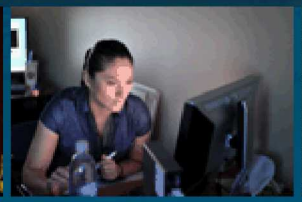
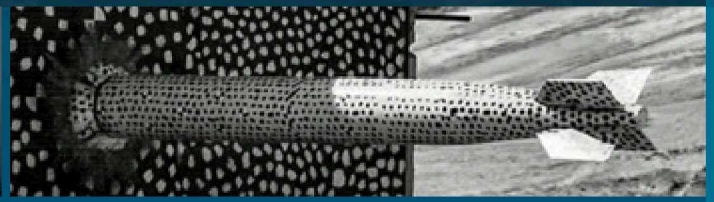
SAND2019-4749C

Laika BOSS: File-Centric Intrusion Detection System





PRESENTED BY

Wellington Lee, Cybersecurity R&D

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Overview

File-Centric IDS

Laika BOSS

Examples

Why Laika BOSS?

Installation

Laika BOSS Development

File-Centric IDS

IDS that analyzes files (objects transferred through network)

- Scan
  - (yara, xor-search, pdfrate, etc)
- Decode
  - (zip, MIME, OLE, etc)
- Metadata
  - (document author, PE section name, image size, etc)

Benefits

- Address attacks visible in network payloads vs. network protocols
- Consistency/re-use of content (mail, web, bulk malware, analyst driven)
- Ease of detection content creation/deployment

Network IDS vs File IDS

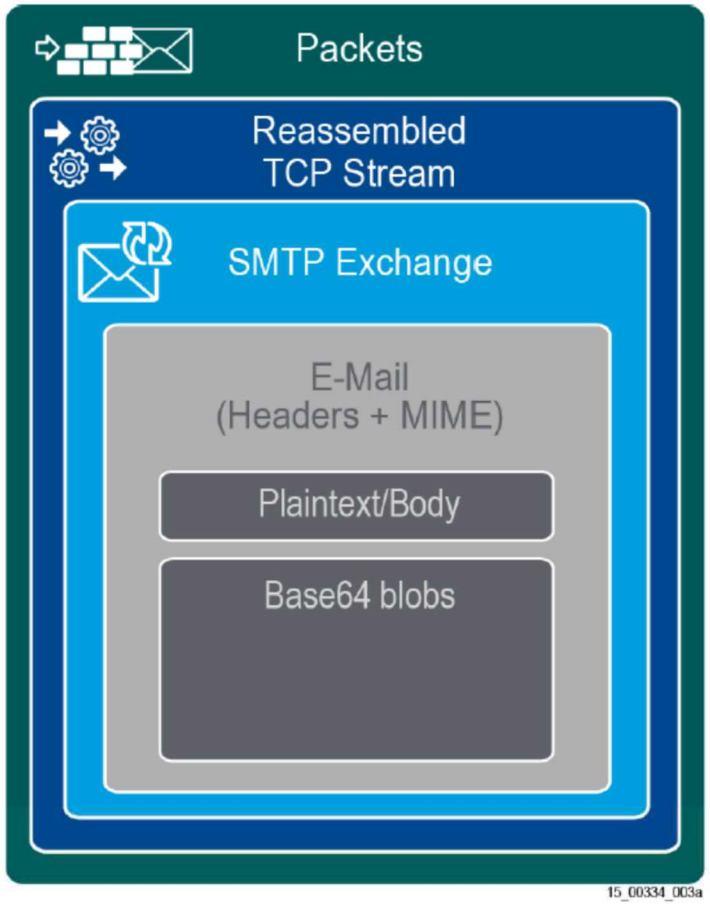


Figure 3: Traditional NIDS view of a malicious email with payload hidden through encoding

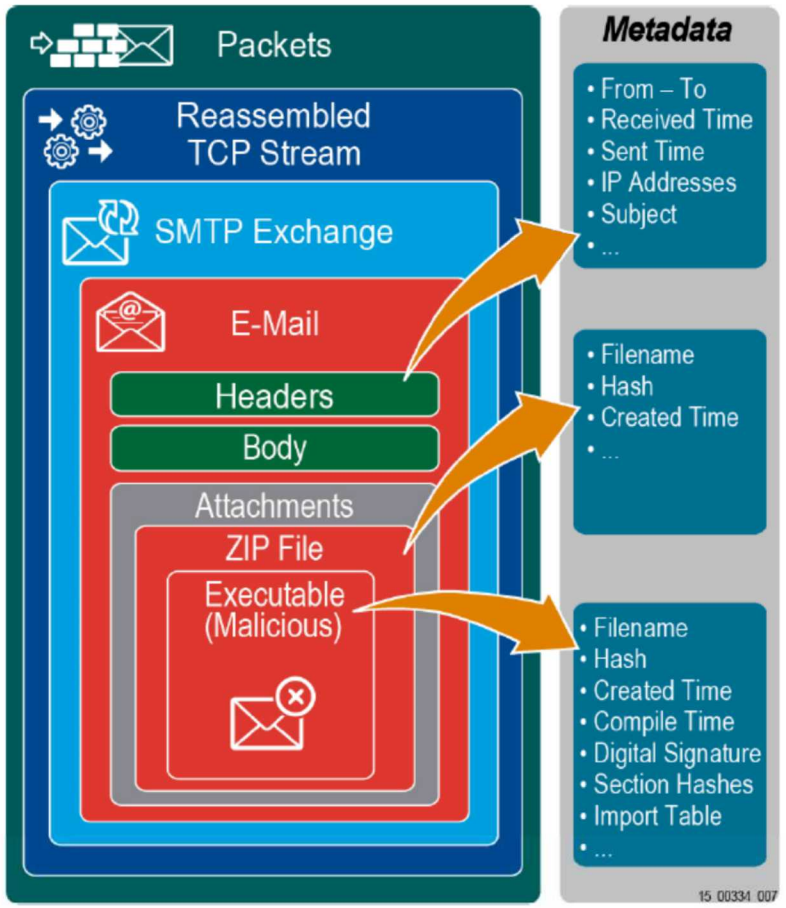


Figure 4: Laika IDS view of an exploded email, showing a malicious executable contained within a ZIP file and extracted metadata

Credit: Lockheed Martin Laika BOSS whitepaper

Laika BOSS Overview

File Centric IDS

Designed for email, web, bulk file, and analyst directed scanning

Modules for each file analyzer

Implemented in Python

Relies heavily on Yara for signature matching, configuration

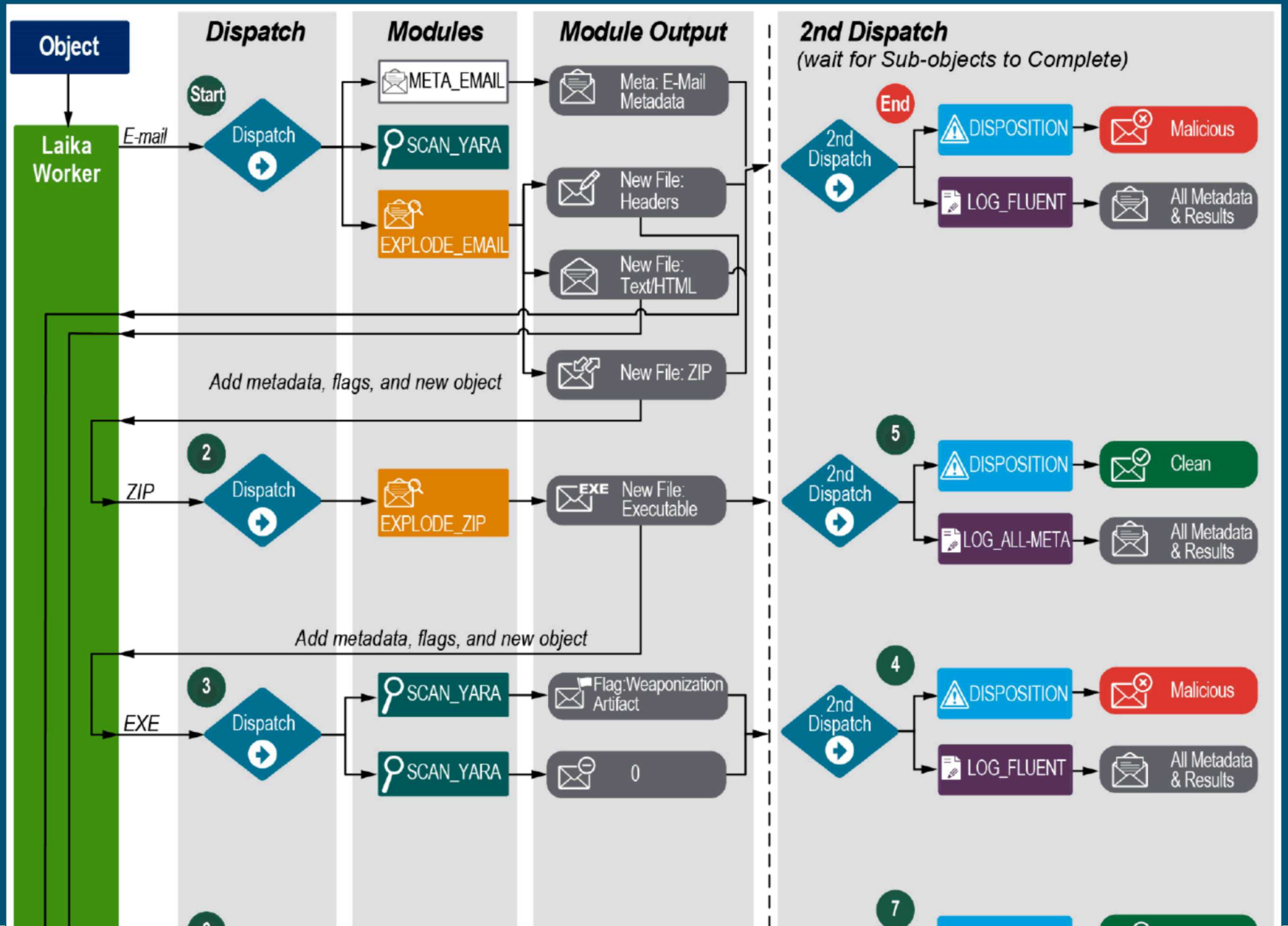
Highly Scalable

Inline (Blocking Mode) Capable

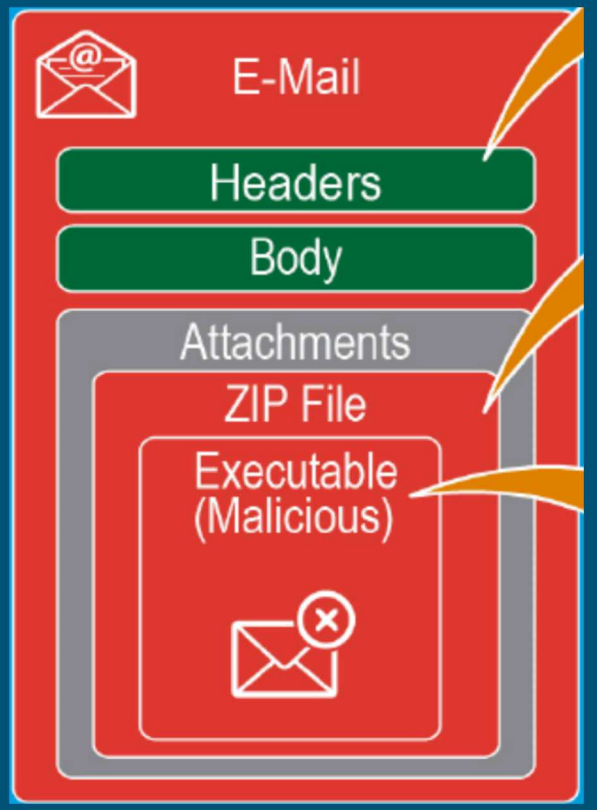
Strong Configurability, Great Transparency, Good Enough Performance

Open Source by Lockheed Martin

Laika BOSS Recursive Scanning

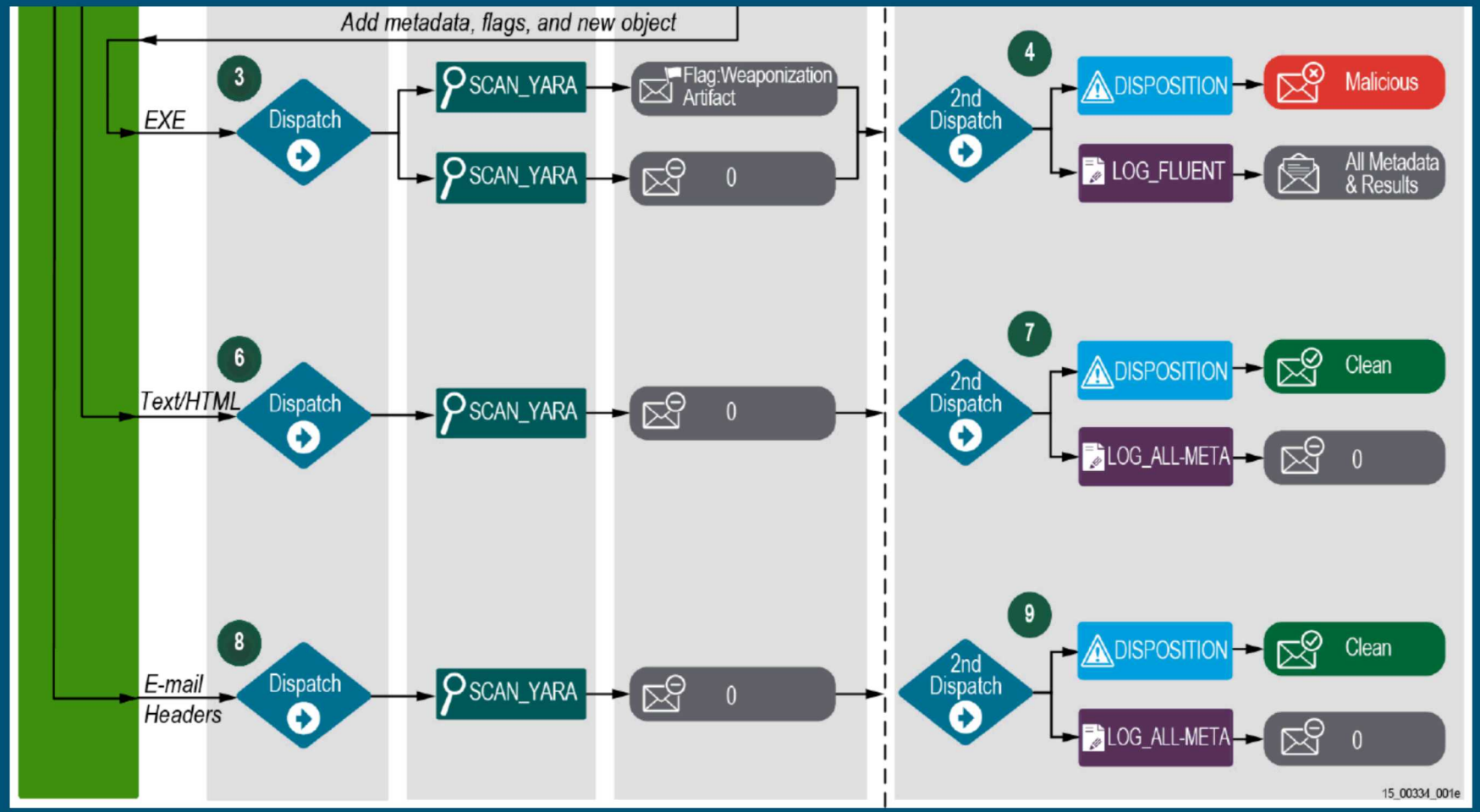


Malicious PE in Zip as Email Attachment

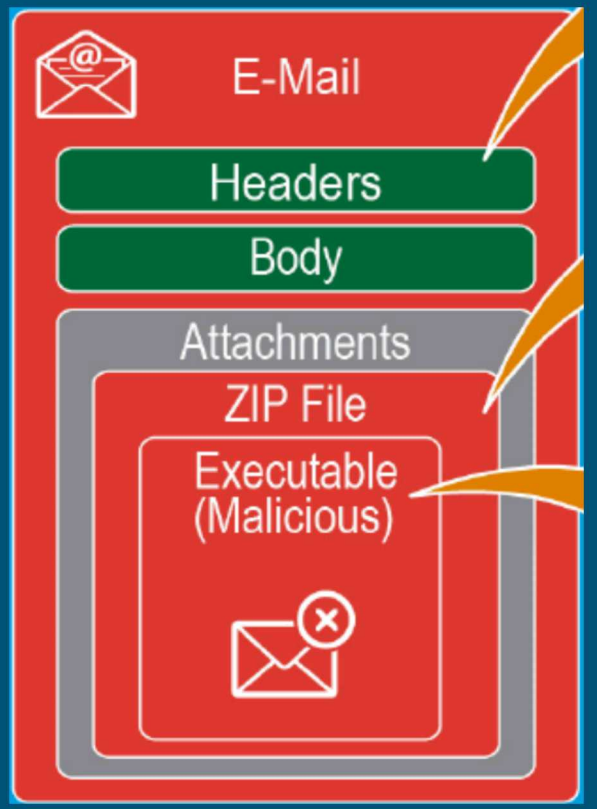


Credit: Lockheed Martin Laika BOSS whitepaper

Laika BOSS Recursive Scanning (cont.)

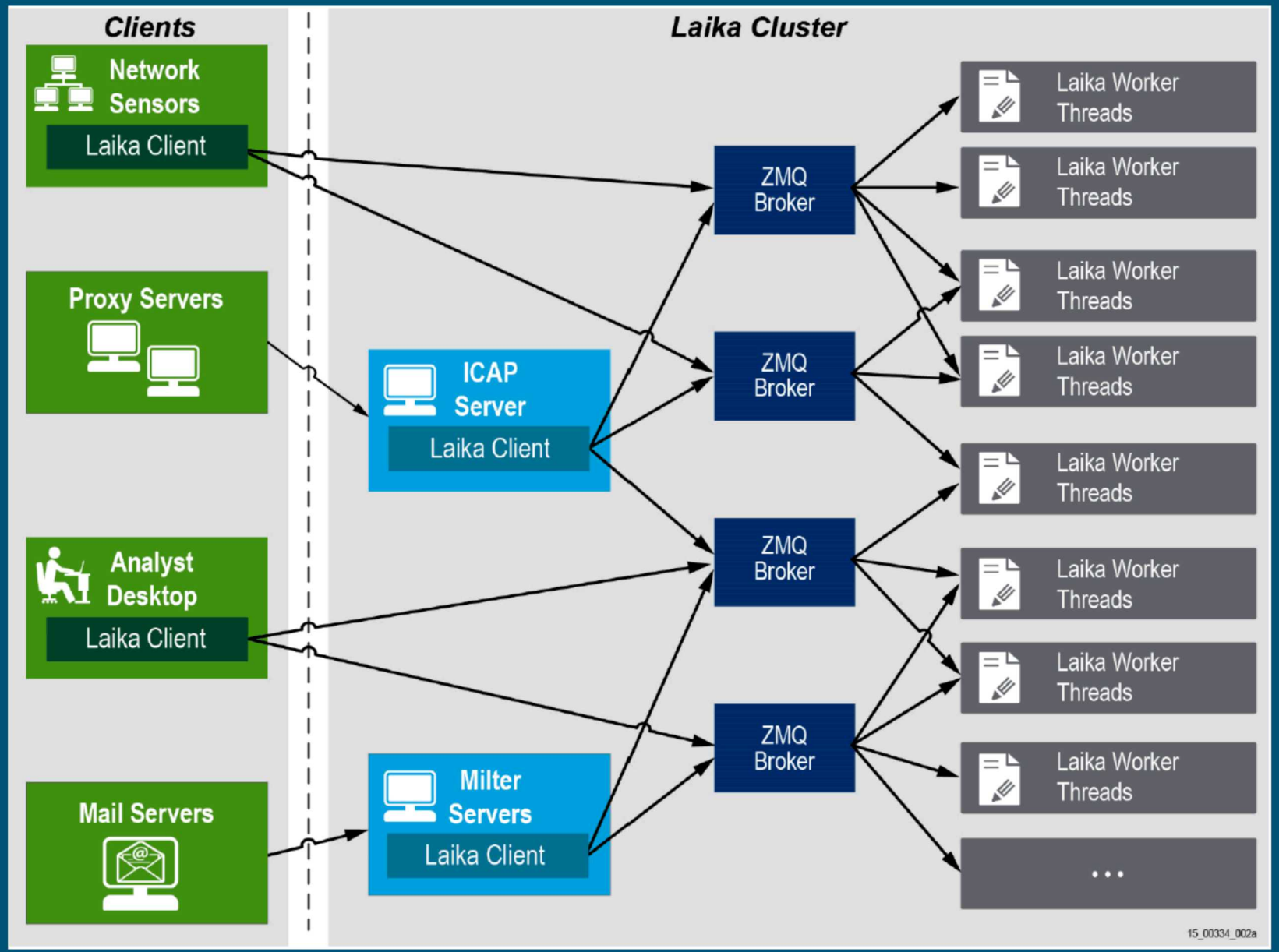


Malicious PE in Zip as Email Attachment



Credit: Lockheed Martin Laika BOSS whitepaper

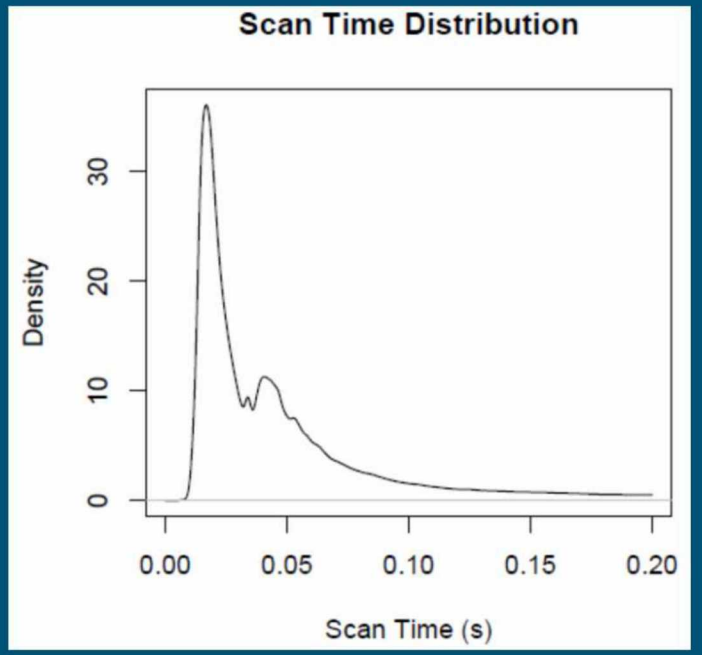
Laika BOSS Scalability, Versatility, Performance



Example Enterprise Deployment

16 servers x
24 cores / server

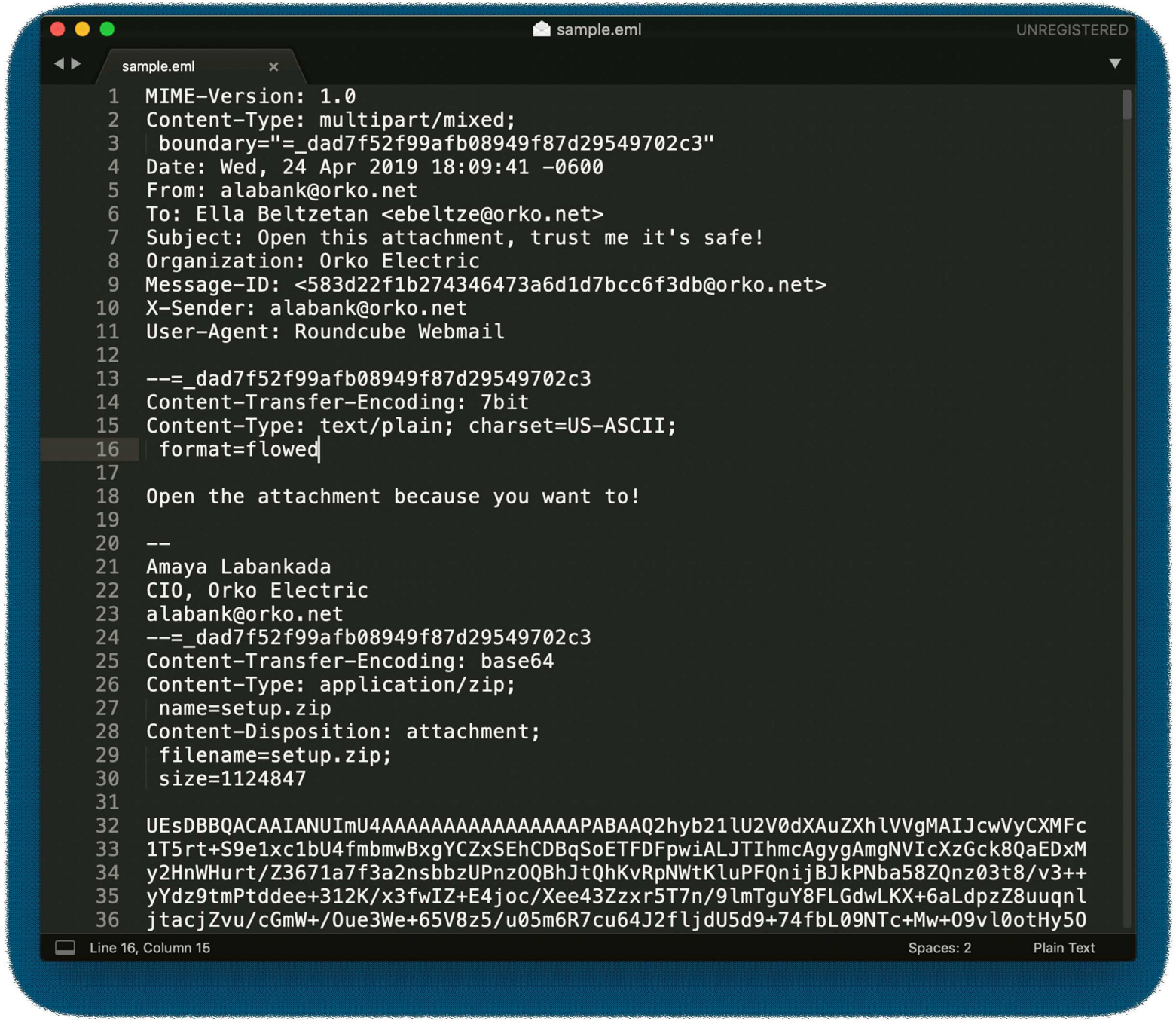
384 scanning cores



Credit: Lockheed Martin Laika BOSS whitepaper

Zip with Exe

Email -> Zip -> Exe



Relevant Modules

META_EMAIL:

- Metadata on email

```
"META_EMAIL": {
        "Attachments": [
          "setup.zip"
        ]
      },
```

EXPLODE_EMAIL:

- Extract out parts and attachments of email

EXPLODE_ZIP:

- Extract files from zip archives

```
"EXPLODE_ZIP": {
        "Total_Files": 3,
        "Unzipped": 3
      },
```

Relevant Modules (cont.)

META_PE:

- Extract metadata from PE files


```
"META_PE": {
        "Subsystem": "IMAGE_SUBSYSTEM_WINDOWS_GUI",
        "Image Characteristics": [
          "IMAGE_FILE_32BIT_MACHINE",
          "IMAGE_FILE_EXECUTABLE_IMAGE"
        ],
        "Timestamp": 1552947293,
        "Stack Commit Size": 4096,
        "ImageBase": "0x400000",
        "Heap Commit Size": 4096,
        "Heap Reserve Size": 1048576,
        "Machine Type": {
          "Type": "IMAGE_FILE_MACHINE_I386",
          "Id": 332
        },
        "Rich Header": {
          "Checksum": 652346176,
          "Hashes": {
            "SHA1": "4ebbf2e70992243e0fad5a10eb5dd74afa790e10",
            "SHA256": "77079f70f0a4b3326a7f3f8ded4d73587512cfc63739d6e10f98dbe81bcbd4bc",
```

```
rule type_is_email
{
    meta:
        scan_modules = "META_EMAIL EXPLODE_EMAIL"
        file_type = "eml"
    strings:
        $from = "From "
        $received = "\x0aReceived:"
        $return = "\x0aReturn-Path:"
    condition:
        (not ext_sourceModule contains "EXPLODE_EMAIL") and
        (($from at 0) or
         ($received in (0 .. 2048)) or
         ($return   in (0 .. 2048)))
}
```

```
rule type_is_zip
{
    meta:
        scan_modules = "EXPLODE_ZIP(filelimit=1000)"
        file_type = "zip"
    condition:
        uint32(0) == 0x04034b50 and not uint32(4) == 0x00060014
}
```

```
rule type_is_mz
{
    meta:
        scan_modules = "META_PE"
        file_type = "pe"
    condition:
        uint16(0) == 0x5a4d
        and not ext_sourceModule contains "META_PE"
}
```

Why Laika BOSS?

Community Platform/Sharing Vision

- Community development, support of core framework
- Modules can be shared at all levels

Weaknesses

- Python 2
- Often not pythonic (ex. test cases)
- Submissions API, queueing, logging, etc. could be more modular

Alternatives

- stoQ https://stoq.punchcyber.com/
- Strelka https://github.com/target/strelka
- File Scanning Framework (FSF) https://github.com/EmersonElectricCo/fsf

Installation

https://github.com/lmco/laikaboss#getting-started

Install dependencies (depends slightly on Linux version)

Download and use Laika BOSS

Module Development

Modules have 3 primary actions

- Extract Metadata (META_*)
- Decode subfiles (EXPLODE_*)
- Flag (~alert) conditions (SCAN_*)

Secondary Actions

- Format/Log/Store data (LOG_*, STORE_*)
- Correlations/Lookups (LOOKUP_*)

laikaboss/meta_hash.py at maste

GitHub, Inc. [US] | https://github.com/lmco/laikaboss/blob/master/laikaboss/modules/meta_hash.py

```
# You may obtain a copy of the License at
#
#     http://www.apache.org/licenses/LICENSE-2.0
#
# Unless required by applicable law or agreed to in writing, software
# distributed under the License is distributed on an "AS IS" BASIS,
# WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
# See the License for the specific language governing permissions and
# limitations under the License.
#
from laikaboss.si_module import SI_MODULE
import ssdeep
import hashlib

class META_HASH(SI_MODULE):
    def __init__(self,):
        self.module_name = "META_HASH"
    def _run(self, scanObject, result, depth, args):
        moduleResult = []
        metaDict = {}
        metaDict['md5']    = hashlib.md5(scanObject.buffer).hexdigest()
        metaDict['SHA1']   = hashlib.sha1(scanObject.buffer).hexdigest()
        #metaDict['SHA224'] = hashlib.sha224(scanObject.buffer).hexdigest()
        metaDict['SHA256'] = hashlib.sha256(scanObject.buffer).hexdigest()
        #metaDict['SHA384'] = hashlib.sha384(scanObject.buffer).hexdigest()
        metaDict['SHA512'] = hashlib.sha512(scanObject.buffer).hexdigest()
        metaDict['ssdeep'] = ssdeep.hash(scanObject.buffer)

        scanObject.addMetadata(self.module_name, "HASHES", metaDict)

        return moduleResult
```

laikaboss/decode_base64.py at m

GitHub, Inc. [US] | https://github.com/lmco/laikaboss/blob/master/laikaboss/modules/decode_base64.py

30 lines (28 sloc) | 1.13 KB

Raw Blame History

```
1  # Copyright 2015 Lockheed Martin Corporation
2  #
3  # Licensed under the Apache License, Version 2.0 (the "License");
4  # you may not use this file except in compliance with the License.
5  # You may obtain a copy of the License at
6  #
7  #     http://www.apache.org/licenses/LICENSE-2.0
8  #
9  # Unless required by applicable law or agreed to in writing, software
10 # distributed under the License is distributed on an "AS IS" BASIS,
11 # WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied.
12 # See the License for the specific language governing permissions and
13 # limitations under the License.
14 #
15 import base64
16 from laikaboss.objectmodel import ModuleObject, ExternalVars
17 from laikaboss.si_module import SI_MODULE
18
19 class DECODE_BASE64(SI_MODULE):
20     def __init__(self,):
21         self.module_name = "DECODE_BASE64"
22     def _run(self, scanObject, result, depth, args):
23         moduleResult = []
24         try:
25             decoded = base64.b64decode(scanObject.buffer)
26             moduleResult.append(ModuleObject(buffer=decoded, externalVars=ExternalVars(filename="d_base64_%s" % len(decoded))))
27             return moduleResult
28         except:
29             raise
```

laikaboss/scan_clamav.py at mast

GitHub, Inc. [US] | https://github.com/lmco/laikaboss/blob/master/laikaboss/modules/scan_clamav.py

```
51          moduleResult = []
52
53          unix_socket = str(get_option(args, 'unixsocket', 'scanclamavunixsocket', '/var/run/clamav/clamd.ctl'))
54          max_bytes = int(get_option(args, 'maxbytes', 'scanclamavmaxbytes', 20000000))
55
56          # Connect to daemon
57          if not self.clam:
58              try:
59                  self.clam = pyclamd.ClamdUnixSocket(filename=unix_socket)
60              except IOError:
61                  logging.debug('IOError: Cannot connect to clamd unix socket file')
62                  scanObject.addMetadata(self.module_name, 'Error', 'IOError: clamd socket')
63                  raise
64
65          try:
66              # Scan the buffer with clamav
67              if max_bytes <= 0:
68                  clam_result = self.clam.scan_stream(scanObject.buffer)
69              else:
70                  clam_result = self.clam.scan_stream(str(buffer(scanObject.buffer, 0, max_bytes)))
71
72              # Process a result
73              if clam_result:
74                  status, virusname = clam_result['stream']
75                  scanObject.addFlag("%s:%s" % (self.flag_prefix, str(virusname)))
76          except ValueError as e:
77              scanObject.addMetadata(self.module_name, 'Error', 'ValueError (BufferTooLong): %s' % str(e))
78          except IOError as e:
79              scanObject.addMetadata(self.module_name, 'Error', 'IOError (ScanError): %s' % str(e))
80
81          return moduleResult
```

Dispatching

Use Yara signatures to determine which modules to run on a given (sub)file

Include some metadata to increase flexibility

Primary Dispatch (dispatch.yara)

- Runs on files
- Most signatures based on file magic number

Secondary Dispatch (conditional-dispatch.yara)

- Runs on concatenation of flags (allows running modules based on detections)
- Most signatures based on metadata or flags

laikaboss/dispatch.yara at master

GitHub, Inc. [US] | https://github.com/lmco/laikaboss/blob/master/etc/framework/dispatch.yara

```
109
110 /*-------------------------PE File Grouping-------------------------------*/
111 rule type_is_mz
112 {
113     meta:
114         scan_modules = "META_PE"
115         file_type = "pe"
116     condition:
117         uint16(0) == 0x5a4d
118         and not ext_sourceModule contains "META_PE"
119 }
120 /*______________________________________________________________________*/
121
122 /*--------------------------Archive Grouping-------------------------------*/
123 rule type_is_zip
124 {
125     meta:
126         scan_modules = "EXPLODE_ZIP(filelimit=1000)"
127         file_type = "zip"
128     condition:
129         uint32(0) == 0x04034b50 and not uint32(4) == 0x00060014
130 }
131
132 rule type_is_rar
133 {
134     meta:
135         scan_modules = "EXPLODE_RAR(filelimit=1000)"
136         file_type = "rar"
137     strings:
138         $a = { 52 61 72 21 1A 07 00 }
139     condition:
140         $a at 0
141 }
142
143 rule type_is_cab
```

Flags

Concise tags indicative of specific conditions

Should be related to potential maliciousness, often loosely

- But not necessarily high fidelity
- Sometimes closely tied to scanning errors, etc.

Examples

- yr:backdoor_abc
- pdf:url
- rar:BYTE_LIMITED_EXCEEDED
- pdf:PDFNotImplementedError
- x509:nfo:self_signed_cert

Flags

Middle ground between metadata and binary alert

Allows for abstraction of conditions and actions

- Module/Signature authors focus on identifying relevant conditions
  - Not required to know and maintain alert/block worthiness

Special roles in LB:

- Provided as an input for conditional dispatching
- Use by Dispositioner to determine disposition (action: alert or block)

Dispositioner

Module used to convert flags into end action (alert or block)

- Only flags, not metadata generally or file content

Configured using yara

- yara runs on space separated list of flag rollup (all flags from children objects)

Supports arbitrary outcomes

- Recommend one alert level per alerting class
- “Deny” used by clients (milter) to block content

laikaboss/disposition.yara at mas

GitHub, Inc. [US] | https://github.com/lmco/laikaboss/blob/master/etc/modules/disposition.yara

31 lines (26 sloc) | 724 Bytes

```
/*

* Overview
    * This file is used by the DISPOSITIONER module to determine the outcome of a
      scan. It takes all of the flags from the current object as well as any
      descendent objects and combines them into a space separated list. The rules
      in this file run against that list.
*/

rule Deny
{
    strings:
        $backdoor_family_1 = "backdoor_family_1"
        $exploit_CVE_2015_1337 = "exploit_CVE_2015_1337"
        $info_1 = "informational_sig_1"
        $susp_1 = "suspicious_sig_1"
    condition:
        any of ( $backdoor_* ) or
        any of ( $exploit_* ) or
        ($info_1 and $susp_1)

}

rule Alert
{
    strings:
        $susp_1 = "suspicious_sig_1"
    condition:
        $susp_1
}
```

Questions?

wklee@sandia.gov