Suricata Performance with a S like Security

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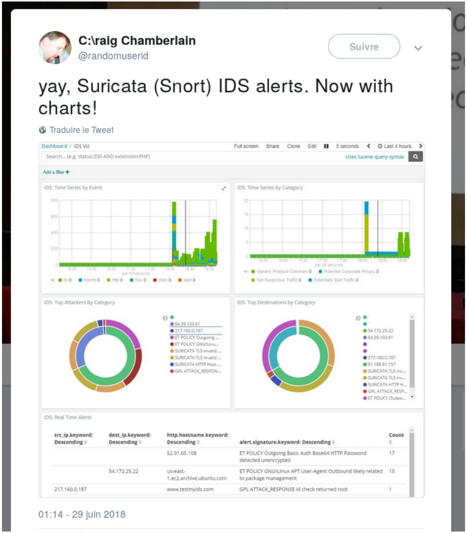
Stamus Networks

July. 03, 2018

What it is not ?



https://twitter.com/randomuserid/status/1012474246503845888

A signature based IDS

From individual traffic to detection

- Get packet per packet
- Reconstruct to application layer
- Run detection engine

Identity

- GPLv2
- owned by OISF (non for profit foundation)
- Scalability via multithreading
- Written in C and Rust

Example signature

```
alert http $EXTERNAL_NET any  -> $HOME_NET any (msg:"ET CURRENT_EVENTS [PTsecurity] Gran
dsoft EK Payload"; flow:established,to_client; content:"200"; http_stat_code; content:"|
96 08 FA EC DE C0 22 84 66 58 4A BC 2E|"; http_server_body; fast_pattern; metadata: form
er_category CURRENT_EVENTS; reference:url,www.malware-traffic-analysis.net/2018/03/15/in
dex3.html; classtype:trojan-activity; sid:2025437; rev:2; metadata:affected_product Wind
ows_XP_Vista_7_8_10_Server_32_64_Bit, attack_target Client_Endpoint, deployment Perimete
r, signature_severity Major, created_at 2018_03_21, malware_family GrandSoft_EK, updated
_at 2018_03_21;)
```

Suricata (Bro) NSM features

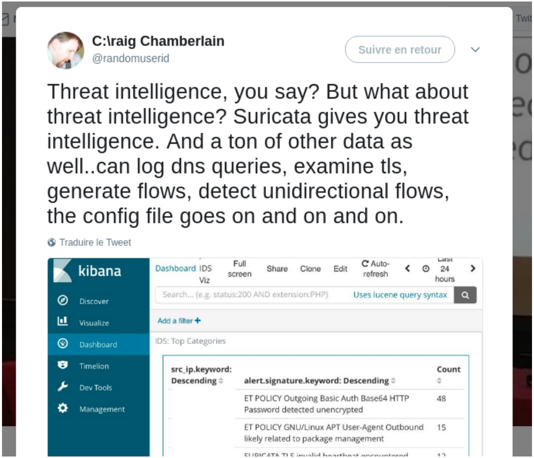
Supported protocols

- Protocol analysis: http, ftp, smtp, tls, ssh smb, dcerpc, dns, nfs, ntp, ftp-data, tftp, ikev2, krb5, dhcp
- Protocol recognition: imap, msn

Log example


```
  "timestamp": "2018-06-30T10:07:40.738055+0200",
  "flow_id": 210480145384532,
  "in_iface": "wlp3s0",
  "event_type": "tls",
  "src_ip": "[illegible]",
  "src_port": 57784,
  "dest_ip": "2607:5300:0060:5958:0000:0000:0000:0000",
  "dest_port": 443,
  "proto": "TCP",
  "tls": {
    "subject": "CN=www.stamus-networks.com",
    "issuerdn": "C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3",
    "serial": "03:84:4B:EA:4A:17:3D:45:30:74:5B:8C:DD:5A:4B:CC:0C:0C",
    "fingerprint": "4c:84:61:7c:2b:74:2a:c6:5e:47:af:57:02:d4:9e:25:3a:67:ce:b8",
    "sni": "www.stamus-networks.com",
    "version": "TLS 1.2",
    "notbefore": "2018-05-16T09:43:01",
    "notafter": "2018-08-14T09:43:01",
    "ja3": {
      "hash": "a2d9e37641f5ba558913675a08401356",
      "string": "771,49196-49287-52393-49325-49162-49188-49267-49195-49286-49324-49161-49187-49266-49160-49200-49291-52392-49172-49192-492
71-49199-49290-49171-49191-49270-49170-157-49275-49309-53-61-132-192-156-49274-49308-47-60-65-186-10-159-49277-52394-49311-57-107-136-196-
158-49276-49310-51-103-69-190-22,5-0-65281-35-10-11-13-21,23-24-25-21-19,0"
    }
  }
```

What it is ? or how to please developers



https://twitter.com/randomuserid/status/1012705279098490880

File related features

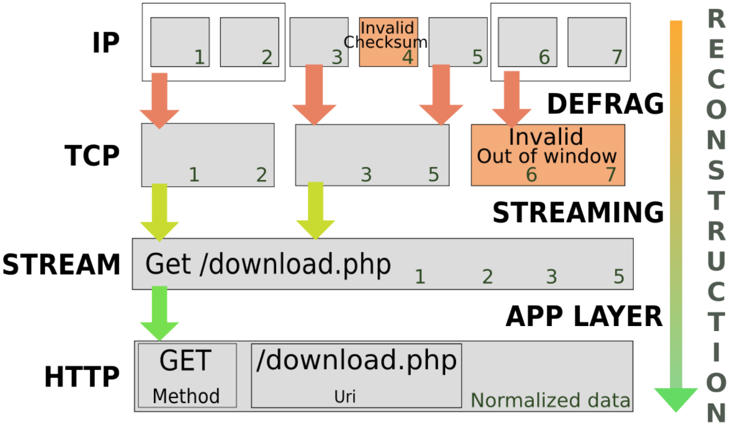
File analysis

- Magic computation and in file data match
- Checksum computation and file extraction to disk
- Supported protocols: http, smtp, smb, ftp, nfs

Fileinfo example


```
"proto": "TCP",
"http": {
  "hostname": "vcrvcr.3322.org",
  "url": "/ww/aa24.exe",
  "http_user_agent": "MyIE/1.0",
  "http_content_type": "application/octet-stream",
  "http_method": "GET",
  "protocol": "HTTP/1.1",
  "status": 200,
  "length": 24592
},
"app_proto": "http",
"fileinfo": {
  "filename": "/ww/aa24.exe",
  "magic": "PE32 executable (GUI) Intel 80386, for MS Windows, UPX compressed",
  "gaps": false,
  "state": "CLOSED",
  "sha1": "d7c8ff3971d256bede2a3ab97d72bcf7072f6fb6",
  "stored": false,
  "size": 24592,
  "tx_id": 23
}
```

Suricata reconstruction and normalization



Impact of loosing packets

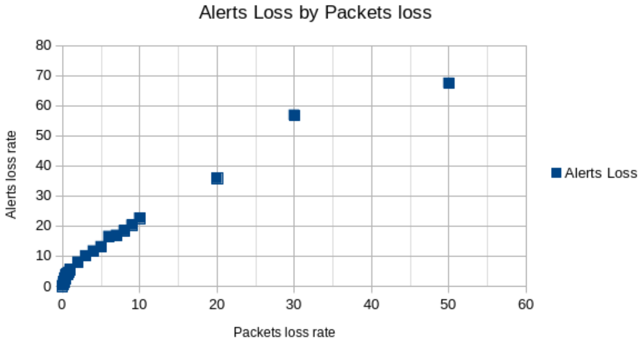
Methodology

- Use a sample traffic
- Modify the pcap file to have specified random packet loss
- Do it 3 times par packet loss
- Get graph out of that

Test data

- Using a test pcap of 445Mo.
- Real traffic but lot of malicious behaviors
- Traffic is a bit old

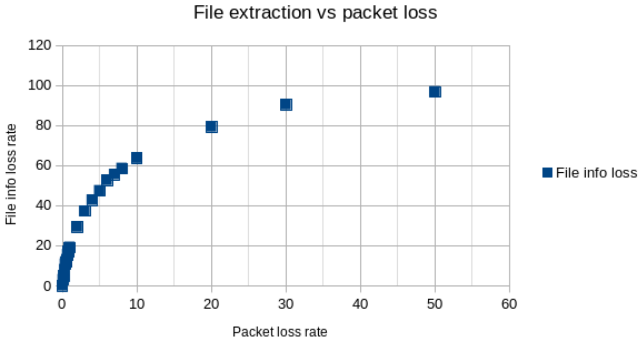
Alert loss by packet loss



Some numbers

- 10% missed alerts with 3% packets loss
- 50% missed alerts with 25% packets loss

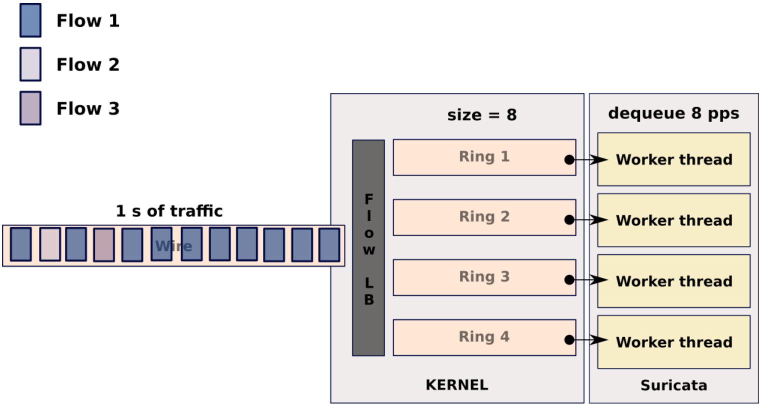
The case of file extraction



Some numbers

- 10% failed file extraction with 0.4% packets loss
- 50% failed file extraction with 5.5% packets loss

The elephant flow problem (1/2)



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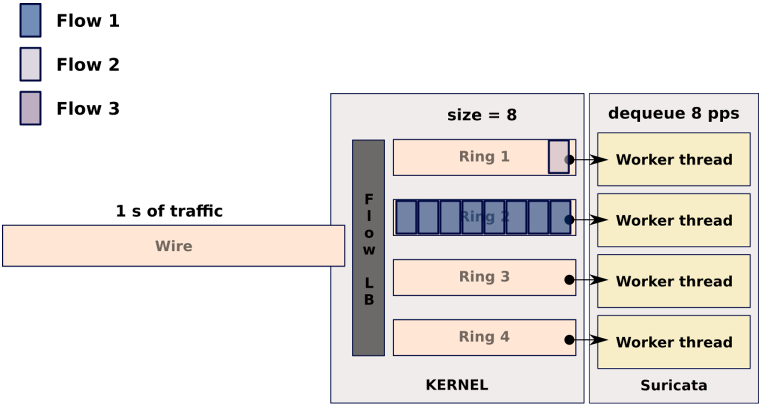

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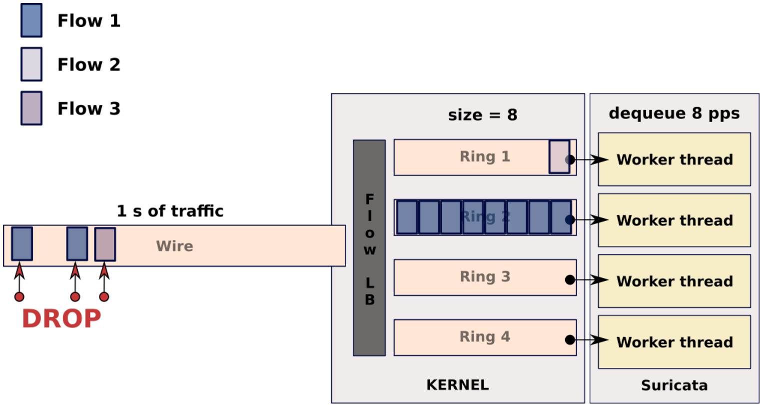


The elephant flow problem (2/2)

Ring buffer overrun

- Limited sized ring buffer
- Overrun cause packets loss
- that cause streaming malfunction

Ring size increase

- Work around
- Use memory
- Fail for non burst
  - Dequeue at N
  - Queue at speed N+M

Stream depth method

Attacks characteristic

- In most cases attack is done at start of TCP session
- Generation of requests prior to attack is not common
- Multiple requests are often not even possible on same TCP session

Stream reassembly depth

- Reassembly is done till `stream.reassembly.depth` bytes.
- Stream is not analyzed once limit is reached
- Individual packet continue to be inspected

Introducing bypass

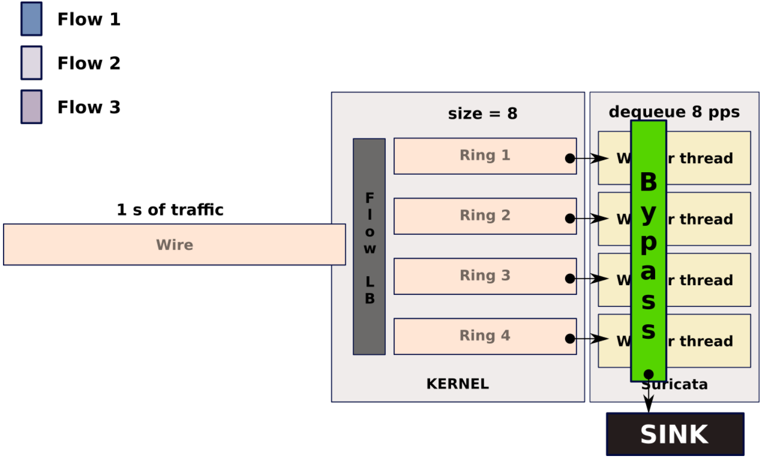
Stop packet handling as soon as possible

- Tag flow as bypassed
- Maintain table of bypassed flows
- Discard packet if part of a bypassed flow

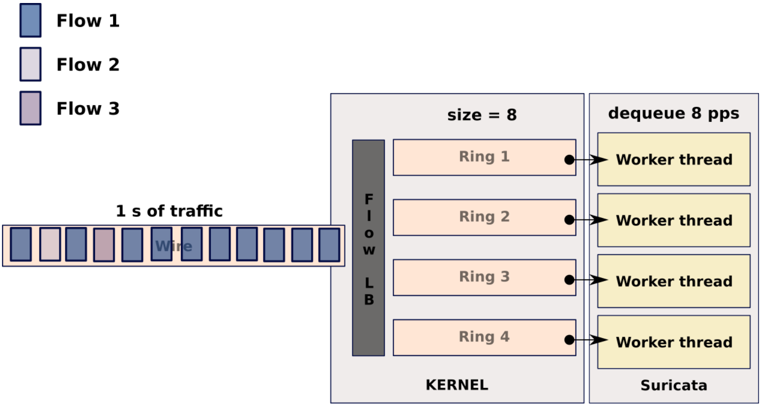
Bypass method

- Local bypass: Suricata discard packet after decoding
- Capture bypass: capture method maintain flow table and discard packets of bypassed flows

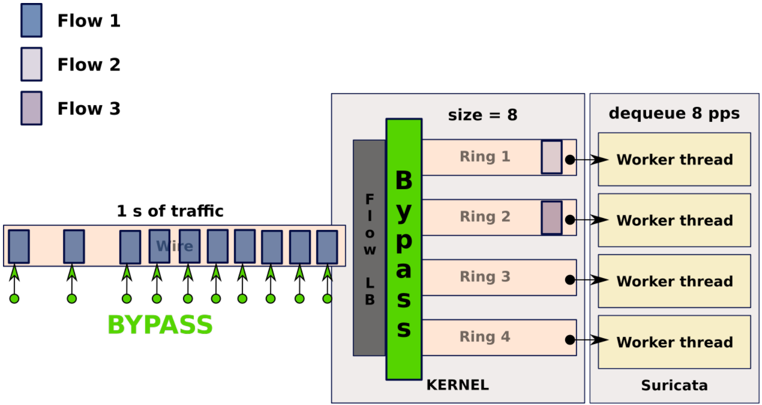
Bypassing big flow: local bypass



Bypassing big flow: capture bypass



Bypassing big flow: capture bypass



Implementation

Suricata update

- Add callback function
- Capture method register itself and provide a callback
- Suricata calls callback when it wants to offload

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NFQ bypass in Suricata 3.2

- Update capture register function
- Written callback function
  - Set a mark with respect to a mask on packet
  - Mark is set on packet when issuing the verdict

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Stream depth bypass

Stop all treatment after bypass

- Go beyond what is currently done
- Disable individual packet treatment once stream depth is reached

Activating stream depth bypass

- Set `stream.bypass` to yes in YAML

TLS bypass

- `encrypt-handling: bypass`

Selective bypass

Ignore some traffic

- Ignore intensive traffic like Netflix
- Can be done independently of stream depth
- Can be done using generic or custom signatures

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The bypass keyword

- A new `bypass` signature keyword
- Trigger bypass when signature match
- Example of signature

```
pass http any any -> any any (content:"suricata.io"; \\
          http_host; bypass; sid:6666; rev:1;)
```

Extended Berkeley Packet Filter

Berkeley Packet Filter

- Virtual machine inside kernel
- Arithmetic operations and tests on the packet data
- Filters are injected by userspace in kernel via syscall

Extended BPF

- Extended virtual machine: more operators, data and function access
- Various attachment points
  - Socket
  - Syscall
  - Traffic control
- Kernel and userspace shared structures
  - Hash tables
  - Arrays

LLVM backend

From C file to eBPF code

- Write C code
- Use eBPF LLVM backend (since LLVM 3.7)
- Use libbpf
  - Get ELF file
  - Extract and load section in kernel

BCC: BPF Compiler collection

- Inject eBPF into kernel from high level scripting language
- Trace syscalls and kernel functions
- `https://github.com/iovisor/bcc`

And now AF_PACKET

What's needed

- Suricata to tell kernel to ignore flows
- Kernel system able to
  - Maintain a list of flow entries
  - Discard packets belonging to flows in the list
  - Update from userspace

And now AF_PACKET

What's needed

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eBPF filter using maps

- eBPF introduce maps
- Different data structures
  - Hash, array, ...
  - Update and fetch from userspace
- Looks good!

Test methodology

Test setup

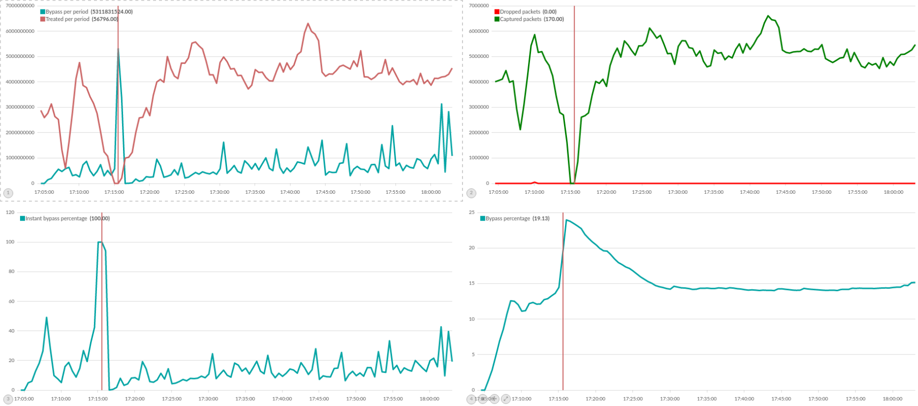
- Intel(R) Xeon(R) CPU E5-2680 0 @ 2.70GHz
- Intel Corporation 82599ES 10-Gigabit SFI/SFP+
- Live traffic:
  - Around 1Gbps to 2Gbps
  - Real users so not reproducible

Tests

- One hour long run
- Different stream depth values
- Collected Suricata statistics counters (JSON export)
- Graphs done via Timelion (`https://www.elastic.co/blog/timelion-timeline`)

NETWORKS

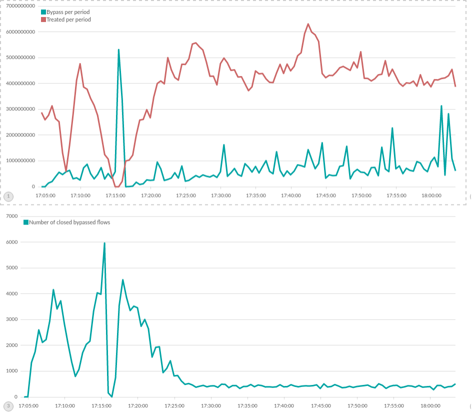
Results: stream bypass at 512kb



A few words on graphics

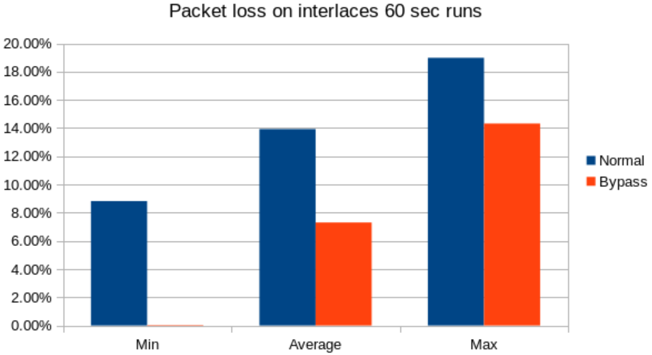
Tests at 512kb

- We have on big flow that kill the bandwidth
- Capture get almost null
- Even number of closed bypassed flows is low



STAMUS NETWORKS

Results


Packet loss on interlaces 60 sec runs
20.00%
18.00%
16.00%
14.00%
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
Min
Average
Max
Normal
Bypass

A Linux kernel feature

Run a eBPF code the earliest possible

- in the driver
- in the card
- before the regular kernel path

Act on data

- Drop packet (eXtreme Drop Performance)
- Transmit to kernel
- Rewrite and transmit packet to kernel
- Redirect to another interface
- CPU load balance

Implementation

Similar to eBPF filter

- Same logic for bypass
- Only verdict logic is different

But annoying difference

- eBPF code does the parsing
- Need to bind to an interface

Results

TODO: Ask OISF marketing for some fake numbers to show

Conclusion

Suricata, eBPF and XDP

- A fresh but interesting method
- Network card bypass for Netronome coming
- AF_XDP capture is now in Linux vanilla

More information

- Stamus Networks: `https://www.stamus-networks.com/`
- Septun II: `https://github.com/pevma/SEPTun-Mark-II/`
- Suricata doc: `http://suricata.readthedocs.io/en/latest/capture-hardware/ebpf-xdp.html`

Questions ?

Thanks to

- Jesper Dangaard Brouer
- Alexei Storovoitov
- Daniel Borkmann

Contact me

- el@stamus-networks.com
- Twitter: @regiteric

Want more fun ?

- Come to Suricata and SELKS workshop !
- Suricon: `https://suricon.net/`