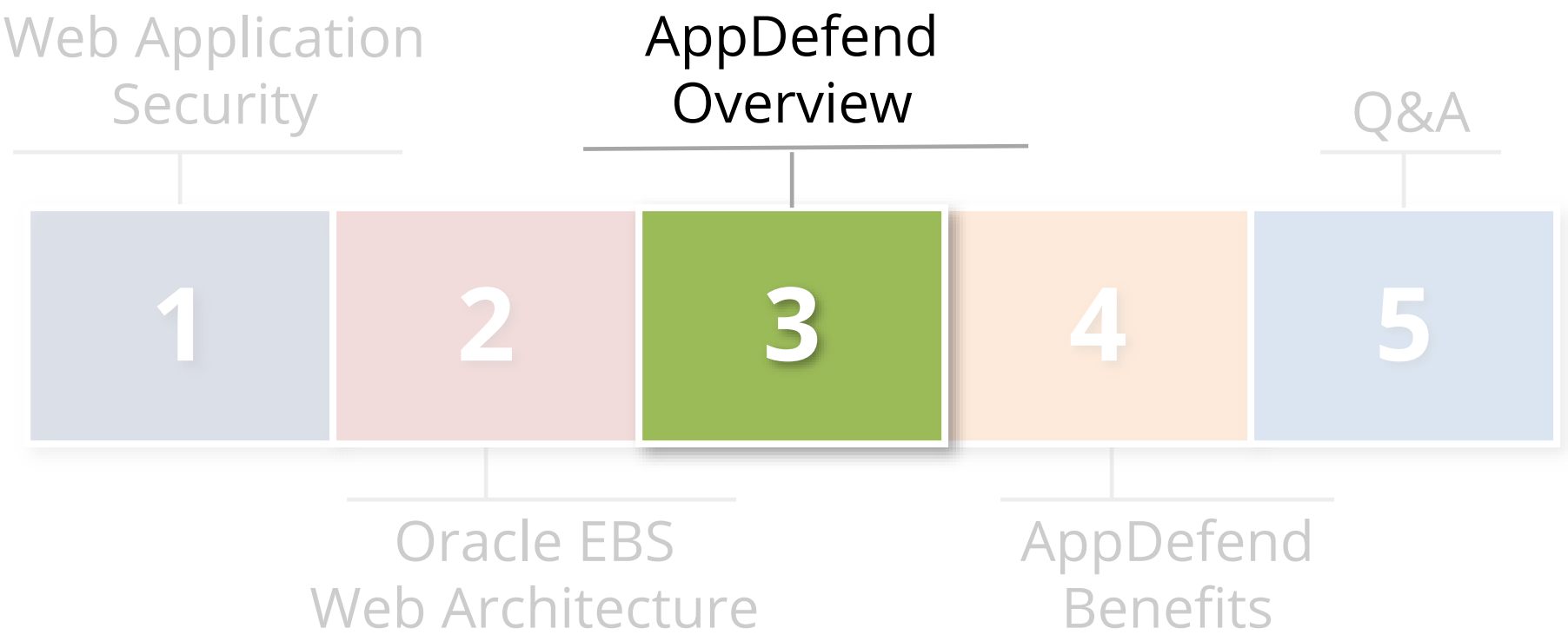
Web Application Security
AppDefend Overview
Q&A
1
2
3
4
5
Oracle EBS Web Architecture
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Integrigy AppDefend

AppDefend is an **enterprise application firewall** designed and optimized for the Oracle E-Business Suite.

Prevents Web Attacks
Detects and reacts to SQL Injection, XSS, and known Oracle EBS vulnerabilities

Limits EBS Modules
More flexibility and capabilities than URL firewall to identify EBS modules

Application Logging
Enhanced application logging for compliance requirements like SOX, GDPR, PCI-DSS 10.2

Protects Web Services
Detects and reacts to attacks against native Oracle EBS web services (SOA, SOAP, REST)

Two-factor Authentication (2FA/MFA)
Enables two-factor authentication for login, user, responsibility, or function

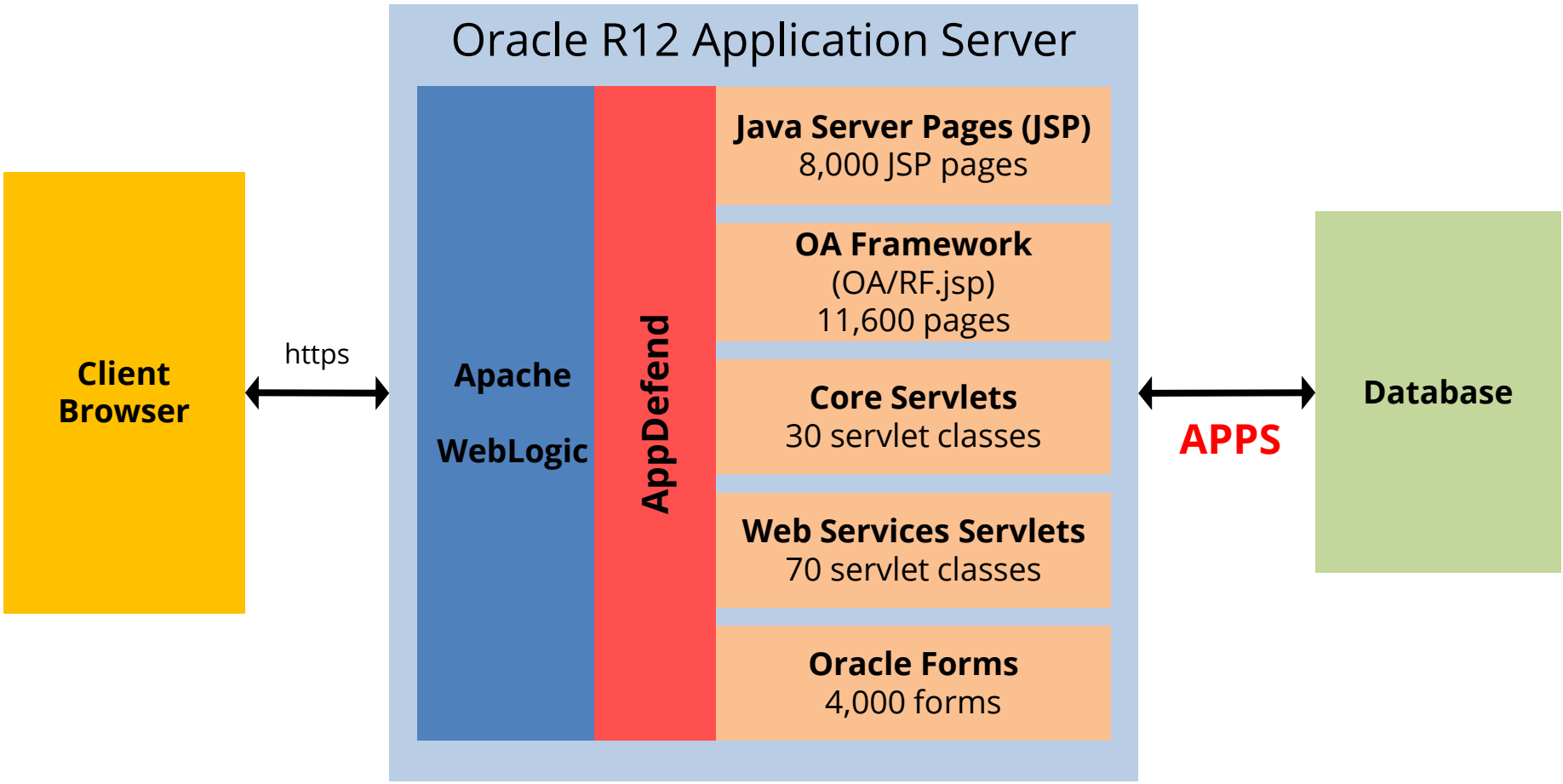
Protects Mobile Applications
Detects and reacts to attacks against Oracle EBS mobile applications

AppDefend Oracle E-Business Suite Support

Oracle E-Business Suite	▪ 12.2.x ▪ 12.1.x ▪ 12.0.x [1] ▪ 11.5.10.x (proxy mode)
Operating Systems	Supported operating systems [2] ▪ Linux x86 (Oracle Enterprise Linux, Red Hat Enterprise Linux AS/ES, SuSe) ▪ Sun SPARC Solaris ▪ HP PA-RISC HP/UX ▪ IBM AIX

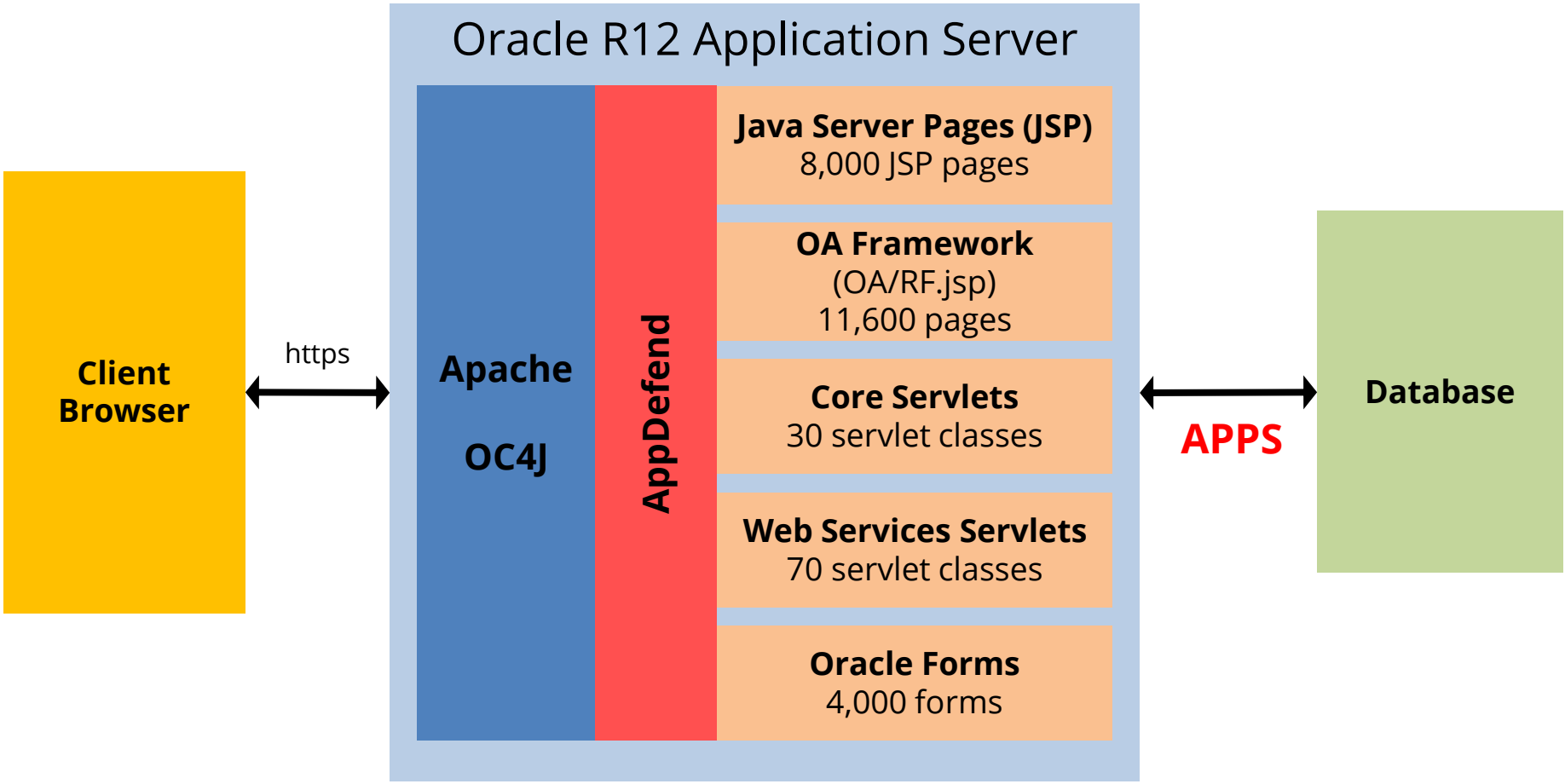
[1] For 12.0.x, application server Java version must be upgraded to JDK 1.6. [2] For 11.5.x, OS version must be supported by JDK 1.8.

AppDefend and Oracle EBS 12.2



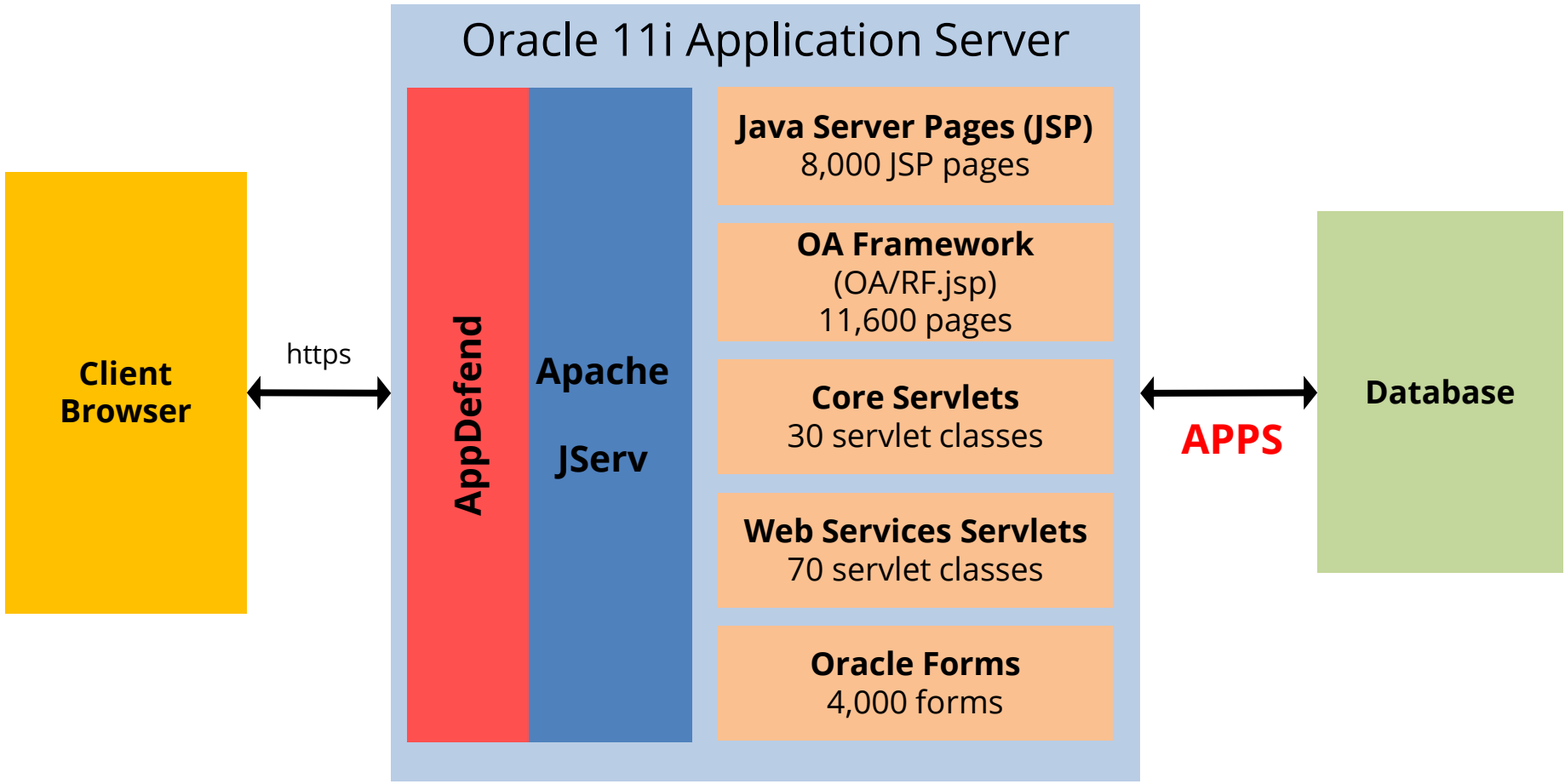
- **AppDefend** runs within the WebLogic Java containers as a servlet filter and monitors all incoming requests and out-going responses. Being in the Java container, AppDefend can access all session state, attributes, error messages, and the database.

AppDefend and Oracle EBS 12.0 & 12.1



- **AppDefend** runs within the Oracle E-Business Suite OC4J containers as a servlet filter and monitors all incoming requests and out-going responses. Being in the OC4J container, AppDefend can access all session state, attributes, error messages, and the database.

AppDefend and Oracle EBS 11i



- **AppDefend** runs as a reverse proxy on the Oracle EBS application server intercepting all requests and responses. AppDefend is able to act as an SSL termination point due to the vulnerabilities in the EBS SSL libraries.

AppDefend Virtual Patching

Eliminate risk and exploitation of the security bug by blocking access to the vulnerable code

- Integrigy analyzes the Oracle Critical Patch Update (CPU)
- Delivers pre-defined rules for CPU web bugs
- Rules may be at the page or field level to block known vulnerabilities

Integrigy Oracle CPU Analysis

For each quarterly Oracle CPU, Integrigy performs an analysis and updates the AppDefend rule set to include virtual patch rules for all external and internal web vulnerabilities

Sample from Integrigy CPU Analysis

CVE ID	Oracle EBS Versions	Vulnerability Information	Recommended Additional Steps and CPU Patch Testing	AppDefend External (DMZ) Rules (rule ID)	AppDefend Internal Rules (rule ID)	AppSentry Detection (check name)
CVE-2013-5890	11.5.10.2 12.0.6 12.1.1 - 12.1.3 12.2.2	*Module:* **Oracle Payroll – Public Sector Payroll** *Sub-Component:* **Payroll Exception Reporting** *Type:* **SQL Injection** *Remotely Exploitable without Authentication:* **No** *CVSS Metric:* **5.5** A SQL injection vulnerability in payroll exception report groups.	Basic testing of payroll exception report group configuration and reporting.	New request parameter rule (Rule ID 453) **Module should be blocked*	New request parameter rule (Rule ID 453)	Vulnerable file version check (oraappcpu0114)
CVE-2014-0398	11.5.10.2 12.0.6 12.1.1 - 12.1.3 12.2.2	*Module:* **Oracle Application Object Library** *Sub-Component:* **Discoverer and OBIEE Launcher** *Type:* **Information Disclosure and XSS** *Remotely Exploitable without Authentication:* **Yes** *CVSS Metric:* **5.0** Multiple information disclosure and cross-site scripting (XSS) vulnerabilities in the launcher for Discoverer and OBIEE. FND_DIAGNOSTICS has to be set to "Yes" in order to exploit most of these vulnerabilities. FND_DIAGNOSTICS should always be set to "No" at the site level for all Oracle EBS environments.	1. Ensure FND_DIAGNOSTICS is set to "No" at the site level for all environments, especially external facing implementations (i.e., iSupplier, iStore, iRecruitment, etc.). Review all applications, responsibilities, and users where FND_DIAGNOSTICS is set to "Yes". 2. Test to see if Discoverer and OBIEE launch successfully.	New request parameter rule (Rule ID 454) **Page should be blocked*	New request parameter rule (Rule ID 454)	Vulnerable file version check (oraappcpu0114)

Deep Request Inspection™

Analyze all user provided input to identify and block malicious input

- **Intelligent checking of ALL parameters, user input**
- **Uses best practice libraries for XSS and SQL injection detection**
  - OWASP AntiSamy, Java HTML Sanitizer
  - OWASP ESAPI
- **Malicious input may be detected, blocked, or sanitized**

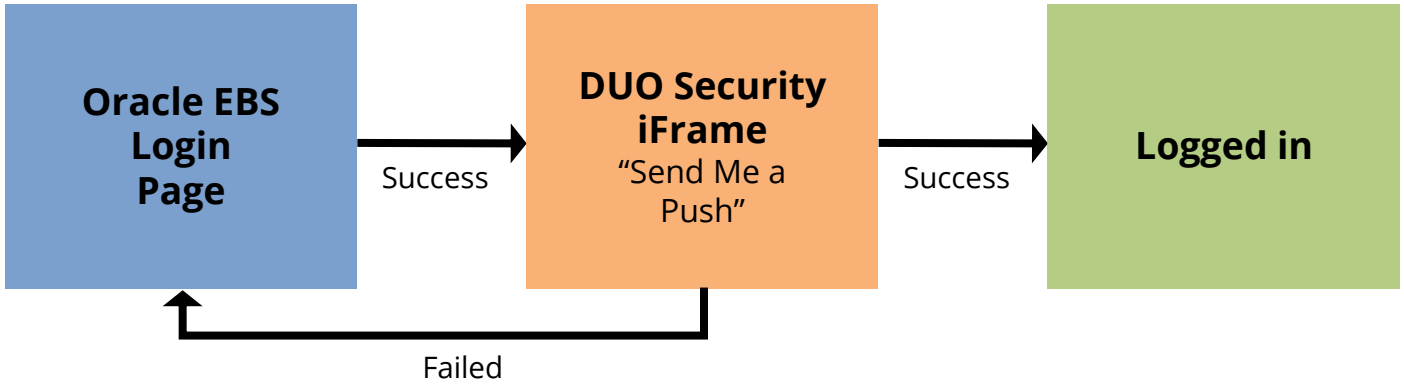
Application Logging and Auditing

Log and audit key application and security events beyond Oracle EBS current capabilities

- Any page, action, parameter, session attribute may be logged or audited
- PCI logging includes all sessions, responsibilities, and potentially card number access through the application
- Log data can be sent to external systems such as Splunk, ElasticSearch, ArcSight, QRadar, LogRhythm, …
- Solves gaps in Oracle EBS logging such as IP address for failed logins

AppDefend Adaptive Multi-Factor Authentication

AppDefend enables adaptive multi-factor authentication (MFA/2FA) for Oracle EBS using DUO Security, TOTP, or PKI (smartcards).



- **Multi-Factor Authentication**
  Enhances Oracle EBS login security by integrating with 2FA to provide secondary authentication
- **Per Page, Responsibility, Function**
  Require 2FA when user selects or accesses specific pages, responsibilities, or functions through menus or directly

AppDefend Two-Factor Authentication

- **Application-aware**
  - 2FA for login, user, responsibility, function, or page
  - Multiple 2FA authentications can be configured for different use cases and controls
- **Context-aware**
  - 2FA may be triggered based on session context such as time, location, device, etc.
- **Single 2FA request per application session**
  - 2FA authentications only when required
- **Enhanced logging and audit trail for all authentications**
- **Supports local EBS authentication or single-signon**
- **No additional hardware or single point of failure**

Two-Factor Authentication Use Cases

- **Entire Application**
  - Require 2FA when logging into Oracle EBS
- **Privileged Responsibilities**
  - Require 2FA when user accesses specific responsibilities like **System Administrator**
  - Protect highly privileged responsibilities from malicious use
- **Privileged Users**
  - Require 2FA when highly privileged users like **SYSADMIN** login
  - Preventative control for privileged, generic users accounts for SOX compliance
  - Limit access to generic user accounts by 2FA devices
  - Audit trail of named users accessing generic user accounts
- **High Risk Functions or Pages**
  - Require 2FA when user access specific functions or pages
  - Prevent fraud by requiring 2FA when user accesses self-service HR bank accounts

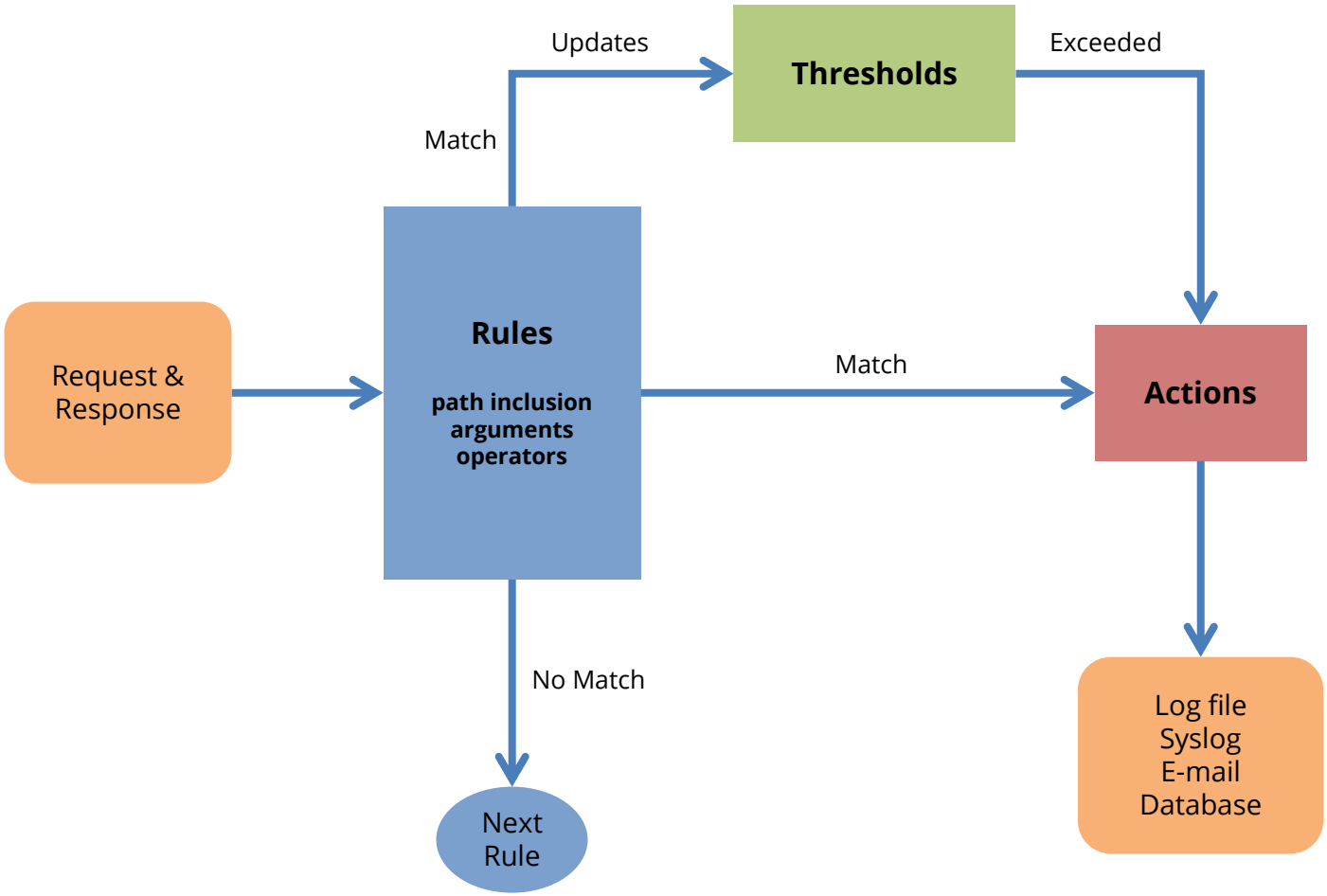
AppDefend Features

Configuration	▪ Rules and configuration files use JSON notation ▪ XSS and ESAPI detection fully configurable ▪ Support for shared APPL_TOPs ▪ Dynamic reloading of configuration files – no restarting of the application server required
Logging and Alerting	▪ Flexible formatting and destinations ▪ Destinations include files, syslog, e-mail, database ▪ Files with periodic or sized-based rotation, size limits ▪ Syslog with support for major logging platforms (Splunk, ArcSight, enVision, QRadar, etc.)
Resiliency	▪ Fail open or closed upon internal errors ▪ Fail open or closed upon startup or configuration errors

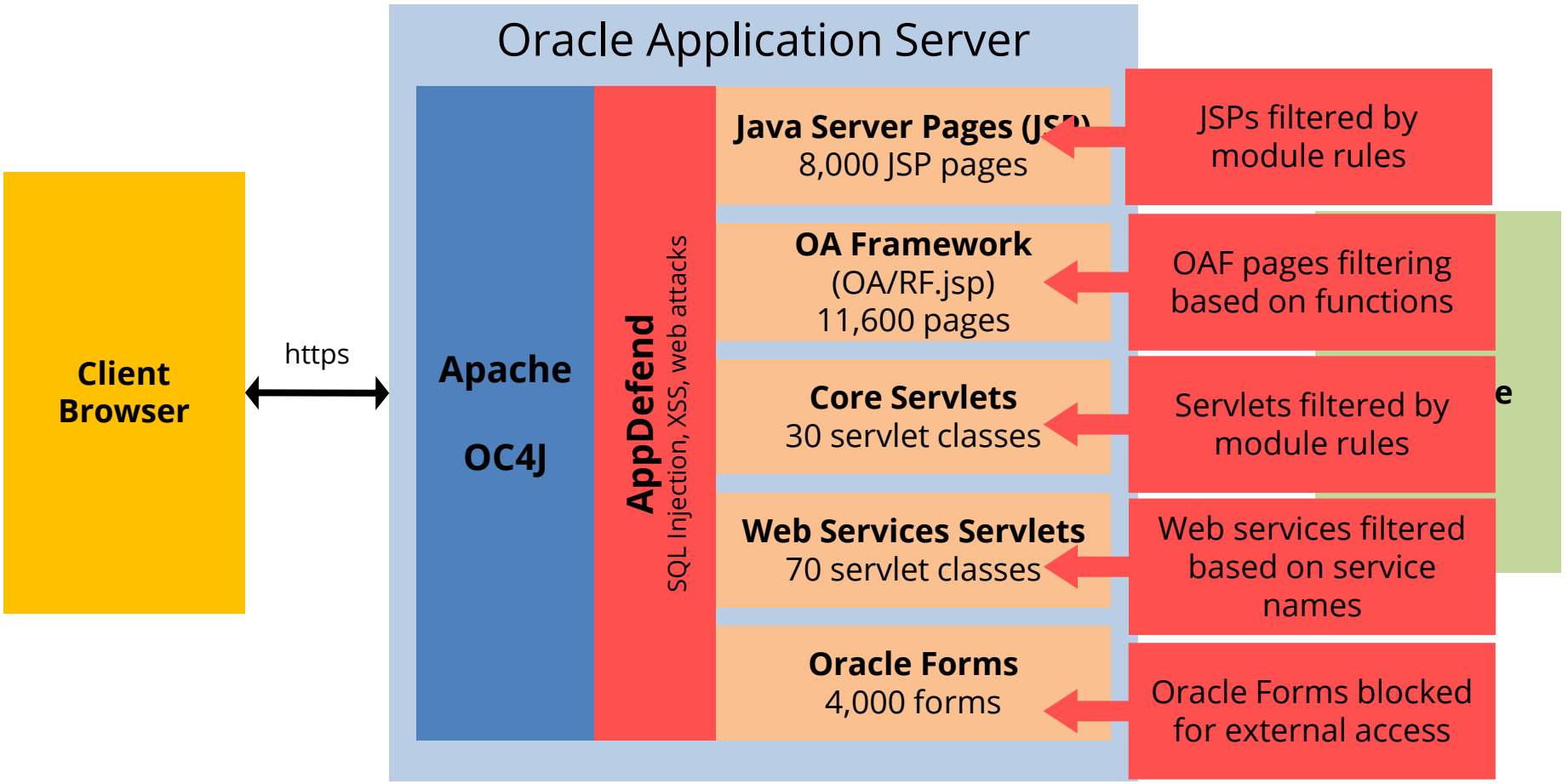
AppDefend Installation and Updates

Installation	▪ One hour installation web sessions included with subscription – 15-minute install, 45-minute walk-through ▪ Download and install AppDefend binary and rules ▪ Customization AppDefend base configuration ▪ AutoConfig customization ▪ Restart oacore Java container
Updates	▪ New rules and rule updates – quarterly or as needed ▪ Download and unzip appdefend.zip ▪ AppDefend dynamically reloads rules
Upgrades	▪ New features and non-rule fixes – biannual or as needed ▪ Download and unzip appdefend.zip ▪ Restart oacore Java container

AppDefend Processing



AppDefend Permit Rule



- **AppDefend** allows access to only permitted Oracle EBS modules based on a group of white-listed modules. Individual files may be permitted also. Web page and OA Framework customizations are supported.

AppDefend Arguments

AppDefend rules and alerts may use one or more of these arguments.

```
ebs.function_id
ebs.function_id_all
ebs.function_name
ebs.resp_id
ebs.resp_name
ebs.user_id
ebs.user_name
ebs.user_signon_name
request.attribute.<name>
request.attributes.names
request.auth_type
request.body_length
request.character_encoding
request.content_length
request.context_path
request.cookie.<name>
request.cookies.names
request.file_extension
request.file_name
request.header.<name>
request.headers.names
request.is_secure
request.line
request.local_addr
request.local_port
request.method
request.parameter.<name>
request.parameters.combined_size
request.parameters.get_names
request.parameters.get_values
request.parameters.names
request.parameters.put_names
request.parameters.put_values
request.parameters.values
request.path_info
request.path_translated
request.protocol
request.query_string
request.remote_addr
request.remote_host
request.remote_port
request.remote_user
request.scheme
request.server_name
request.server_port
request.servlet_path
request.servletcontext.<name>
request.session_id
request.uri
request.url
response.content
response.content_length
response.header.<name>
response.header.names
session.attribute.<name>
session.attributes.names
```

AppDefend Operators

AppDefend rules can use any of these operators.

```
beginswith
byterange
contains
notcontains
endswith
equals
exists
greater
greatereq
ingroup
notingroup
inlist
notinlist
ipmatch
notipmatch
less
lesseq
regex
within
notwithin
```

AppDefend Actions

Log	Generates a log entry or alert to a file, syslog, e-mail
Redirect	Redirects the request to a specified full URL or relative URL for the site such as the Oracle EBS error page
Block	Block the request by returning the specified HTTP error code such as 403 Forbidden
Pause	Pause the request for the specified number of milliseconds perhaps to slow down a brute force attack
Sanitize	Sanitize one or all parameters and headers in the request to prevent XSS, HTML injection, or SQL injection
Stop	Stop the processing of all subsequent AppDefend rules. The Stop action is useful to minimize AppDefend analyzing static request such as images, etc.
DoNothing	This action will do nothing as an action

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OWASP Top 10 – AppDefend

AppDefend is the layer of defense for Oracle E-Business Suite against OWASP Top 10 security vulnerabilities.

AppDefend	AppDefend	AppDefend	AppDefend
A1: Injection	A2: Broken Authentication	A3: Sensitive Data Exposure	A4: XML External Entities (XXE)
AppDefend	**AppDefend**	**AppDefend**	**AppDefend**
A5: Broken Access Control	A6: Security Misconfiguration	A7: Cross-Site Scripting (XSS)	A8: Insecure Deserialization
	AppDefend	**AppDefend**	
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http://www.owasp.org/index.php/Top_10

Integrigy Contact Information

Integrigy Corporation

web – **www.integrigy.com**

e-mail – **info@integrigy.com**

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

youtube – **youtube.com/integrigy**