BREACH

"The Core Rule Set":
Generic detection of application layer attacks

Ofer Shezaf

ModSecurity Core Rule Set Project Leader

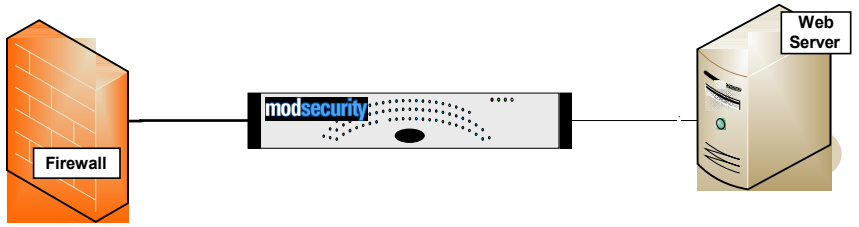
CTO, Breach Security

BREACH

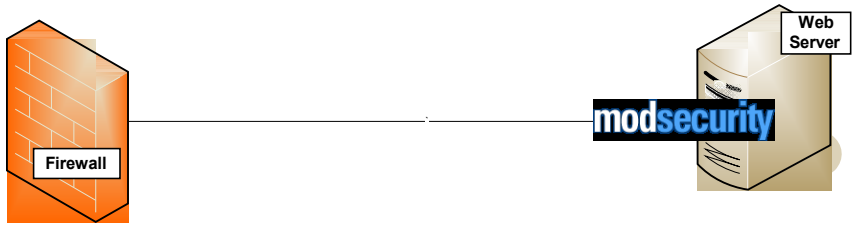
Web Application Firewalls
vs.
Intrusion Prevention Systems

Multiple Deployment Modes

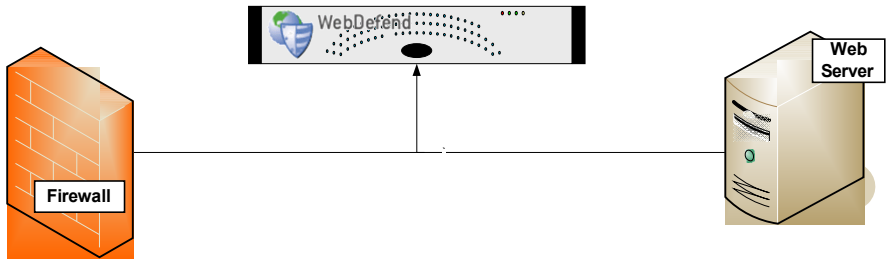
In-Line mode



Embedded mode



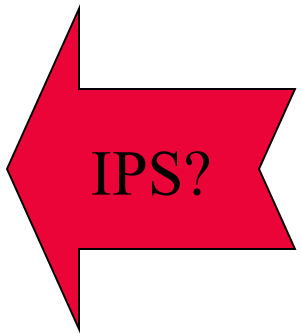
Out of line mode



BREACH

Three Protection Strategies for WAFs

1. **External patching**
   - Also known as "just-in-time patching" or "virtual patching".
2. **Positive security model**
   - An independent input validation envelope.
   - Rules must be adjusted to the application.
   - Automated and continuous learning (to adjust for changes) is the key.
3. **Negative security model**
   - Looking for bad stuff,
   - Mostly signatures based.
   - Generic but requires some tweaking for each application.



Virtual Patching

- Testing reveals that the login field is vulnerable to SQL injection.
- Login names cannot include characters beside alphanumerical characters.
- The following rule will help:

```
<LocationMatch "^/app/login.asp$">
        SecRule ARGS:username "!^\w+$" "deny,log"
>/LocationMatch>
```

BREACH

Positive security

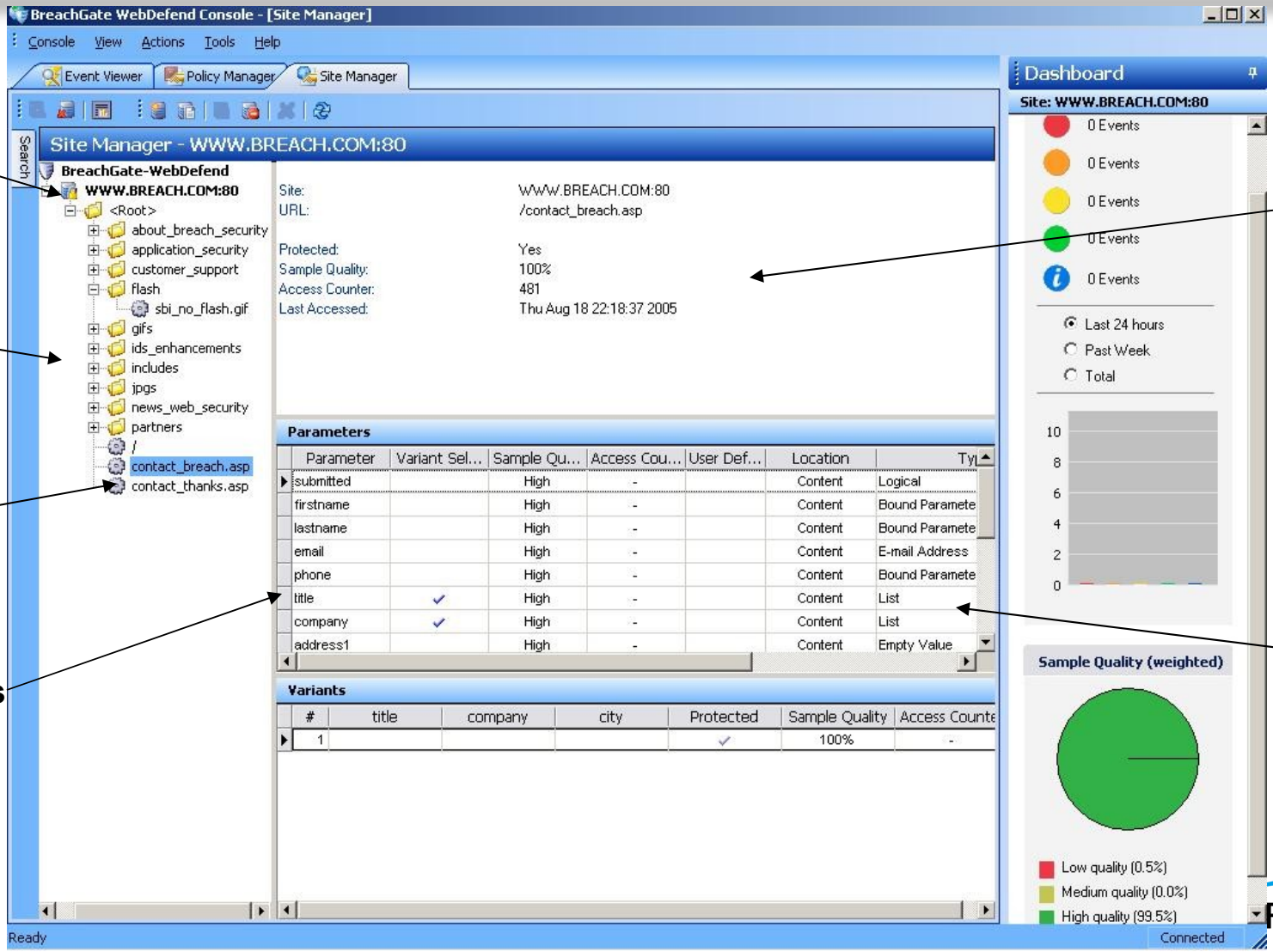
- The same, but for every field in every application

```
<LocationMatch "^/exchweb/bin/auth/owaauth.dll$">
  SecDefaultAction "log,deny,t:lowercase"
  SecRule REQUEST_METHOD !POST
  SecRule ARGS:destination "URL" "t:urlDecode"
  SecRule ARGS:flags "[0-9]{1,2}"
  SecRule ARGS:username "[0-9a-zA-Z].{256,}"
  SecRule ARGS:password ".{256,}"
  SecRule ARGS:SubmitCreds "!Log.On"
  SecRule ARGS:trusted "!(0|4)"
</LocationMatch>
```

- Very hard to create, requires learning by:
  - Monitoring outbound traffic (match input to web server request)
    - Caveats: JavaScript, Web Services
  - Monitoring inbound traffic (normal behavior):
    - Caveats: Statistics, attacks in learning period.

BREACH

Positive Security



Site

Site Map

URLs

Parameters

Site Status

Parameter Types

REACH

Negative Security

An IPS, but:

- **Deep understanding of HTTP and HTML**
  - Breaking up to individual fields: headers, parameters, uploaded files.
  - Validation of field attributes such as content, length or count
  - Correct breakup and matching of transactions and sessions.
  - Compensation for protocol caveats and anomalies, for example cookies.
- **Robust parsing:**
  - Unique parameters syntax
  - XML requests (SOAP, Web Services)
- **Anti Evasion features:**
  - Decoding
  - Path canonizations
  - Thorough understanding of application layer issues: Apache request line delimiters, PHP parameter names anomalies.
- **Rules instead of signatures:**
  - Sessions & state management, Logical operators, Control structures.

BREACH

BREACH

The Core Rule Set

```
modsecurity-core-rules_2.0-1.1.1 (blocking).zip
modsecurity_crs_10_config.conf
modsecurity_crs_20_protocol_violations.conf
modsecurity_crs_30_http_policy.conf
modsecurity_crs_35_bad_robots.conf
modsecurity_crs_40_generic_attacks.conf
modsecurity_crs_45_trojans.conf
modsecurity_crs_50_outbound.conf
modsecurity_crs_55_marketing.conf
```

Detection of generic app layer attacks

- Core Rule Set available for ModSecurity at:
  - http://www.modsecurity.org/projects/rules/index.html
  - Probably translatable to any App Firewall
- Benefits from ModSecurity features:
  - Anti Evasion
  - Granular Parsing
- Detection Mechanisms:
  - Protocol Validation
  - Generic Attack Signatures
  - Known Vulnerabilities Signatures
  - More…

BREACH

Protocol Validation

Protocol Violations

- Protocol vulnerabilities such as Response Splitting, Request Smuggling, Premature URL ending:
  - Content length only for none GET/HEAD methods
  - Non ASCII characters or encoding in headers.
  - Valid use of headers (for example, content length is numerical)
  - Proxy Access
- Attack requests are different due to automation:
  - Missing headers such as Host, Accept, User-Agent.
  - Host is an IP address.

BREACH

Protocol Policy

- Policy is usually application specific:
  - Some restrictions can usually be applied generically.
  - White lists can be build for specific environments.
- Items that can be allowed or restricted:
  - Methods - Allow or restrict WebDAV, block abused methods such as CONNECT, TRACE or DEBUG.
  - File extensions – backup files, database files, ini files.
  - Content-Types (and to some extent other headers)
- Limitations on sizes:
  - Request size, Upload size,
  - # of parameters, length of parameter.

BREACH

BREACH

Application Layer Signatures

IDS/IPS signatures

- Simple text strings or regular expression patterns matched against input data.
- Usually detect attack vectors:
  - Used for known vulnerabilities, while web applications are usually custom made.
  - Variations on attack vectors are very easy to create

Snort signature
for Bugtraq vulnerability #21799

Exploit:

```
/cacti/cmd.php?1+1111)/**/UNION/**/SELECT/**/2,0,1,1,12
7.0.0.1,null,1,null,null,161,500, proc,null,1,300,0, ls
-la >
./rra/suntzu.log,null,null/**/FROM/**/host/*+11111
```

Snort Signature:

```
alert tcp $EX                T any -> $H          $HTTP_PORTS
(
  msg:"BLEEDI              EB Cacti cmd.php Remote Arbitrary
  SQL Command Execution Attempt";
  flow:t_server,established;
  uricontent:"/cmd.php?"; nocase;
  uricontent:"UNION"; nocase;
  uricontent:"SELECT"; nocase;
                ence:cve,CVE-2006-6799;          raq,21799;
                type: web-application-att        334; rev:1;
```

Does the application accepts POST requests?

Signature built for specific exploit

An SQL injection does not have to use SELECT or UNION

UNION and SELECT are common English words. So is SELECTION

Case study: 1=1

- Classic example of an SQL injection attacks. Often used as a signature.
- But, can be avoided easily using:
  - Encoding: 1%3D1
  - White Space: 1 =%091
  - Comments 1 /* This is a comment */ = 1
- Actually not required at all by attacker.
  - Any true expression would work: 2 > 1
  - In some cases, a constant would also work. In MS-Access all the following are true: 1, “1”, “a89”, 4-4.
- No simple generic detection

WAF Rules

- Multiple operators and logical expressions:
  - Is password field length > 8?
- Selectable anti-evasion transformation functions:
  - Path normalization can be used also in parameters.
  - Base64 decode for basic authentication header.
- Control structures:
  - If content is XML or parameters names are not standard, perform a different set of rules.
- Variables, Session & state management:
  - Aggregate events over a sessions.
  - Detect brute force & denial of service.
  - Audit user name for each transaction

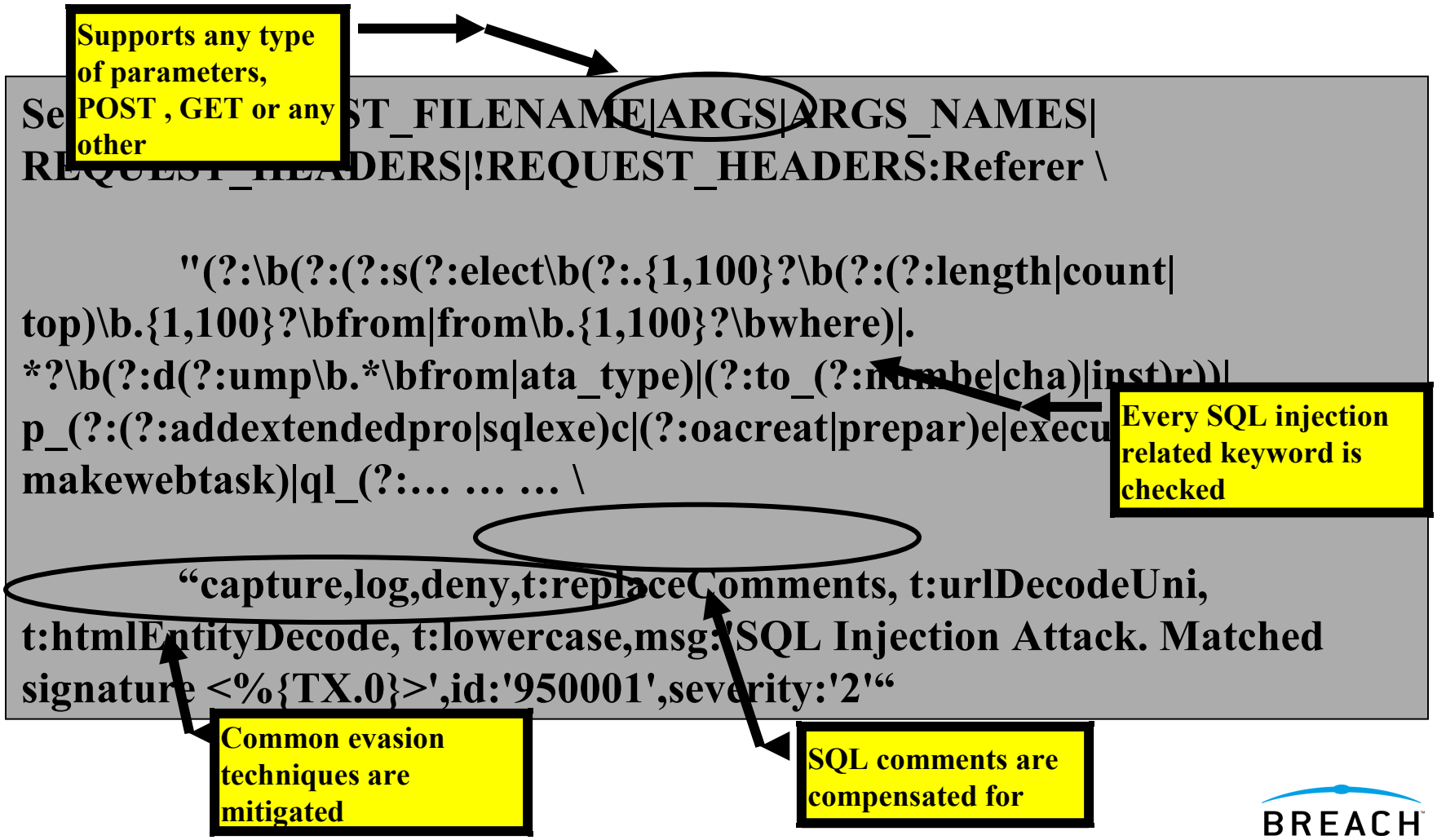
Generic application layer signatures

- Detect attack indicators and not attack vectors:
  - xp_cmdshell,
  - “<“, single quote - Single quote is very much needed to type *O'Brien*
  - *select*, *union – which are English words*
- *Aggregate indicators to determine an attack:*
  - Very strong indicators: xp_cmdshell, varchar,
  - Sequence: *union …. select, select … top … 1*
  - Amount: *script, cookie* and *document* appear in the same input field.
  - Sequence over multiple requests from the same source.

BREACH

Back to Bugtraq vulnerability #21799

The Core Rule Set Generic Detection



BREACH

Back to Bugtraq vulnerability #21799

Virtual Patching

```
<LocationMatch :"/cmd.php$">
        SecRule QUERY_STRING "^[\d\s]*$" “deny,log"
>/LocationMatch>
```

Parameters Must Be Numeric

Or

```
SecRule REQUEST_FILENAME :"/cmd.php$" “deny,log"
```

Actually script should not be

Simpler, isn’t it?

BREACH

BREACH™

Odds and Ends

Malicious Robots

- Detection of malicious robots:
  - Unique request attributes: User-Agent header, URL, Headers
  - Black list of IP addresses
- Not aimed against targeted attacks, but against general malicious internet activity:
  - Offloads a lot of cyberspace junk & noise
  - Effective against comment spam.
  - Reduce event count.
- In addition:
  - Detection of security scanners
  - Detection of non malicious robots (such as search engines).
  - Confusing security testing software (HTTPrint)

Trojans and Viruses

- Major problem at hosting environments
  - Uploading is allowed.
  - Some sites may be secure while others not.
- Generic detection:
  - Check upload of Viruses.
  - Check upload of Trojans – AV software is not very good at that.
  - Check for access to Trojans:
    - Known signatures (x_key header)
    - Generic file management output (gid, uid, drwx, c:\)

Error conditions

- Last line of defense if all else fails
- Provide feedback to application developers
- Important for customer experience
- Makes life for the hacker harder

BREACH

Future Plans

- Session bases protection:
  - Brute force detection.
  - Scanner and automation detection based on rate and result code.
  - Anomaly scoring.
- XML protection:
  - Schema validation for known XML payloads, such as SOAP.
  - Context based signature check in XML using XPath.

Thank You!

Ofer Shezaf

ofers@breach.com