Log Analysis using OSSEC

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Agenda

- OSSEC Overview
- Installation demo
- Log decoding and analysis with OSSEC
- Writing decoders
- Writing rules
- Examples of rules and alerts in the real world

What is OSSEC?

- Open Source Host-based IDS (HIDS)
- http://www.ossec.net
- Main tasks:
  - *Log analysis*
  - *File Integrity checking (Unix and Windows)*
  - *Registry Integrity checking (Windows)*
  - *Host-based anomaly detection (for Unix – rootkit detection)*
  - *Active response*

OSSEC is an Open Source Host-based Intrusion Detection System. It performs log analysis, integrity checking, Windows registry monitoring, Unix-based rootkit detection, real-time alerting and active response.

Why OSSEC?

- Solves a real problem and does it well (log analysis)
- Free (as in cookies and speech)
- Easy to install
- Easy to customize (rules and config in xml format)
- Scalable (client/server architecture)
- Multi-platform (Windows, Solaris, Linux, *BSD, etc)
- Secure by default
- Comes with hundreds of decoders/rules out of the box:
  - *Unix Pam, sshd (OpenSSH), Solaris telnetd, Samba, Su, Sudo, Proftpd, Pure-ftpd, vsftpd, Microsoft FTP server, Solaris ftpd, Imapd, Postfix, Sendmail, vpopmail, Microsoft Exchange, Apache, IIS5, IIS6, Horde IMP, Iptables, IPF. PF, Netscreen, Cisco PIX/ASA/FWSM, Snort, Cisco IOS, Nmap, Symantec AV, Arpwatch, Named, Squid, Windows event logs, etc ,etc,*

Concepts

- *OSSEC does “security log analysis”*
  - *It is not a log management tool*
  - *Only stores alerts, not every single log*
  - *I still recommend log management and long term storage of ALL logs*

- *Security Log Analysis can be called LID(S)*
  - *Log-based Intrusion Detection System*
  - *Every application or system generates some kind of log. There must be some interesting information on them!*
  - *We could even call it OSSEC LIDS, since some users only use the log analysis side of OSSEC*

LIDS benefits

- Cheap to implement
  - OSSEC is free, for example
  - Does not require expensive hardware

- High visibility of encrypted protocols
  - SSHD and SSL traffic are good examples

- Visibility of system activity (kernel, internal users, etc)

- Requires full centralized logging to be useful

- Logs are easy to parse
  - Compared to network packets (at least)
  - Although a log standard would make it easier

Installing OSSEC

- Simple and easy
  - *Two models:*

    Local *(when you have just one system to monitor)*

    Client/Server *for centralized analysis (recommended!)*
  - *Select installation type and answer a few questions*
  - *It will setup the appropriate permissions, create users, etc*

- Installation Demo (of an older version 1.0)

```
# tar -zxvf ossec*.tar.gz
# cd ossec*
# ./install.sh
... (answer all questions – installation available in Polish too)
# /var/ossec/bin/ossec-control start (after completed)
```

Upgrading OSSEC

- Simpler than the install!
  - *It will keep your configuration and local rules*
  - *Just choose the "upgrade" option when running the install.sh script*
- Upgrade Demo (from 1.0 to 1.2)

```
# tar -zxvf ossec*.tar.gz
# cd ossec*
# ./install.sh
...
 - You already have OSSEC installed. Do you want to update it? (y/n): y
 - Do you want to update the rules? (y/n): y
...
... (no more questions asked and OSSEC will even be restarted for you)
```

Understanding OSSEC

- OSSEC two working models
  - *Local (useful when you have only one system to monitor)*
  - *Agent/Server (recommended!)*

- By default installed at **/var/ossec**
- Main configuration file at **/var/ossec/etc/ossec.conf**
- Decoders stored at **/var/ossec/etc/decoders.xml**
- Binaries at **/var/ossec/bin/**
- All rules at **/var/ossec/rules/*.xml**
- Alerts are stored at **/var/ossec/logs/alerts.log**
- Composed of multiple processes (all controlled by **ossec-control**)

Internal processes

- Remember the Secure by default?
  - Installation script does the chroot, user creation, permissions, etc
  - User has no choice to run it “less secure”
- Each process with limited privileges and tasks
  - Most of them running on chroot
  - Most of them with separated unprivileged user
- Processes:
  - Analysisd – on chroot as user ossec
  - Remoted – on chroot as user ossecr
  - Maild – on chroot as user ossecm
  - Logcollector – as root, but only reads the logs, no analysis
  - Agentd – on chroot as user ossec (agent only)

Internal processes (2)

- Each daemon has a very limited task:
  - Analysisd – Does all the analysis (main process)
  - Remoted – Receives and forwards remote logs to analysisd
  - Logcollector – Reads and forwards log files to analysisd (or agentd on the agent)
  - Agentd – Forwards logs to the server
  - Maild – Sends e-mail alerts
  - Execd – Executes the active responses
  - Monitord – Monitors agent status, compresses and signs log files, etc
- **ossec-control** manages the start and stop of all of them

OSSEC configuration

- Multiple sections, one for each process
  - *To configure **logcollector** to monitor one file:*

    ```
    <localfile>
       <log_format>apache</log_format>
       <location>/var/www/logs/error_log</location>
     </localfile>
    ```

  - *To configure **analysisd** to read a specific rules file:*

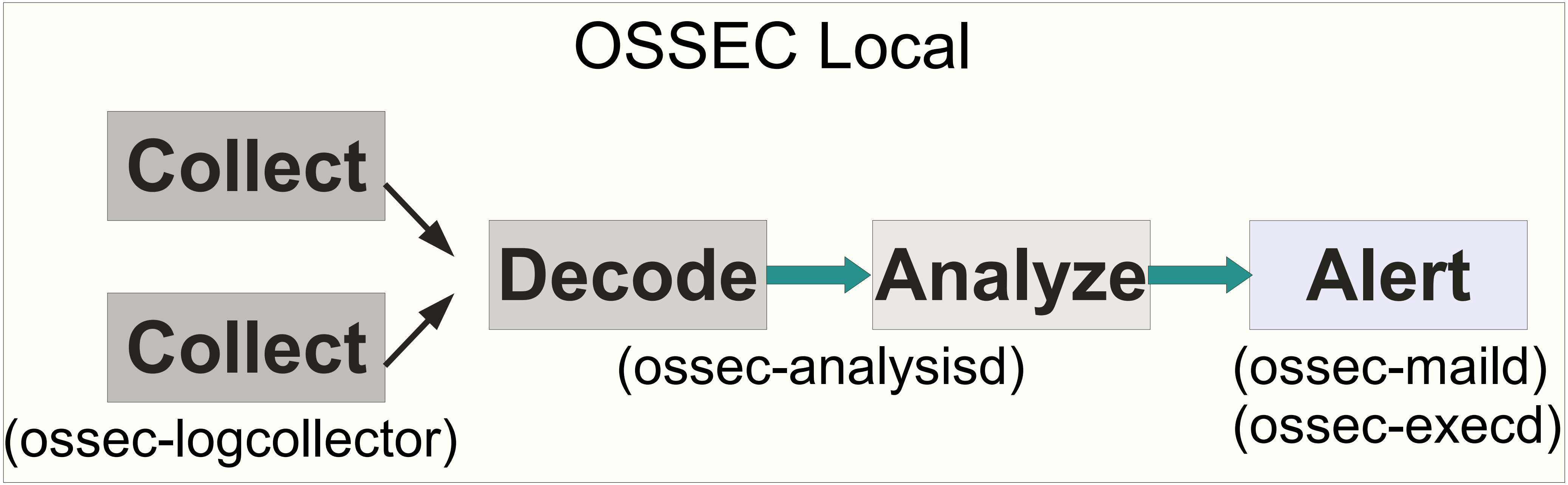
    ```
    <rules>
       <include>myrules.xml</include>
    </rules>
    ```

  - *To configure **remoted** to accept remote syslog:*

    ```
    <remote>
       <connection>syslog</connection>
       <port>514</port>
       <allowed-ips>192.168.2.0/24</allowed-ips>
     </remote>
    ```

  - *Look at our manual/FAQ for all available options!*

Log flow (local)



OSSEC Local

Collect

Collect

(ossec-logcollector)

Decode

Analyze

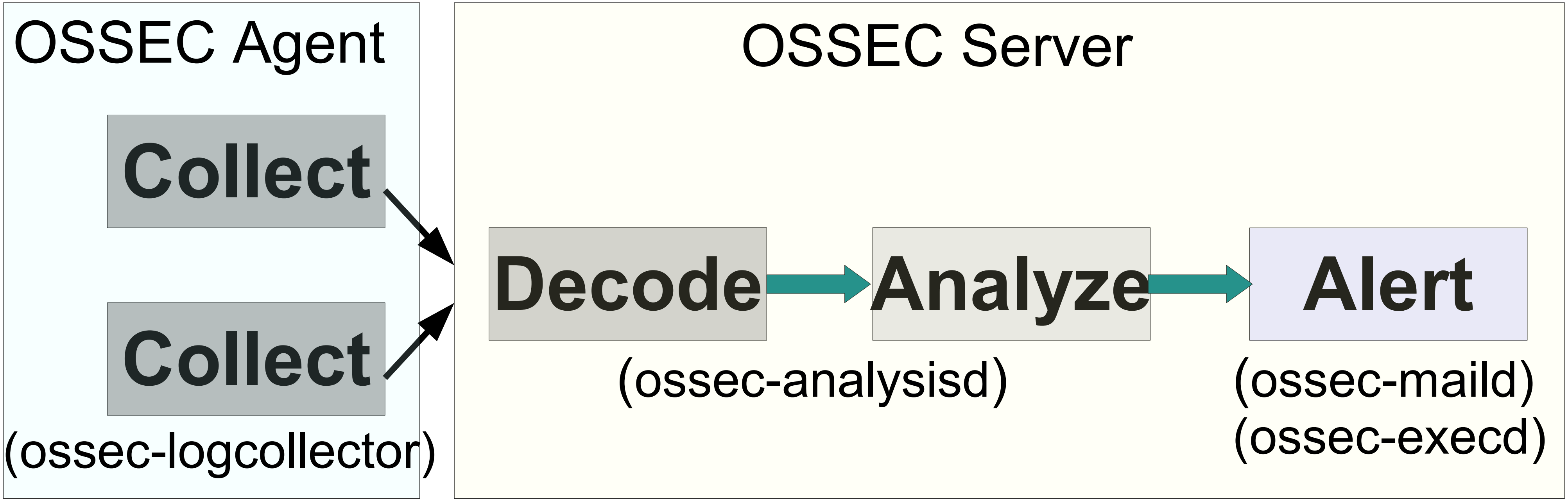
(ossec-analysisd)

Alert

(ossec-maild)
(ossec-execd)

- Generic log analysis flow breakdown (for ossec local)
  - *Log collecting is done by* ***ossec-logcollector***
  - *Analysis and decoding are done by* ***ossec-analysisd***
  - *Alerting is done by* ***ossec-maild***
  - *Active responses are done by* ***ossec-execd***

Log flow (agent/server)



OSSEC Agent

Collect

Collect

(ossec-logcollector)

OSSEC Server

Decode

Analyze

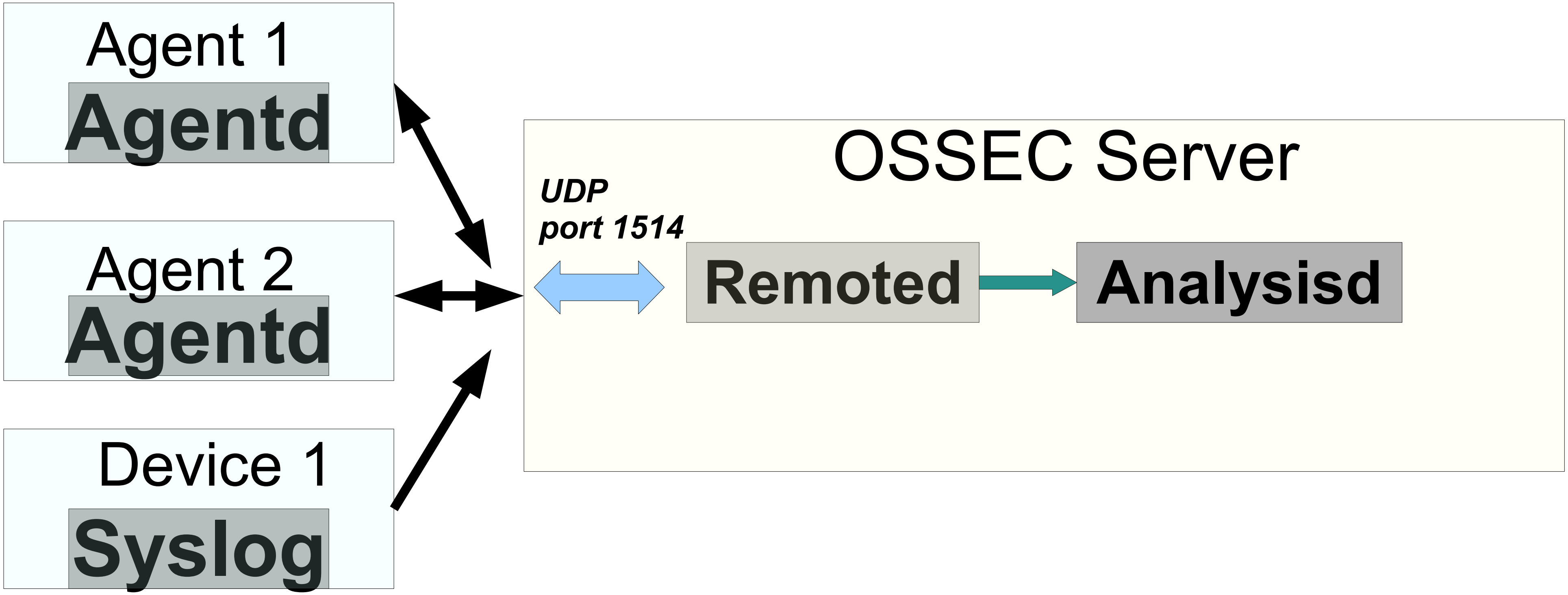
Alert

(ossec-analysisd)

(ossec-maild)
(ossec-execd)

- Generic log analysis flow for client/server architecture
  - *Log collecting is done by* ***ossec-logcollector***
  - *Analysis and decoding are done by* ***ossec-analysisd***
  - *Alerting is done by* ***ossec-maild***
  - *Active responses are done by* ***ossec-execd***

Network communication

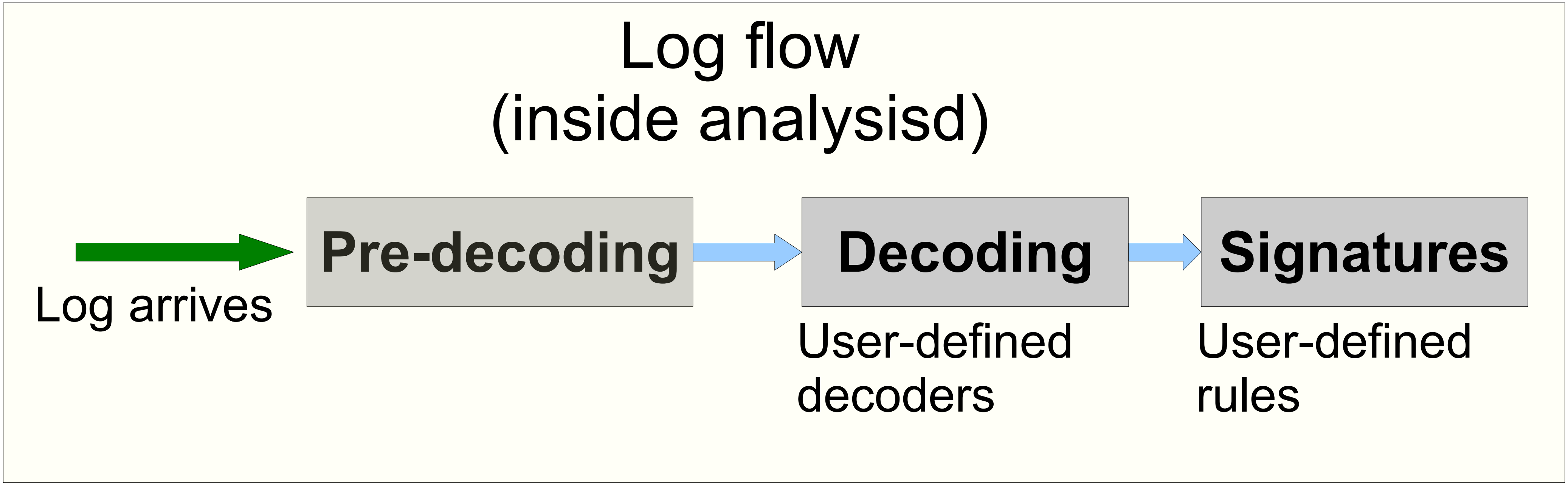


- Agent/Server network communication
  - Compressed (zlib)
  - Encrypted using pre-shared keys with blowfish
  - By default uses UDP port 1514
  - Multi-platform (Windows, Solaris, Linux, etc)

Deep into Log Analysis

- Focus now on the main process (**ossec-analysisd**)
  - ➔ *It does the log decoding and analysis*
  - ➔ *Hard worker!*
- Log **pre-decoding**
- Log **decoding**
- Log **Analysis**
- Example of alerts

Internal log flow



Log flow
(inside analysisd)

- Log flow inside analysisd
- Three main parts:
  - **Pre-decoding** (extracts known fields, like time, etc)
  - **Decoding** (using user-defined expressions)
  - **Signatures** (using user-defined rules)

Log pre-Decoding (1)

- Extracts generic information from logs
  - Hostname, program name and time from syslog header
  - Logs must be well formated
- How OSSEC does it?
  - Log comes in as:

    Apr 13 13:00:01 enigma syslogd: restart
  - How will it look like inside OSSEC?

    time/date *-> Apr 13 13:00:01*
    hostname *-> enigma*
    program_name *-> syslogd*
    log *-> restart*

Log pre-Decoding (2)

- Decoding of a SSHD message:
  - ➔ Log comes in as:

    Apr 14 17:32:06 enigma sshd[1025]: Accepted password for root from 192.168.2.190 port 1618 ssh2
  - ➔ How will it look like inside OSSEC after pre-Decoding?

    time/date *-> Apr 14 17:32:06*
    hostname *-> enigma*
    program_name *-> sshd*
    log *-> Accepted password for root from 192.168.2.190 port ...*

Log pre-Decoding (3)

- Decoding of an ASL message (Mac users):
  - Log comes in as:

```
Time 2006.12.28 15:53:55 UTC] [Facility auth] [Sender sshd] [PID 483]
[Message error: PAM: Authentication failure for username from
192.168.0.2]  [Level 3] [UID -2] [GID -2] [Host mymac]
```

  - How will it look like inside OSSEC after pre-Decoding?

time/date *-> Dec 28, 2006 15:53:55*
hostname *-> mymac*
program_name *-> sshd*
log *-> error: PAM: Authentication failure for username from 192.168.0.2*

Log Decoding (1)

- Process to identify key information from logs
  - Most of the time you don't need to worry about it
  - OSSEC comes with hundreds of decoders by default
  - Generally we want to extract source ip, user name, id ,etc
  - User-defined list (XML) at **decoders.xml**
  - Tree structure inside OSSEC

- How a log will look like after being decoded:

Apr 14 17:32:06 enigma sshd[1025]: Accepted password for root from 192.168.2.190 port 1618 ssh2

time/date *-> Apr 14 17:32:06*
hostname *-> enigma*
program_name *-> sshd*
log *-> Accepted password for root from 192.168.2.190 port ...*
srcip *-> 192.168.2.190*
user *-> root*

Writing decoders 101

- Writing a decoder. What it requires?
  - Decoders are all stored at etc/decoders.xml
  - Choose a meaningful name so they can be referenced in the rules
  - Extract any relevant information that you may use in the rules

- sshd example:
  - We want to extract the user name and source ip
  - If **program name** was **pre-**decoded as sshd (remember pre-decoding?), try this regular expression

```
<decoder name="sshd-success">
  <program_name>sshd</program_name>
  <regex>^Accepted \S+ for (\S+) from (\S+) port </regex>
  <order>user, srcip</order>
</decoder>
```

Writing decoders 102

- Decoders guidelines
  - Decoders must have either **prematch** or **program_name**
  - **regex** is used to extract the fields
  - **order** is used to specify what each field means
  - Order can be: id, srcip, dstip, srcport, dstport, url, action, status, user, location, etc
  - Offset can be: “after_prematch” or “after_parent”

- Vsftpd example:

```
Sun Jun  4 22:08:39 2006 [pid 21611] [dcid] OK LOGIN: Client "192.168.2.10"

<decoder name="vsftpd">
  <prematch>^\w\w\w \w\w\w\s+\d+ \S+ \d+ [pid \d+] </prematch>
  <regex offset="after_prematch">Client "(\d+.\d+.\d+.\d+)"$</regex>
  <order>srcip</order>
</decoder>
```

Writing decoders 103

- Grouping multiple decoders under one parent
  - Use **parent** tag to specify the parent of the decoder
  - Will create a tree structure, where the sub-decoders are only evaluated if their parent matched.

- sshd example 2:

```
<decoder name="sshd">
  <program_name>^sshd</program_name>
</decoder>

<decoder name="sshd-success">
  <parent>sshd</parent>
  <prematch>^Accepted</prematch>
  <regex offset="after_prematch">^ \S+ for (\S+) from (\S+) port </regex>
  <order>user, srcip</order>
</decoder>
```

Writing decoders 103 (2)

- sshd example 3:

```
<decoder name="sshd">
  <program_name>^sshd</program_name>
</decoder>

<decoder name="sshd-success">
  <parent>sshd</parent>
  <prematch>^Accepted</prematch>
  <regex offset="after_prematch">^ \S+ for (\S+) from (\S+) port </regex>
  <order>user, srcip</order>
</decoder>

<decoder name="ssh-failed">
  <parent>sshd</parent>
  <prematch>^Failed \S+ </prematch>
  <regex offset="after_prematch">^for (\S+) from (\S+) port </regex>
  <order>user, srcip</order>
</decoder>
```

Writing decoders 103 (3)

- Apache access log example:
  - We extract the srcip, id and url

```
192.168.2.190 - - [18/Jan/2006:13:10:06 -0500] "GET /xxx.html HTTP/1.1"
200 1732
```

```
<decoder name="web-accesslog">
  <type>web-log</type>
  <prematch>^\d+.\d+.\d+.\d+ </prematch>
  <regex>^(\d+.\d+.\d+.\d+) \S+ \S+ [\S+ \S\d+] </regex>
  <regex>"\w+ (\S+) HTTP\S+ (\d+) </regex>
  <order>srcip, url, id</order>
</decoder>
```

Log Rules (1)

- Next step after decoding is to check the rules
  - Internally stored in a tree structure
  - User-defined XML
  - Very easy to write!
  - Allows to match based on decoded information
  - OSSEC comes with more than 400 rules by default!

- Two types of rules:
  - Atomic (based on a single event)
  - Composite (based on patterns across multiple logs)

Writing your own rules 101

- Writing your first rule. What it requires?
  - A Rule id (any integer)
  - A Level - from 0 (lowest) to 15 (highest)
  - Level 0 is ignored, not alerted at all
  - Pattern - anything from “regex”, to “srcip”, “id”, “user”, etc
- First example (simple sshd rule)
  - If log was decoded as *sshd*, generate rule *“111”*

```
<rule id = "111" level = "5">
<decoded_as>sshd</decoded_as>
<description>Logging every decoded sshd message</description>
</rule>
```

Writing your own rules 102

- Second rule, for failed sshd messages
  - We will create a second rule, dependent on the first
  - Higher severity (level 7)
  - Will only be executed if the first one matches (if_sid)
  - Match is a simple pattern matching (looking for Failed pass)

```
<rule id = "111" level = "5">
  <decoded_as>sshd</decoded_as>
  <description>Logging every decoded sshd message</description>
</rule>

<rule id=”122” level=”7”>
  <if_sid>111</if_sid>
  <match>^Failed password</match>
  <description>Failed password attempt</description>
</rule>
```

Writing your own rules 103

- Third rule, for failed sshd messages on hostname “mainserver” from anywhere outside 192.168.2.0/24
  - ➔ We will create a third rule, dependent on the second
  - ➔ Will only be called if the second one matches!

```
<rule id=”122” level=”7”>
  <if_sid>111</if_sid>
  <match>^Failed password</match>
  <description>Failed password attempt</description>
</rule>

<rule id=”133” level=”13”>
  <if_sid>122</if_sid>
  <hostname>^mainserver</hostname>
  <srcip>!192.168.2.0/24</srcip>
  <description>Higher severity! Failure on the main server</description>
</rule>
```

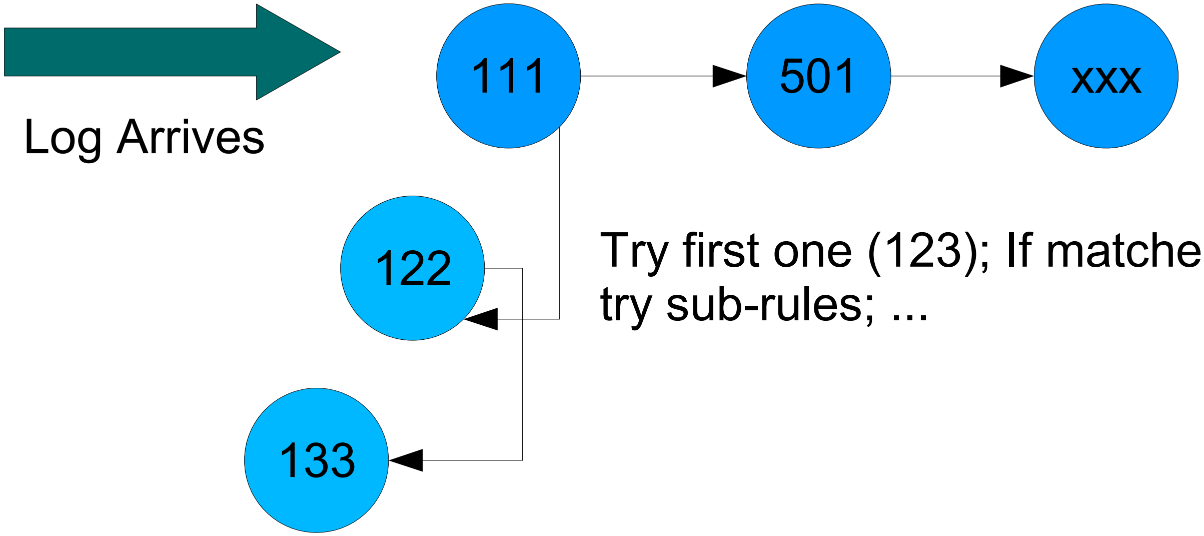
Writing your own rules 103(2)

- Rule for Apache web logs
  - We will create one generic rule for all web logs (501)
  - One sub-rule to alert on ids 4xx or 5xx (HTTP errors)
  - We use here the “id” tag, which is also set in the decoder

```
<rule id=”501” level=”3”>
  <decoded_as>web_log</decoded_as>
  <description>Generic rule for apache logs</description>
</rule>

<rule id=”502” level=”6”>
  <if_sid>501</if_sid>
  <id>^4|^5</id>
  <description>Log with id 4xx or 5xx</description>
</rule>
```

Rule structure after ...



If doesn't match, try next one ...

Try first one (123); If matches, try sub-rules; ...

- After our first five rules, this is how the internal structure would look like.
  - Not a flat format (like most log analysis tools)!
  - Very fast! Non-sshd messages are only checked against the first rule (111), not the sub ones
  - Average of only 7/8 rules per log, instead of 400 (what we have enabled by default)

Writing your own rules 103(3)

- A few more advanced rule options
  - Rule for successful sshd logins
  - Policy-based options, based on time, day of the week, etc
  - You can use groups to classify your rules better

```
<rule id = "153" level = "5">
  <if_sid>111</if_sid>
  <match>Accepted password </match>
  <description>Successful login</description>
  <group>login_ok</group>
</rule>

<rule id=”154” level=”10”>
  <if_sid>153</if_sid>
  <time>6 pm - 8:30 am</time>
  <description>Alert! Logins outside business hours!</description>
  <group>login_ok,policy_violation</group>
</rule>
```

Writing your own rules 200

- Composite rules
  - Rule for multiple failed password attempts
  - We set frequency and timeframe
  - **if_matched_sid**: If we see this rule more than X times within Y seconds.
  - **same_source_ip**: If they were decoded from same IP.

```
<rule id=”133” level=”7”>
  <if_sid>111</if_sid>
  <match>^Failed password</match>
  <description>Failed password attempt</description>
</rule>

<rule id=”1050” level=”11” frequency=”5” timeframe=”120”>
  <if_matched_sid>133</if_matched_sid>
  <same_source_ip />
  <description>Multiple failed attempts from same IP!</description>
</rule>
```

Rules in real world

- Do not modify default rules
  - They are overwritten on every upgrade
  - Use **local_rules.xml** instead (not modified during upgrade)
  - Use and abuse of if_sid, if_group (remember, classify your rules under groups), etc
  - Use an ID within the range 100000-109999 (user assigned)

- If adding support for new rules or new log formats
  - Send them to us, so we can include in ossec
  - We will assign a range ID for your rules

Rules in real world (2)

- Alerting on every authentication success outside business hours
  - Every authentication message is classified as “authentication success” (why we use if_group)
  - Add to **local_rules.xml:**

```
<rule id="100005" level="10">
    <if_group>authentication_success</if_group>
    <time>6 pm - 7:30 am</time>
    <description>Login during non-business hours.</description>
  </rule>
```

Rules in real world (3)

- Changing frequency or severity of a specific rule
  - Rule 5712 alerts on SSHD brute forces after 6 failed attempts
  - To increase the frequency, just overwrite this rule with a higher value. Same applies to severity (level).
  - You can change any value from the original rule by overwriting it
  - Add to **local_rules.xml**:

```
<rule id="5712" level="10" frequency="20" overwrite=”yes”>
   <if_matched_sid>5710</if_matched_sid>
   <description>SSHD brute force trying to get access to </description>
   <description>the system.</description>
   <group>authentication_failures,</group>
 </rule>
```

LID Examples - Squid logs

- Rule to detect internal hosts scanning the outside
  - Useful to detect worms, vulnerable systems or just malicious intent
  - Will fire if same internal system generates multiple 500/600 error codes on different URLs

```
  <rule id="35009" level="5">
    <if_sid>35002</if_sid>
    <id>^5|^6</id>
    <description>Squid 500/600 error code (server error).</description>
  </rule>
<rule id="35058" level="10" frequency="6" timeframe="240">
    <if_matched_sid>35009</if_matched_sid>
    <same_source_ip />
    <different_url />
    <description>Multiple 500/600 error codes (server error).</description>
  </rule>
```

LID Examples - Squid logs 2

- Indication of an internal compromised system:

```
OSSEC HIDS Notification.

Received From: (proxy) 10.1.2.3->/var/log/squid/access.log
Rule: 35058 fired (level 10) -> "Multiple 500/600 error codes (server error)."
Portion of the log(s):

179993 1.2.3.4 TCP_MISS/504 1430 GET http://xx.com/cgi/stats/awstats.pl - NONE/- text/html
179504 1.2.3.4 TCP_MISS/504 1410 GET http://xx.com/awstats.pl - NONE/- text/html
179493 1.2.3.4 TCP_MISS/504 1422 GET http://xx2.com/stats/awstats.pl - NONE/- text/html
179494 1.2.3.4 TCP_MISS/504 1438 GET http://xx2.com//cgi-bin/stats/awstats.pl - NONE/- text/html
179507 1.2.3.4 TCP_MISS/504 1426 GET http://xx3.com/awstats/awstats.pl - NONE/- text/html
```

LID Examples - Web logs

- Rule to detect large URLs
  - ➔ Any URL longer than 2900 characters is very suspicious

```
<rule id="31115" level="13" maxsize="2900">
  <if_sid>31100</if_sid>
  <description>URL too long. Higher than allowed on most </description>
  <description>browsers. Possible attack.</description>
  <group>invalid_access,</group>
</rule>
```

LID Examples - Web logs 2

- Indication of an attack detected
    - Now, what if you see that from an internal box?

```
OSSEC HIDS Notification.
2007 Feb 18 20:52:27

Received From: (jul) 192.168.2.0->/var/log/apache/access_log
Rule: 31115 fired (level 13) -> "URL too long. Higher than allowed on most
  browsers."
Portion of the log(s):

142.167.9.242 - - [18/Feb/2007:21:43:49 -0400] "SEARCH
  /\x90\xc9\xc9\xc9\xc9\xc9
\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\
9\xc99\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\x9
\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9
\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9\xc9...
```

LID Examples – Snort logs

- Multiple IDS events from same source IP address

```
2007 May 08 14:10:58 (jul) 192.168.2.0->/var/log/snort/alert
Rule: 20152 (level 10) -> 'Multiple IDS alerts from same IP Address.'
[**] [1:648:7] SHELLCODE x86 NOOP [**][Classification: Executable code was
  detected] [Priority: 1] 142.167.24.154:1238 -> 192.168.2.32:80
[**] [1:648:7] SHELLCODE x86 NOOP [**][Classification: Executable code was
  detected] [Priority: 1] 142.167.24.154:1238 -> 192.168.2.32:80
[**] [1:648:7] SHELLCODE x86 NOOP [**][Classification: Executable code was
  detected] [Priority: 1] 142.167.24.154:1238 -> 192.168.2.32:80
[**] [119:4:1] (http_inspect) BARE BYTE UNICODE ENCODING
  [Classification: Preprocessor]  142.167.24.154:1238 -> 192.168.2.32:80
[**] [119:15:1] (http_inspect) OVERSIZE REQUEST-URI DIRECTORY
  [**][Classification: access to a potentially vulnerable web application]
  [Priority: 2] 142.167.24.154:1238 -> 192.168.2.32:80
[**] [1:1070:9] WEB-MISC WebDAV search access Classification: access to a
  potentially vulnerable application] 142.167.24.154:1238 -> 192.168.2.32:80
```

LID Examples - Auth logs

- Brute force attempts
- Not only for SSHD, but also ftpd, imapd, webmails, etc

```
OSSEC HIDS Notification.
2007 Feb 21 05:37:59

Received From: enigma->/var/log/authlog
Rule: 5712 fired (level 10) -> "SSHD brute force trying to get access to the sys
tem."
Portion of the log(s):

Feb 21 05:37:58 enigma sshd[7235]: Failed password for invalid user admin
  from 125.152.17.236 port 42198 ssh2
Feb 21 05:37:58 enigma sshd[14507]: Invalid user admin from 125.152.17.236
Feb 21 05:37:56 enigma sshd[10566]: Failed password for invalid user admin
  from 125.152.17.236 port 42132 ssh2
Feb 21 05:37:56 enigma sshd[11502]: Invalid user admin from 125.152.17.236
```

LID Examples - Auth logs 2

- Brute force attempts followed by a success

Rule: 5720 (level 10) -> 'Multiple SSHD authentication failures.'
Src IP: 125.192.xx.xx

```
Feb 11 09:31:58 wpor sshd[4565]: Failed password for root from 125.192.xx.xx port 42976 ssh2
Feb 11 09:31:58 wpor sshd[4565]: Failed password for admin from 125.192.xx.xx port 42976 ssh2
Feb 11 09:31:58 wpor sshd[4565]: Failed password for admin from 125.192.xx.xx port 42976 ssh2
```

Rule: 40112 (level 12) -> '**Multiple authentication failures followed by a success**.'
Src IP: 125.192.67.136
User: admin

```
Feb 11 09:31:58 wpor sshd[7235]: Accepted password for admin from 125.192.xx.xx port 42198 ssh2
```

Conclusion

- OSSEC is very extensible and provides out of the box functionality
- Try it out and check for yourself! :)
- Lots of new features planned for the future

- Look at our manual and FAQ for more information: http://www.ossec.net

- For questions and support, subscribe to our mailing list or visit us at **#ossec** on freenode

QUESTIONS ?