Let me secure that for you!

Appsec AU, 9 Sept 2017

Kirk Jackson | @kirkj
lmstfu.com | @LetMeSecureThat

This talk is not about RedShield!

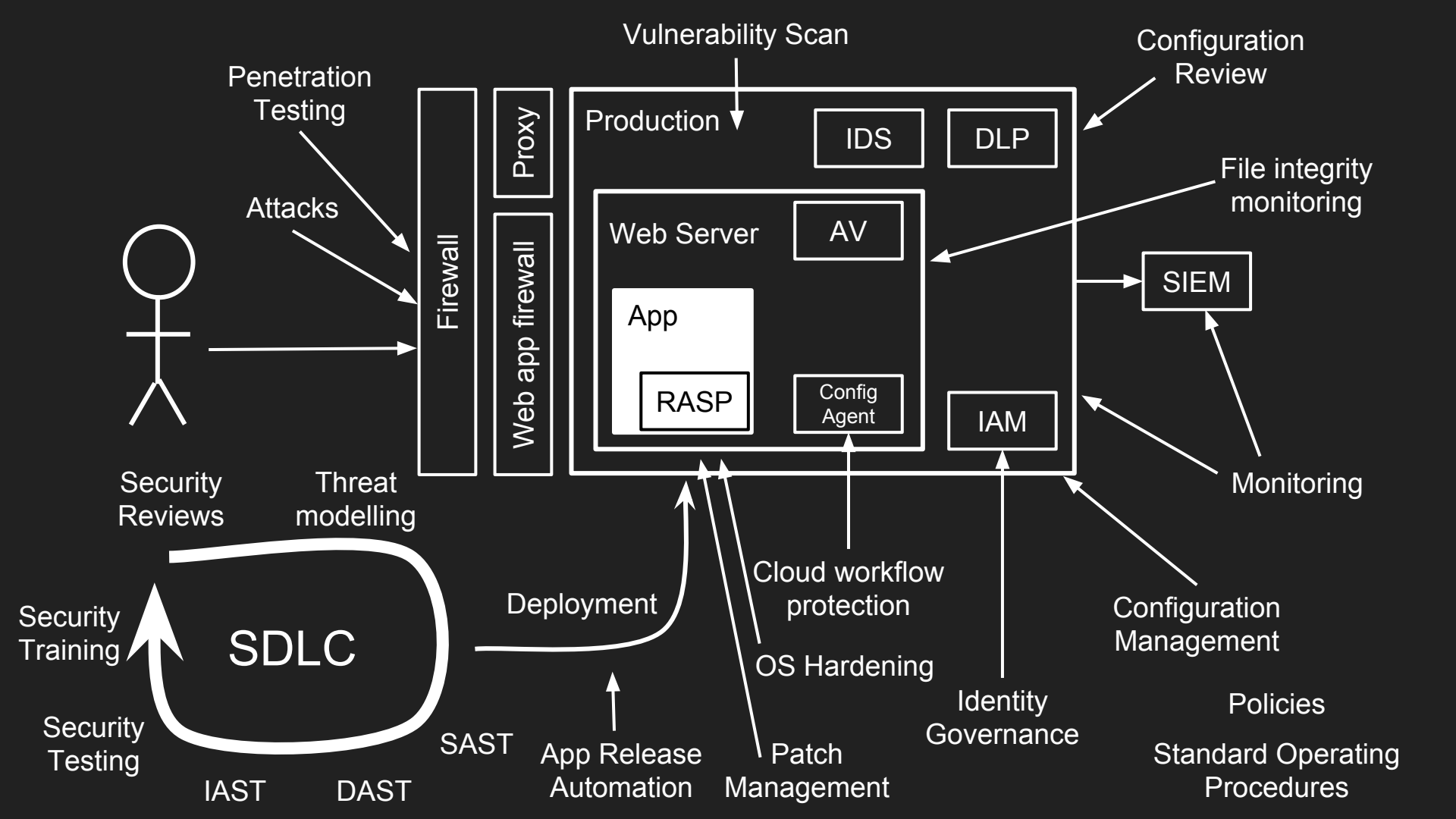
“We are the world's first web application shielding-with-a-service cybersecurity company.”

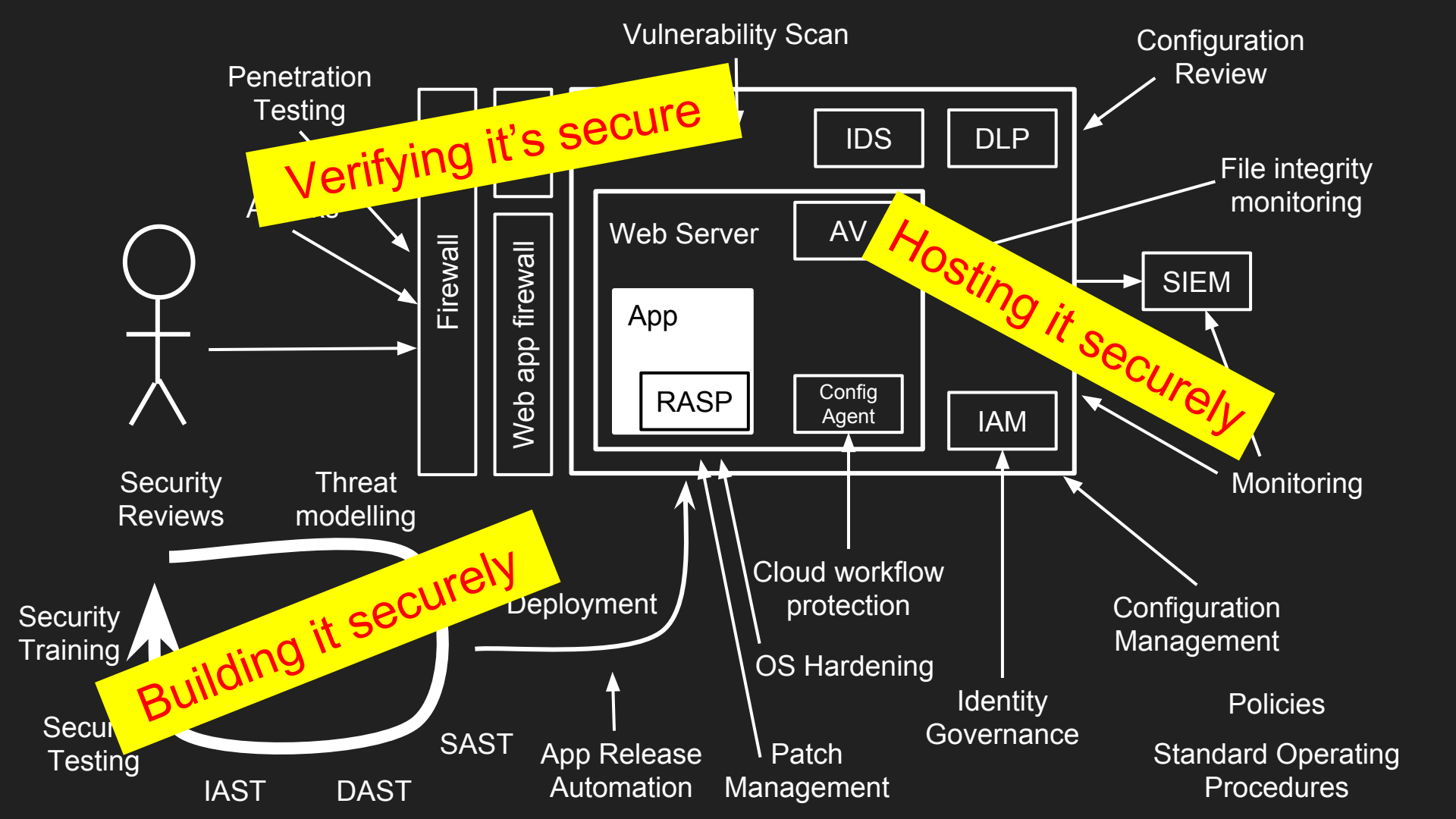
Not an advertisement!

- RedShield don’t use ModSecurity or node.js
- We wrap a service around virtual patching

- How does virtual patching work?
- Can it be done “DIY”?

Building a secure web app


Vulnerability Scan
Configuration Review
Penetration Testing
Attacks
Firewall
Proxy
Web app firewall
Production
IDS
DLP
File integrity monitoring
Web Server
AV
SIEM
App
RASP
Config Agent
IAM
Security Reviews
Threat modelling
Monitoring
Security Training
SDLC
Deployment
Cloud workflow protection
Configuration Management
OS Hardening
Identity Governance
Policies
Security Testing
SAST
App Release Automation
Patch Management
Standard Operating Procedures
IAST
DAST


Vulnerability Scan
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Verifying it's secure
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Deployment
Cloud workflow protection
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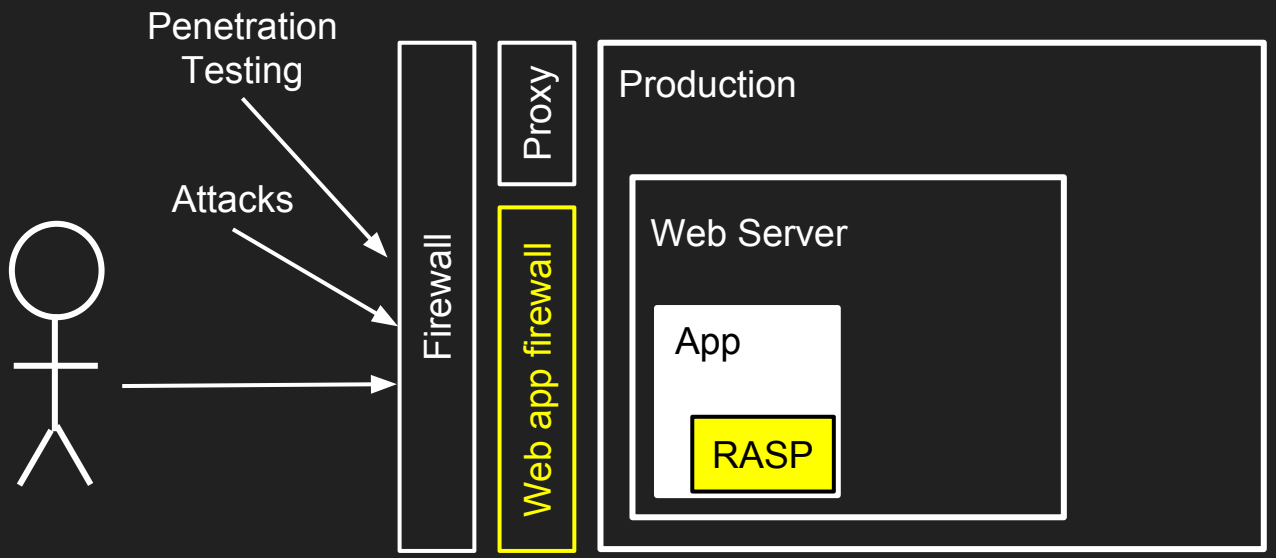
Identity Governance
Policies
Testing
SAST
App Release Automation
Patch Management
Standard Operating Procedures
IAST
DAST

Approximate cost: $4.2m

Building a secure web app

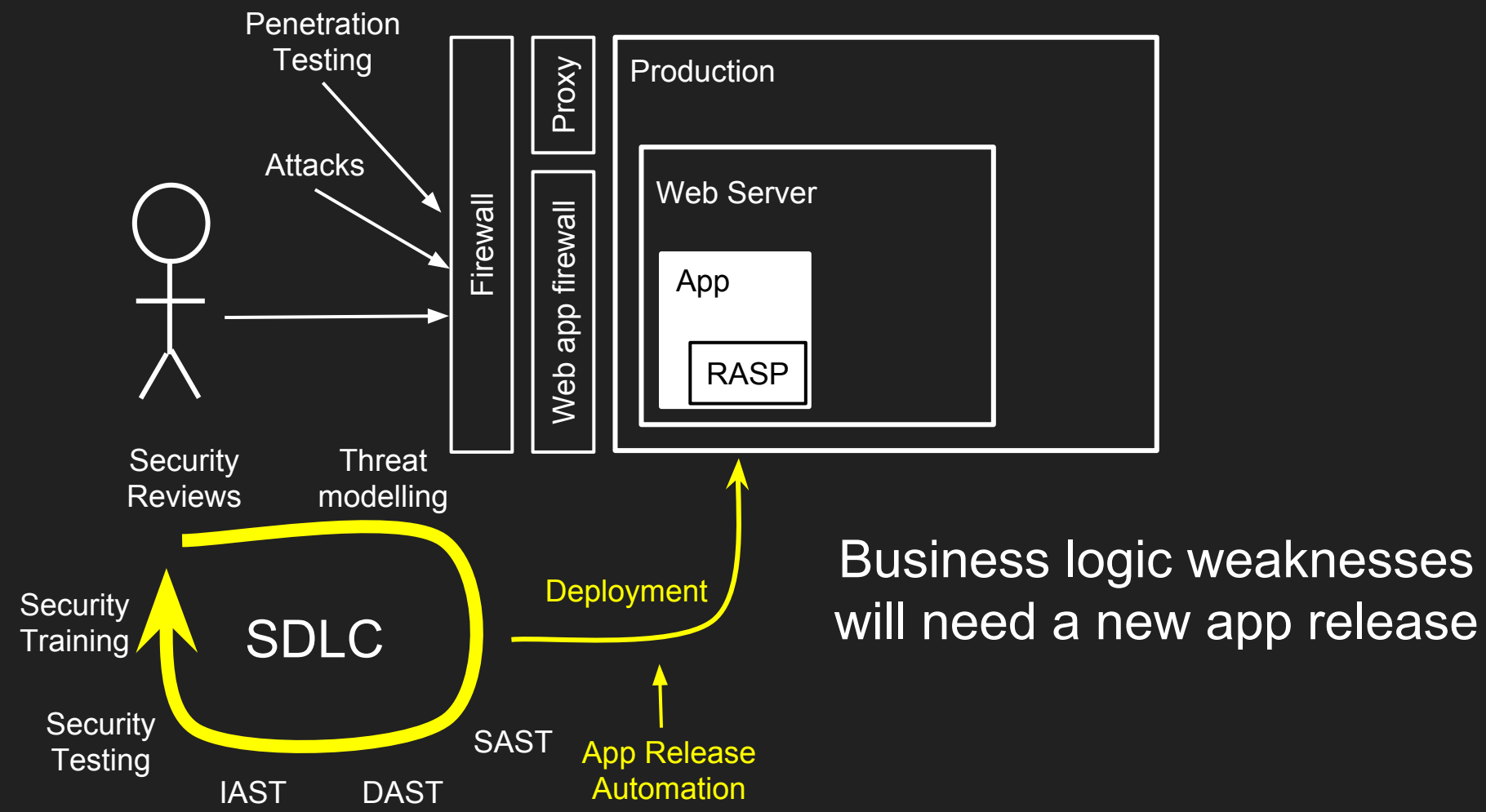
But what if there are bugs?



The WAF might stop signature-based attacks

business logic

But what if there are ^ bugs?



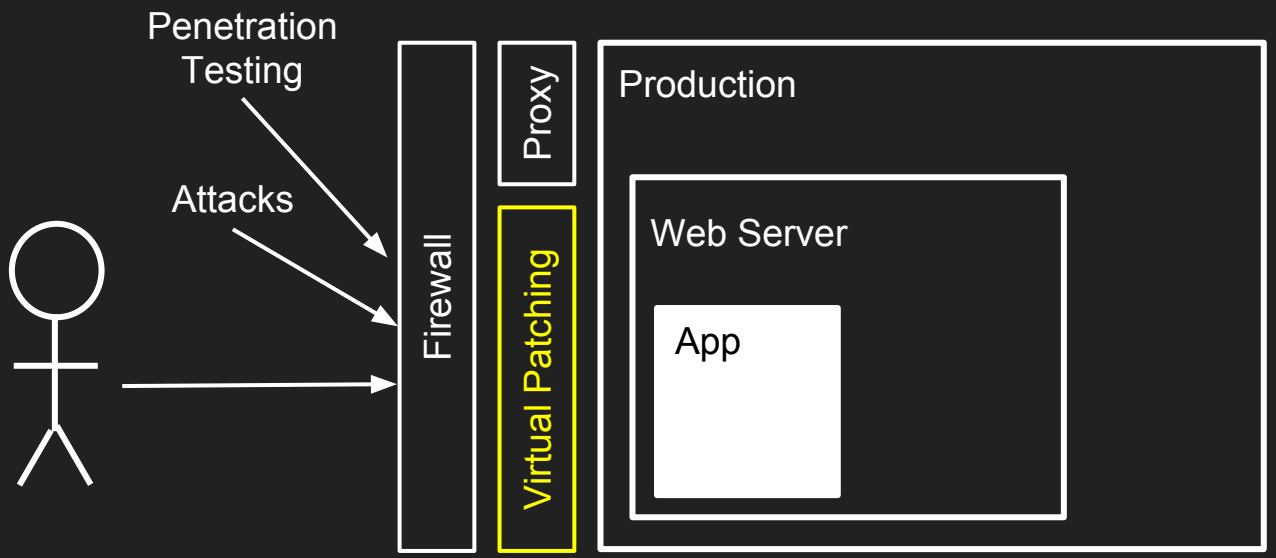
Business logic weaknesses will need a new app release

The cost of releasing updated software

- Divert team from current projects
- Branch, merge, build, test
- Release management, change review board
- Release

- Timeframe from discovery to release?
- Do you even have the source code?
- What “process” do you need to shortcut?

Patch the issues without touching underlying website



Replace the “WAF” with a more capable layer…

“Let me secure that for you!”

Virtual Patching

“ *prevent the exploitation of a known vulnerability* ”

Virtual Patching

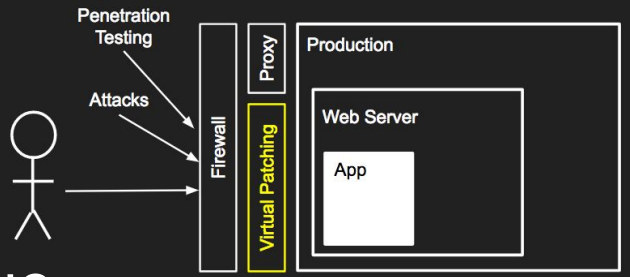
An agile security approach

Available to security teams in lieu of software development

React quickly while waiting for the cleanup

https://www.owasp.org/index.php/Virtual_Patching_Cheat_Sheet

Our Virtual Patching Approach



Understand *how to exploit* the security issue

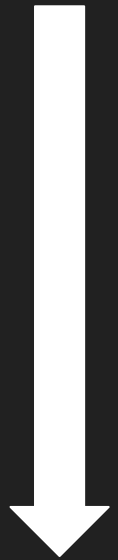
Only patch *known vulnerabilities or weaknesses*

Avoid over-patching or doing things that will cause issues:

- Learning mode, tuning, false positives
- Large blocklists
- Focus *only* on the script, page or parameter affected

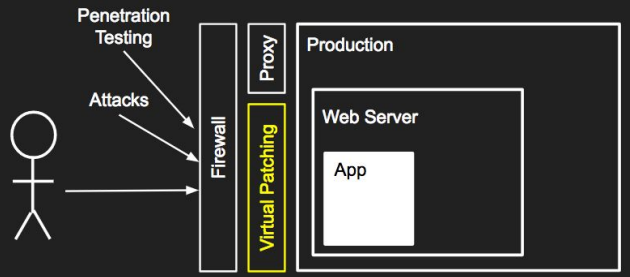
Our Virtual Patching Approach

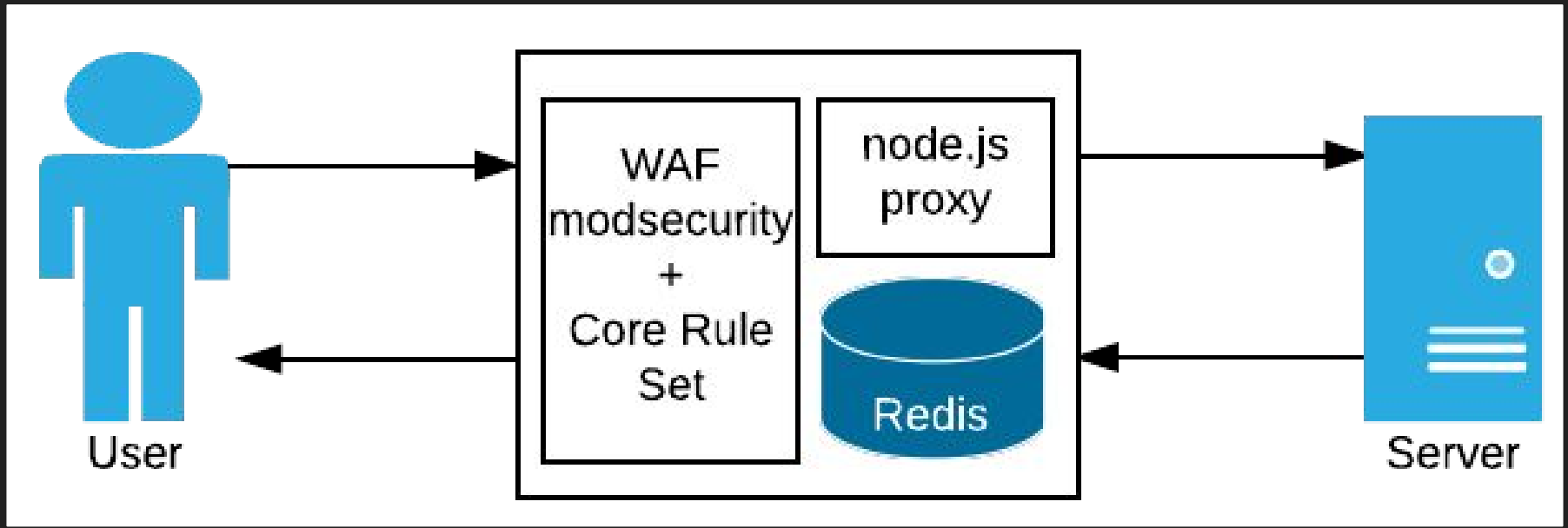
Choose an approach:



Block - if you're not worried about the user's experience
Redirect - send the user to an error page
Transform - change request or response to make safe
Validation - if you want to give helpful messages to guide users to enter correct values
Alert - so you know if there's an attack

“Let me secure that for you!”





lmstfu.com

WAF ALERT!!!!!

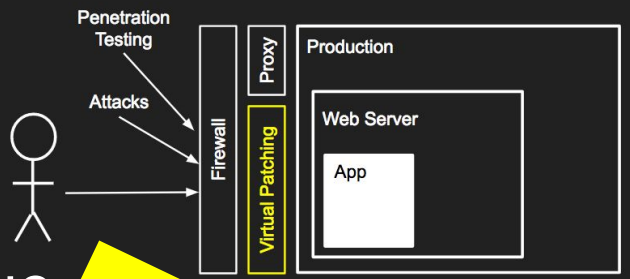
Our users hate our WAF because they're blocked by false positives

Our developers hate our WAF because it slows them down

Our sysadmins hate our WAF because it requires constant tuning

Our security team hate our WAF because it doesn't block real vulnerabilities

Our Virtual Patching Approach



Understand *how to exploit* the security issue

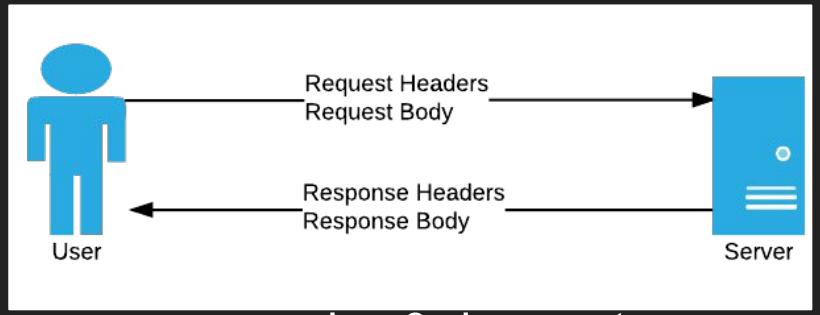
Only patch *known vulnerabilities or weaknesses*

Recap

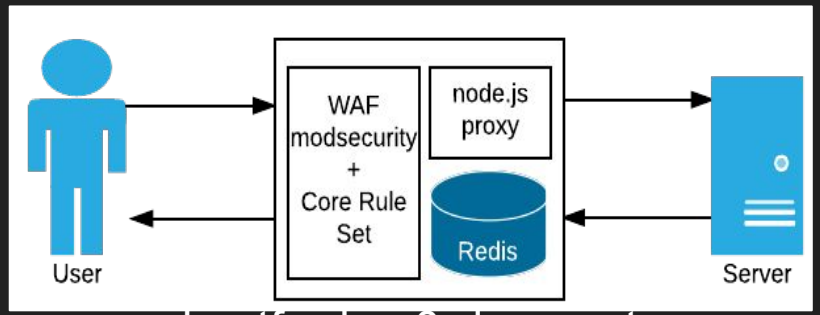
Avoid over-patching or doing things that will cause issues:

- Learning mode, tuning, false positives
- Large blocklists
- Focus *only* on the script, page or parameter affected

[Pause to demo a vulnerable website]



www.dev.0-days.net



lmstfu.dev.0-days.net

Our site has multiple vulnerabilities and weaknesses

OWASP Top 10:

- Access to admin urls
- Purchase negative quantities
- SQL injection in product search
- Cross-site scripting in product comments
- Cross-site request forgery in product comments

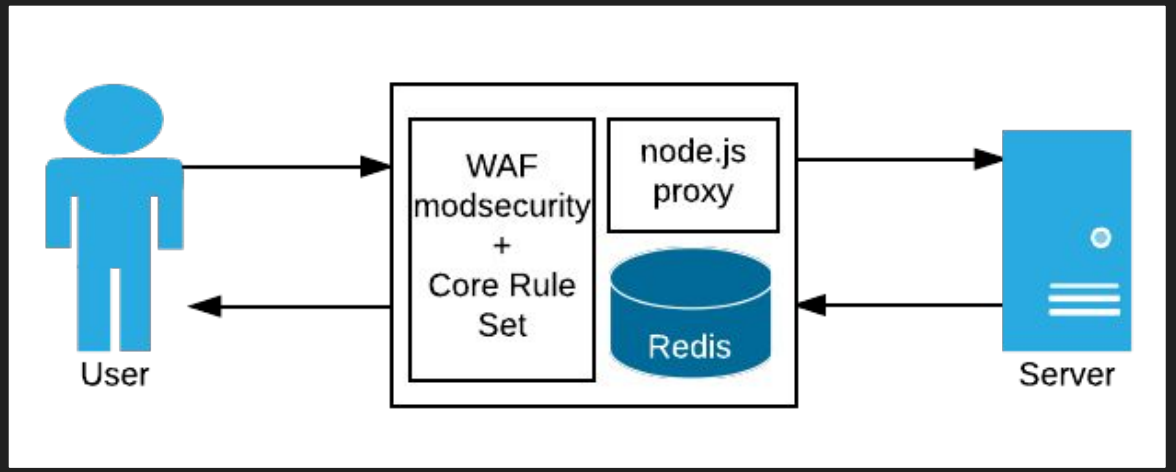
Business-logic vulnerabilities:

- Viewing other people’s orders
- Jumping past the payment screen
- Disclosure of credit card numbers
- Password weaknesses

“Let me secure that for you!”

ModSecurity

- Open-source web app firewall



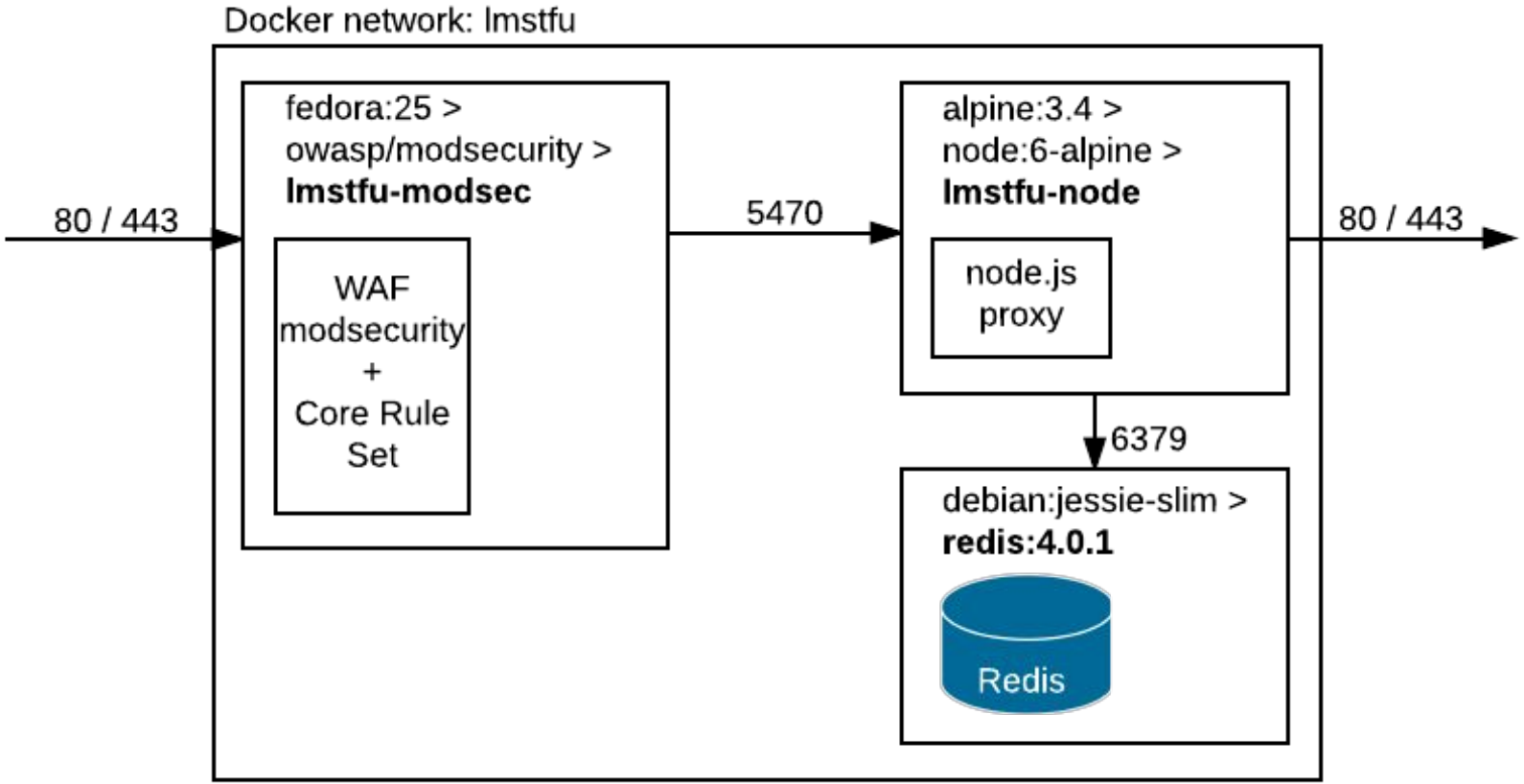
OWASP Core Rule Set

- Signatures for common OWASP attacks

Node.js

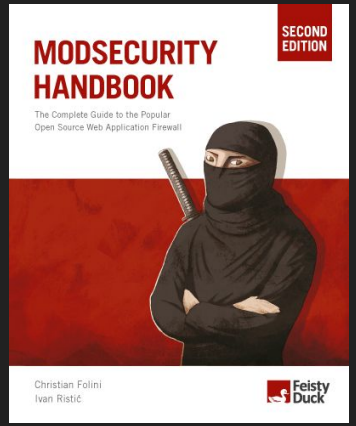
- Fast, flexible, event-driven
- State storage in redis

Docker


Docker network: lmstfu
fedora:25 >
owasp/modsecurity >
lmstfu-modsec
WAF
modsecurity
+
Core Rule
Set
80 / 443
5470
alpine:3.4 >
node:6-alpine >
lmstfu-node
node.js
proxy
80 / 443
6379
debian:jessie-slim >
redis:4.0.1
Redis

Demo of lmstfu setup

ModSecurity



- Originally an Apache httpd module
- v2.9.2 also supports IIS and nginx (instabilities)
- v3.0.0RC rewritten into libmodsecurity + connector
  - Not all features supported yet
- Doesn’t do much out of the box
  - Safe to enable in DetectionOnly mode

```
[[root@677152b32509 modsecurity.d]# wc modsecurity.conf
  226 1176 8441 modsecurity.conf
[[root@677152b32509 modsecurity.d]# cat modsecurity.conf
# -- Rule engine initialization ----------------------------------------------

# Enable ModSecurity, attaching it to every transaction. Use detection
# only to start with, because that minimises the chances of post-installation
# disruption.
#
SecRuleEngine DetectionOnly


# -- Request body handling ---------------------------------------------------

# Allow ModSecurity to access request bodies. If you don't, ModSecurity
# won't be able to see any POST parameters, which opens a large security
# hole for attackers to exploit.
#
SecRequestBodyAccess On
```

modsecurity.org | www.feistyduck.com/books/modsecurity-handbook/

OWASP ModSecurity Core Rule Set

Ruleset for common attacks:

SQL Injection (SQLi)
Cross Site Scripting (XSS)
Local File Inclusion (LFI)
Remote File Inclusion (RFI)
Remote Code Execution (RCE)
PHP Code Injection
HTTPoxy
Shellshock
Session Fixation
Scanner Detection
Metadata/Error Leakages
GeoIP Country Blocking

OWASP
ModSecurity
Core Rule Set
THE 1ST LINE OF DEFENSE

Tuned to avoid false positives

coreruleset.org

OWASP ModSecurity Core Rule Set

`crs-setup.conf.example` - configure mode, paranoia level

Look at requests

```
REQUEST-901-INITIALIZATION.conf
REQUEST-903.9001-DRUPAL-EXCLUSION-RULES.conf
REQUEST-903.9002-WORDPRESS-EXCLUSION-RULES.conf
REQUEST-905-COMMON-EXCEPTIONS.conf
REQUEST-910-IP-REPUTATION.conf
REQUEST-911-METHOD-ENFORCEMENT.conf
REQUEST-912-DOS-PROTECTION.conf
REQUEST-913-SCANNER-DETECTION.conf
REQUEST-920-PROTOCOL-ENFORCEMENT.conf
REQUEST-921-PROTOCOL-ATTACK.conf
REQUEST-930-APPLICATION-ATTACK-LFI.conf
REQUEST-931-APPLICATION-ATTACK-RFI.conf
REQUEST-932-APPLICATION-ATTACK-RCE.conf
REQUEST-933-APPLICATION-ATTACK-PHP.conf
REQUEST-941-APPLICATION-ATTACK-XSS.conf
REQUEST-942-APPLICATION-ATTACK-SQLI.conf
REQUEST-943-APPLICATION-ATTACK-SESSION-FIXATION.conf
```

Look at responses

```
RESPONSE-950-DATA-LEAKAGES.conf
RESPONSE-951-DATA-LEAKAGES-SQL.conf
RESPONSE-952-DATA-LEAKAGES-JAVA.conf
RESPONSE-953-DATA-LEAKAGES-PHP.conf
RESPONSE-954-DATA-LEAKAGES-IIS.conf
```

Is this an attack?

```
REQUEST-949-BLOCKING-EVALUATION.conf
RESPONSE-959-BLOCKING-EVALUATION.conf
RESPONSE-980-CORRELATION.conf
```

Anatomy of a SecRule

```
SecRule VARIABLES OPERATOR [ACTIONS]
```

```
SecRule  REQUEST_FILENAME
```

ARGS, ENV, FILES, IP, PATH_INFO, REMOTE_ADDR, REQUEST_COOKIES, REQUEST_URI, REQUEST_HEADERS, ...

http://lmstfu.com/SecRuleLayout

Anatomy of a SecRule

```
SecRule VARIABLES OPERATOR [ACTIONS]
```

```
SecRule  REQUEST_FILENAME "@rx /order/details/" \
```

@rx, @streq, @beginsWith, @contains, @gt, @lt, ...

http://lmstfu.com/SecRuleLayout

Anatomy of a SecRule

```
SecRule VARIABLES OPERATOR [ACTIONS]
```

```
SecRule  REQUEST_FILENAME "@rx /order/details/" \
  "id:11101,phase:1,deny,log,\
```

Phases:

1) Request headers, 2) Request body, 3) Response headers, 4) Response body, 5)Logging

http://lmstfu.com/SecRuleLayout

Anatomy of a SecRule

```
SecRule VARIABLES OPERATOR [ACTIONS]
```

```
SecRule  REQUEST_FILENAME "@rx /order/details/" \
  "id:11101,phase:1,deny,log,\
  t:none,t:lowercase,t:normalisePath,\
  msg:'Blocking access to %{MATCHED_VAR}'"
```

http://lmstfu.com/SecRuleLayout

SecRule chaining

Logical AND between rules:

```
SecRule ARGS:p "@rx test1" \
   id:2000,chain,...

   SecRule ARGS:q "@rx test2"
```

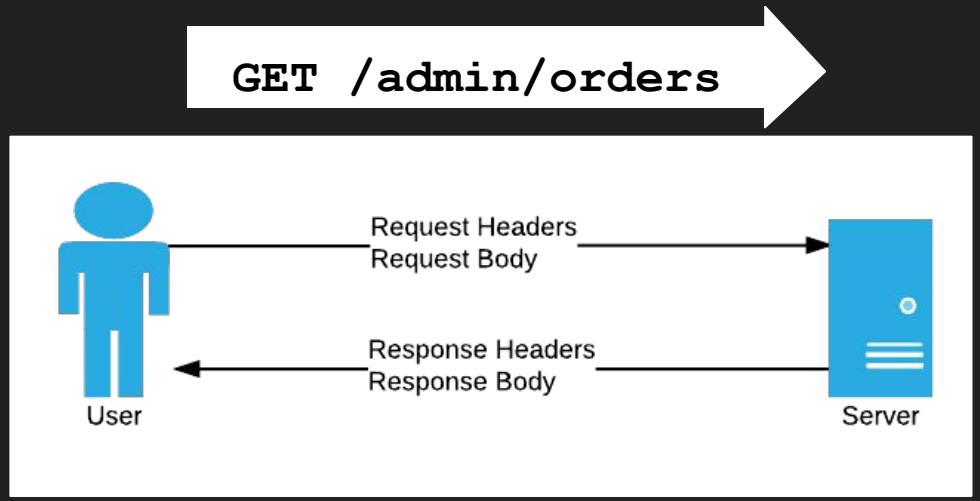
More complex flow control

```
SecMarker IF
    SecRule &ARGS:admin "@gt 0" \
        "id:2000,pass,nolog,skipAfter:ELSE"
SecMarker THEN
    SecRule ARGS:p "@rx K1" "id:2001,block,log"
    SecAction "id:2003,pass,nolog,skipAfter:END"
SecMarker ELSE
    SecRule ARGS:p "@rx K3" "id:2003,block,log"
SecMarker END
```

www.feistyduck.com/books/modsecurity-handbook/

Demo of modsecurity

Block a URL



Modify Request + Response:

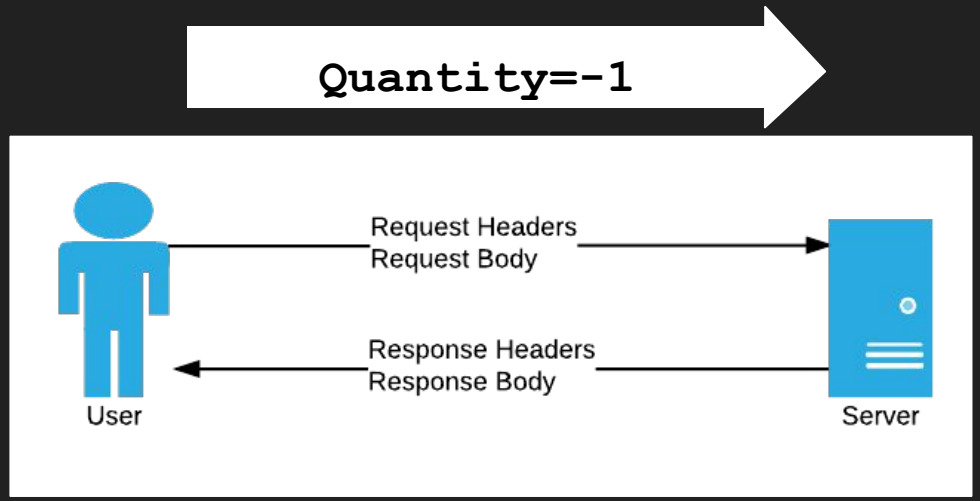
- Inspect Request Headers
  - Is it the right url?

Take action:

- Reject

```
SecRule  REQUEST_FILENAME "/admin/orders" \
 "id:11101,phase:1,deny,log,\
 t:none,t:lowercase,t:normalisePath,\
 msg:'Blocking access to %{MATCHED_VAR}'"
```

Validating a parameter



Modify Request + Response:

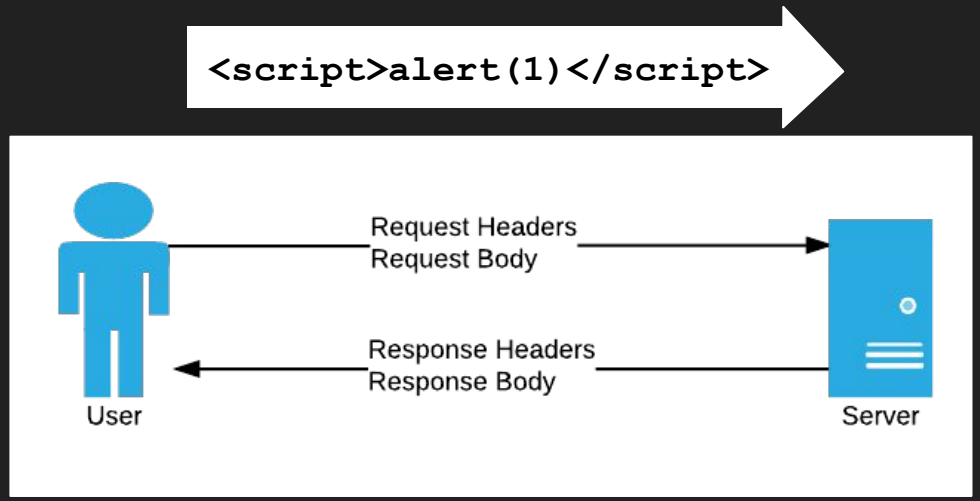
- Inspect Request Headers + Body
  - Is parameter a positive number?

Take action:

- Reject

```
SecRule ARGS:/^ProductChoices\[.*\].Quantity$/ "!@rx ^\d+$" \
   "id:10050, phase:2, pass, log, \
    t:none, t:removeWhitespace, \
    msg:'Invalid quantity entered: %{MATCHED_VAR}'"    (V15)
```

XSS in the input?



Modify Request + Response:

- Inspect Request Headers + Body
  - Does parameter look like XSS?

Take action:

- Reject

```
# Configure-Time: Only test XSS for the Comment parameter
SecRuleUpdateTargetByID 941100-941999 "ARGS:Comment"
# See V15
```

Blocking XSS

Blocking XSS

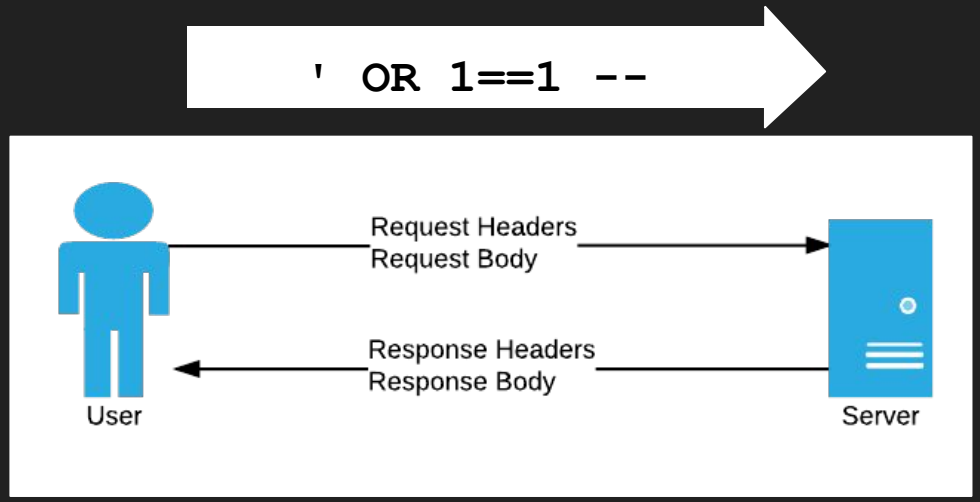
ModSecurity also uses libinjection for XSS and SQLi detection

Guns and Butter: Towards Formal Axioms of Validation
Hanson and Patterson

> *…formally proved that for any regex validator, we could construct either a safe query which would be flagged as dangerous, or a dangerous query which would be flagged as correct*

https://github.com/client9/libinjection | http://slidesha.re/OBch5k

SQL injection in the input?



Modify Request + Response:

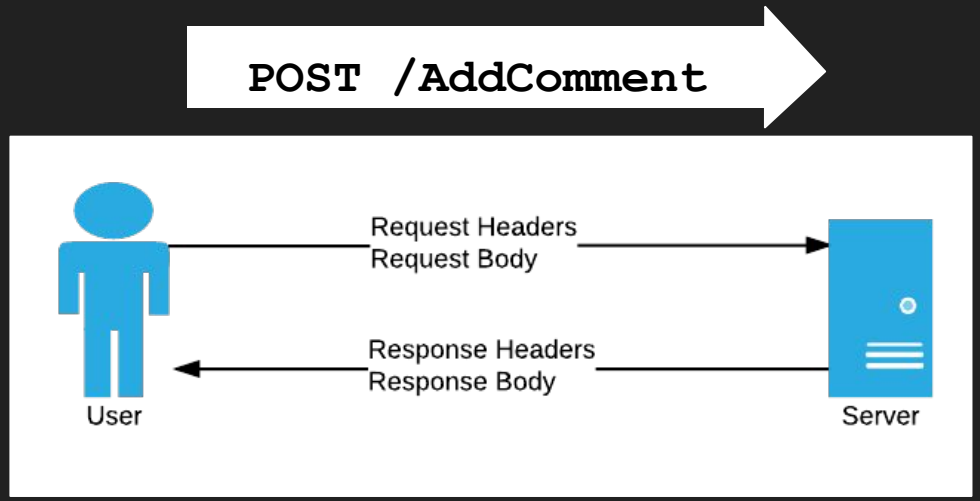
- Inspect Request Headers + Body
  - Does parameter look like SQLi?

Take action:

- Reject

```
# Configure-Time: Only test SQLi for the SearchTerm parameter
SecRuleUpdateTargetByID 942100-942999 "ARGS:SearchTerm"
# See V17
```

Cross-Site Request Forgery



Modify Request + Response:

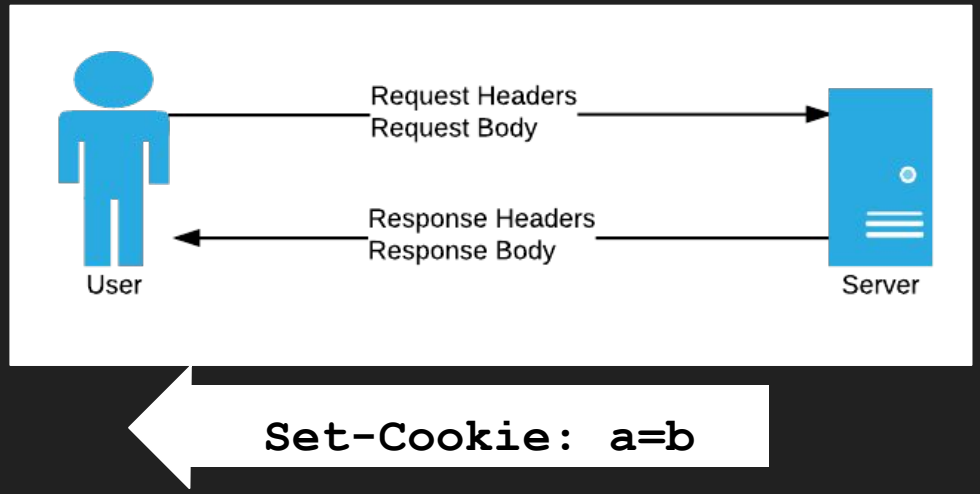
- Inspect Request Headers + Body
  - Is the referrer wrong?
  - Is the origin wrong?
  - Is there a valid CSRF token?

Take action:

- Reject

```
# If no token exists:
# - Create a CSRF token using ModSecurity
# - Send the token as a cookie
# - Add the token to the form post using inserted
    javascript
# - On POST, check if the cookie value matches the posted value
See V16
```

Missing headers and cookie flags



Modify Request + Response:

- Alter Response Headers
  - Set cookie flags
  - Add new headers

```
Header edit Set-Cookie "(?i)^(.AspNetCore.Antiforgery.(?:(?!httponly).)+)$" "$1; HttpOnly"
```

See V13

Why do we use ModSecurity + CRS?

Good, low false positive set of XSS and SQLi rules

Efficient processing and blocking

Allows simple things to be done *relatively* easily

Can be extended to do complex things, but it gets complicated fast!

Limitations of ModSecurity

- Hard to capture *program state*
- Limited manipulation of the response body
  - Hard to remove sensitive data, add validation text etc
- Daunting syntax
- Extensible via Lua, but not many examples

How do we keep state in web apps?

Client-side:

- URL
- Cookies
- Hidden Fields

Server Side:

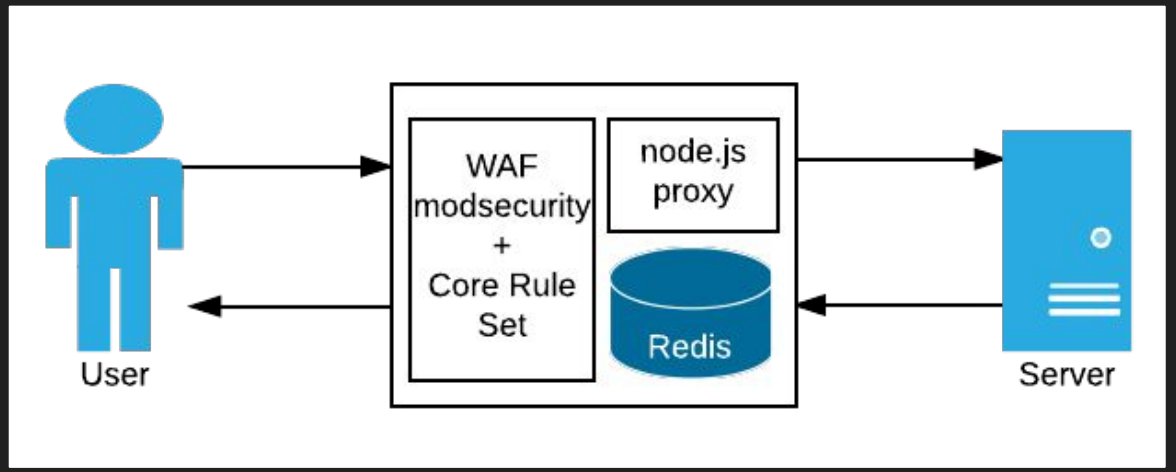
- In memory
- On disk
- Databases
- “Web farm” state servers

State storage needs to survive reboots and protect against tampering

“Let me secure that for you!”

node.js proxy

- Business logic
- Storing state in redis
- Transforming HTML



Redbird, http-proxy, harmon, trumpet

Redbird

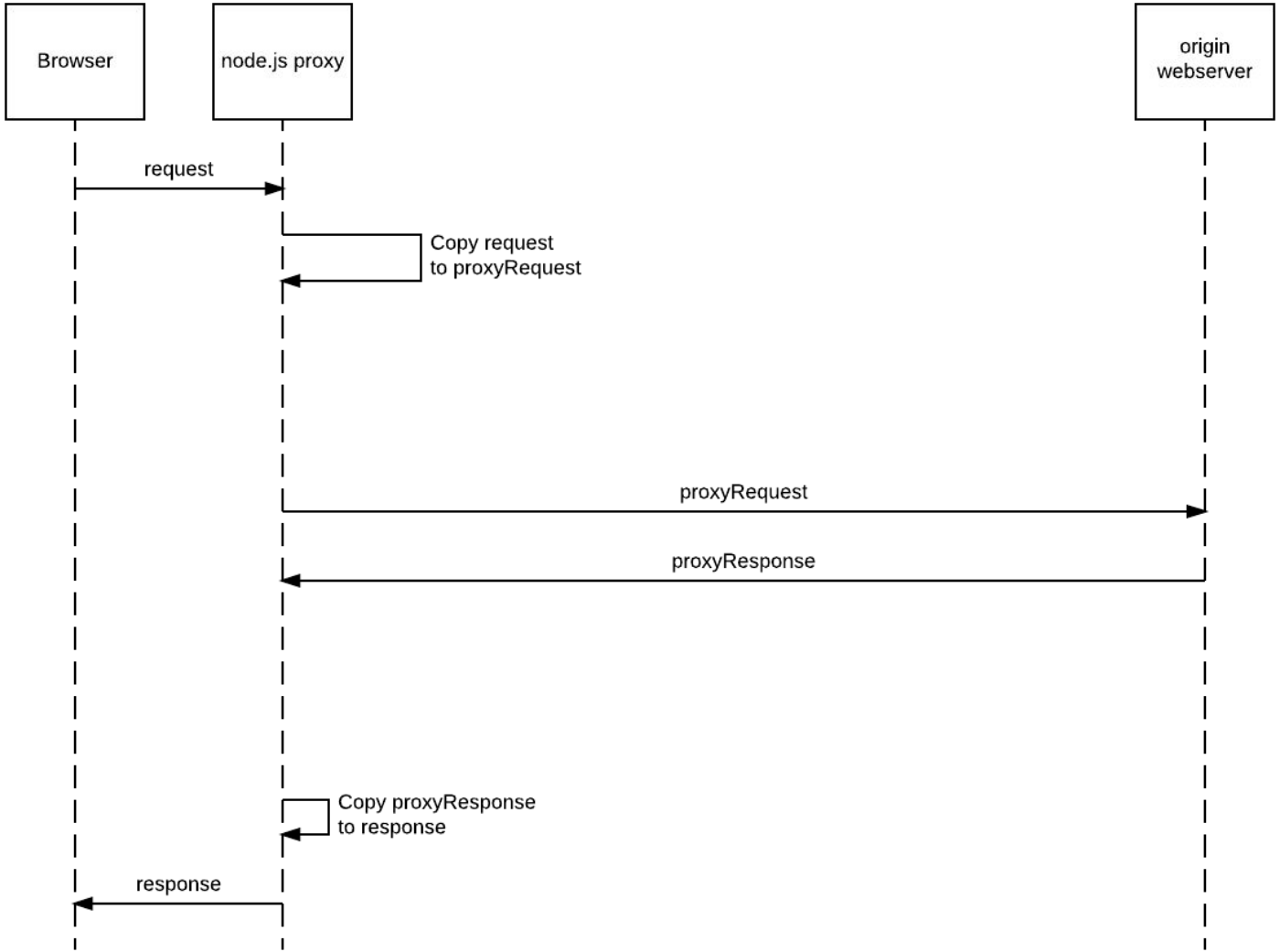
- Wraps http-proxy with extra features

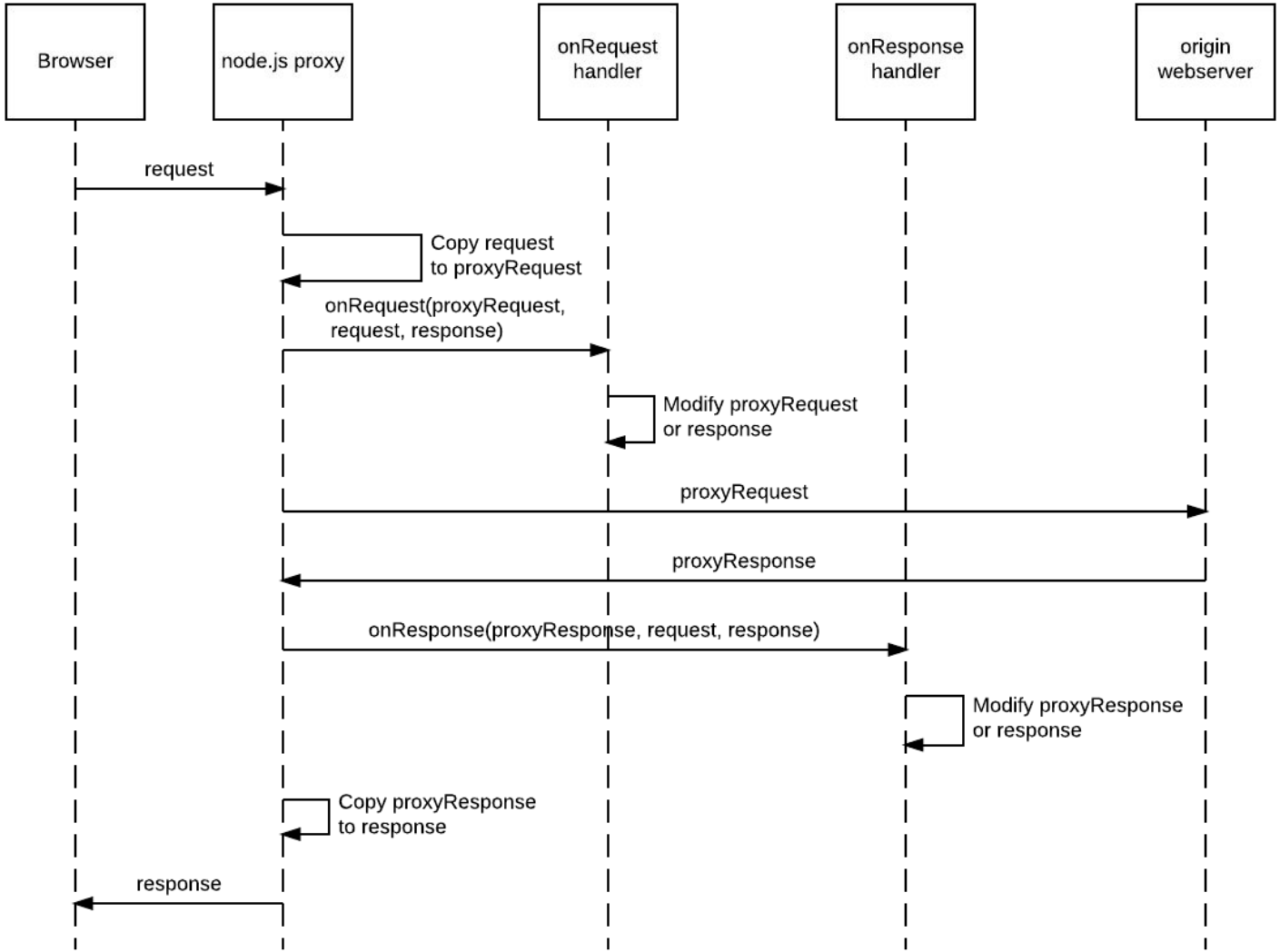
Harmon

- Uses trumpet for streaming HTML manipulation

160+ node modules!

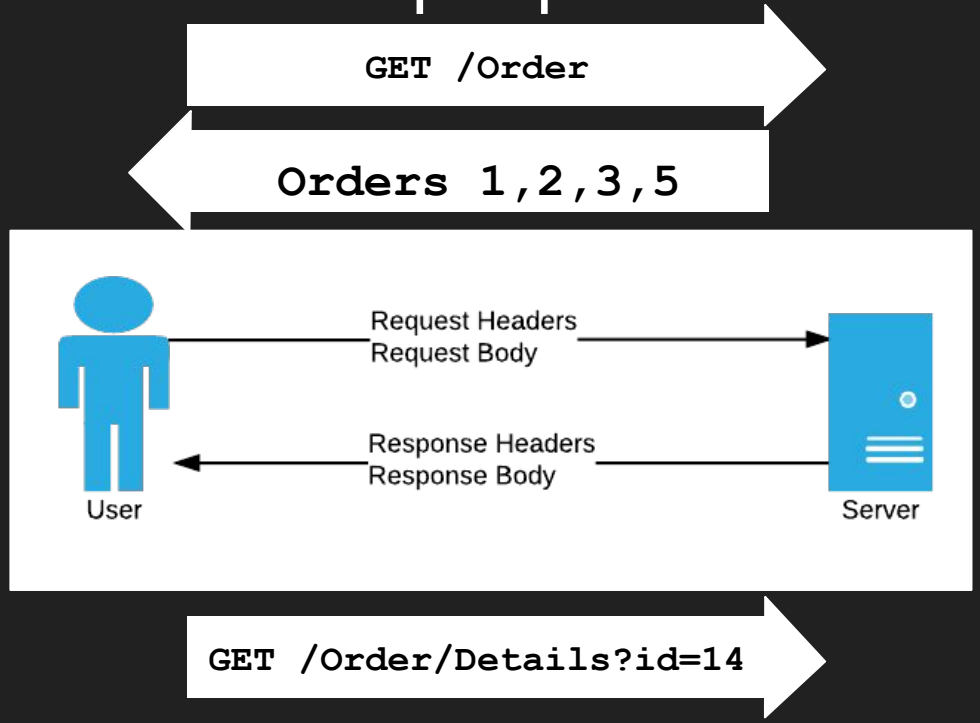
Search www.npmjs.com for Redbird, http-proxy, harmon, trumpet


Browser
node.js proxy
origin webserver
request
Copy request to proxyRequest
proxyRequest
proxyResponse
Copy proxyResponse to response
response


Browser
node.js proxy
onRequest handler
onResponse handler
origin webserver
request
Copy request to proxyRequest
onRequest(proxyRequest, request, response)
Modify proxyRequest or response
proxyRequest
proxyResponse
onResponse(proxyResponse, request, response)
Modify proxyResponse or response
Copy proxyResponse to response
response

Demo - More complex vulnerabilities

View other people's orders



Modify Request + Response:

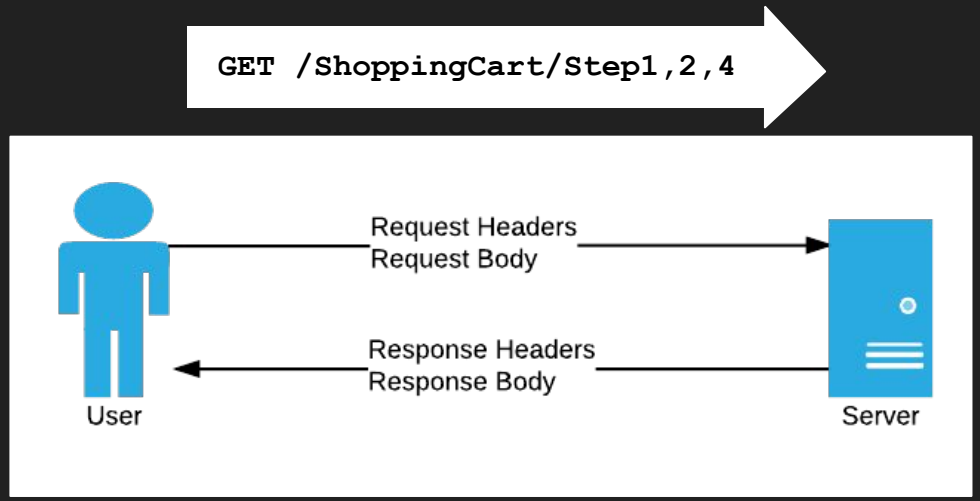
- Inspect the response to the "My Orders" request
- Store all the user's orders persistently
- Check requests for order details to make sure the user can access

Take action:

- Block

ordercontrol.js

Skip the payment step and get free orders



Modify Request + Response:

- Keep track of which steps have submitted successfully
- Check no step is missed

Take action:

- Redirect to Step1

stepcontrol.js

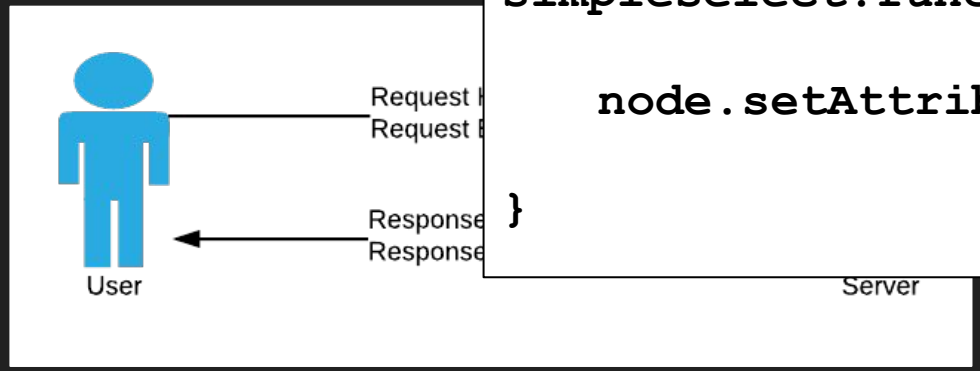
HTML Manipulation

```
simpleselect.query = 'input[type=password]';

simpleselect.func = function (node) {

    node.setAttribute('autocomplete','off');

}
```



stepcontrol.js

Other examples

- Password strength checking
- HTML manipulation
- Tamper-protection on hidden fields
- Changing validation rules and messages
- XML / json inspection
- API protection

Why use node.js proxy?

Javascript is the language of the internet

Fast, scalable, mature

Often used for node.js load balancing

Performant HTML manipulation

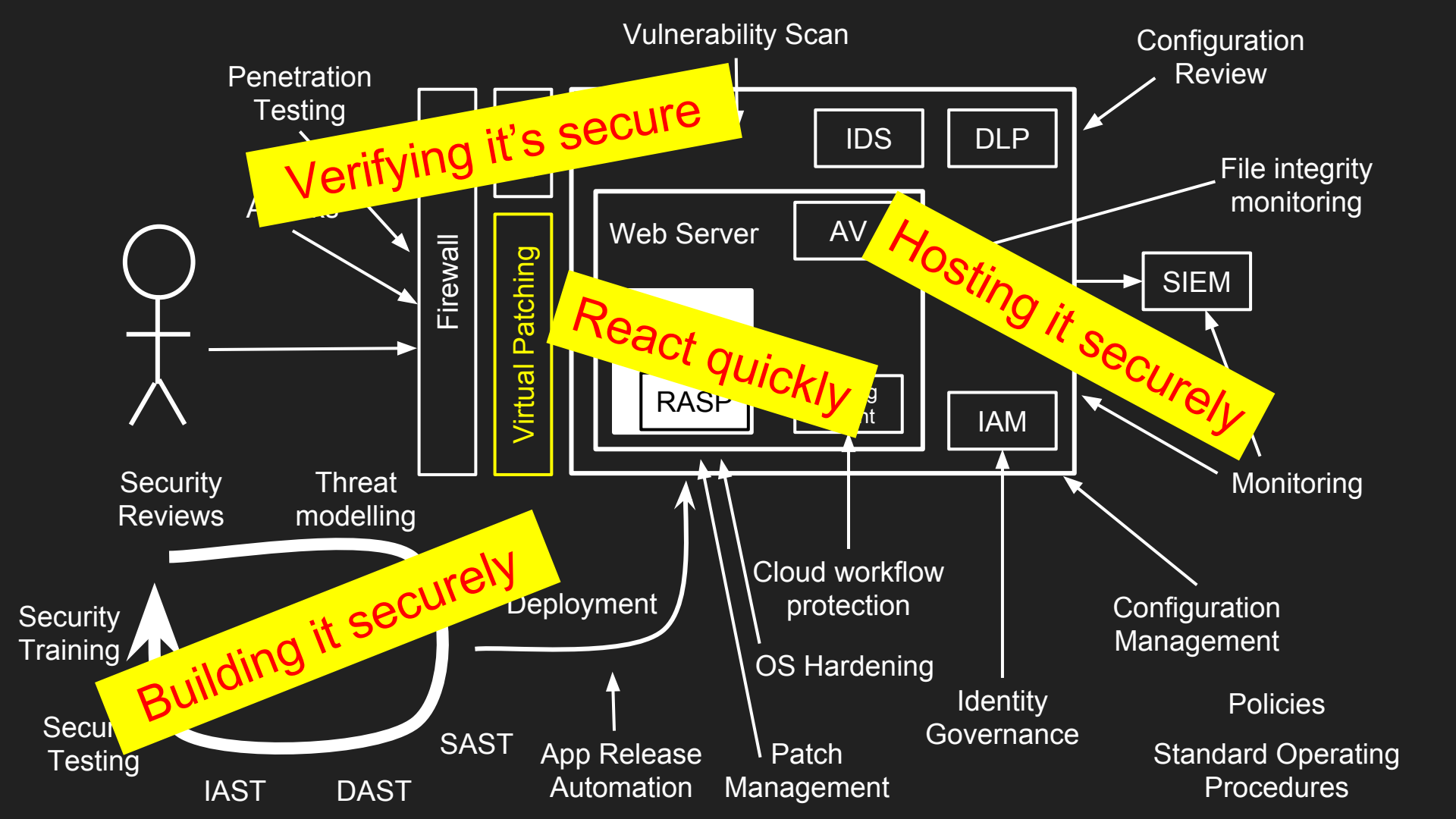
Limitations of node.js proxy

- Asynchronous programming is hard
- Still need modsecurity + CRS for signatures
- Lot of overlaps with modsecurity - which tool is the right one?

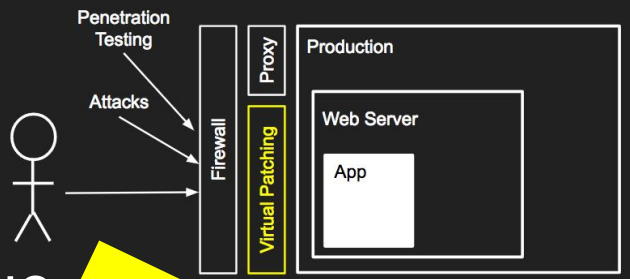
Virtual Patching is a thing

Another tool to add to your toolbelt

Prepare the infrastructure in advance


Vulnerability Scan
Configuration Review
Penetration Testing
Verifying it's secure
IDS
DLP
File integrity monitoring
Firewall
Virtual Patching
Web Server
AV
Hosting it securely
React quickly
SIEM
RASP
IAM
Security Reviews
Threat modelling
Monitoring
Building it securely
Security Training
Deployment
Cloud workflow protection
Configuration Management
OS Hardening
Identity Governance
Policies
Standard Operating Procedures
Patch Management
App Release Automation
SAST
IAST
DAST

Our Virtual Patching Approach



Understand *how to exploit* the security issue

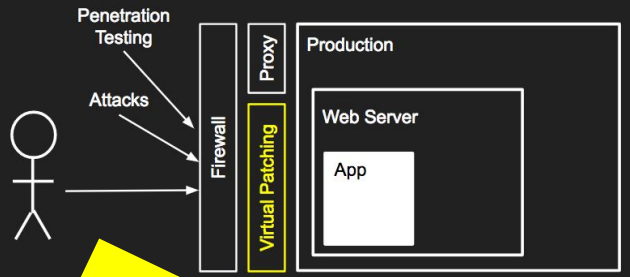
Only patch *known vulnerabilities or weaknesses*

Recap

Avoid over-patching or doing things that will cause issues:

- Learning mode, tuning, false positives
- Large blocklists
- Focus *only* on the script, page or parameter affected

Our Virtual Patching Approach



Only patch *known vulnerabilities or weaknesses*

Recap

This talk is not about RedShield!

“We are the world's first web application shielding-with-a-service cybersecurity company.”

Not an advertisement!

- RedShield don’t use ModSecurity or node.js
- We wrap a service around virtual patching

- How does virtual patching work?
- Can it be done “DIY”?

Let me secure that for you!

Appsec AU, 9 Sept 2017

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lmstfu.com | @LetMeSecureThat