



# Finding a Needle in a PCAP

Flocon 2015

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# Goal

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Describe a full packet capture solution that can quickly and efficiently produce requested information.

Show analysis capabilities of YAF, super\_mediator, and SiLK.

Demonstrate PCAP features in YAF.

# PCAP Challenges

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## Volume (4Gbps):

- 1 Hour: 1.7TB
- 1 Day: 40.8TB
- 1 Week: 285.6TB
- 1 Month: 1.1PB

## Data Stored on Sensors

- Separate from analysis

## Indexing:

- Timestamp Files
- BPF Filters
- GUI tools
- Splunk



jolyon.co.uk

# YAF PCAP Features

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## Rolling PCAP dump

- Rotates files using time or size.
- Creates meta file with flows contained in each PCAP file.

## Index a PCAP File

- Uses flow key hash and start time.

## PCAP per flow

- Creates a PCAP file for each flow.
- Use with BPF filters.



# Gh0st Rat Investigation

# Gh0st

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Remote Access Trojan

Free source code

Easy to modify

Distinctive Network Signature



Signature <i>Usually 5</i> BYTES	Compressed Length 4 BYTES	Uncompressed Length 4 BYTES	ZLIBHDR 0x789C 2 BYTES	Data
--	---------------------------------	-----------------------------------	------------------------------	------

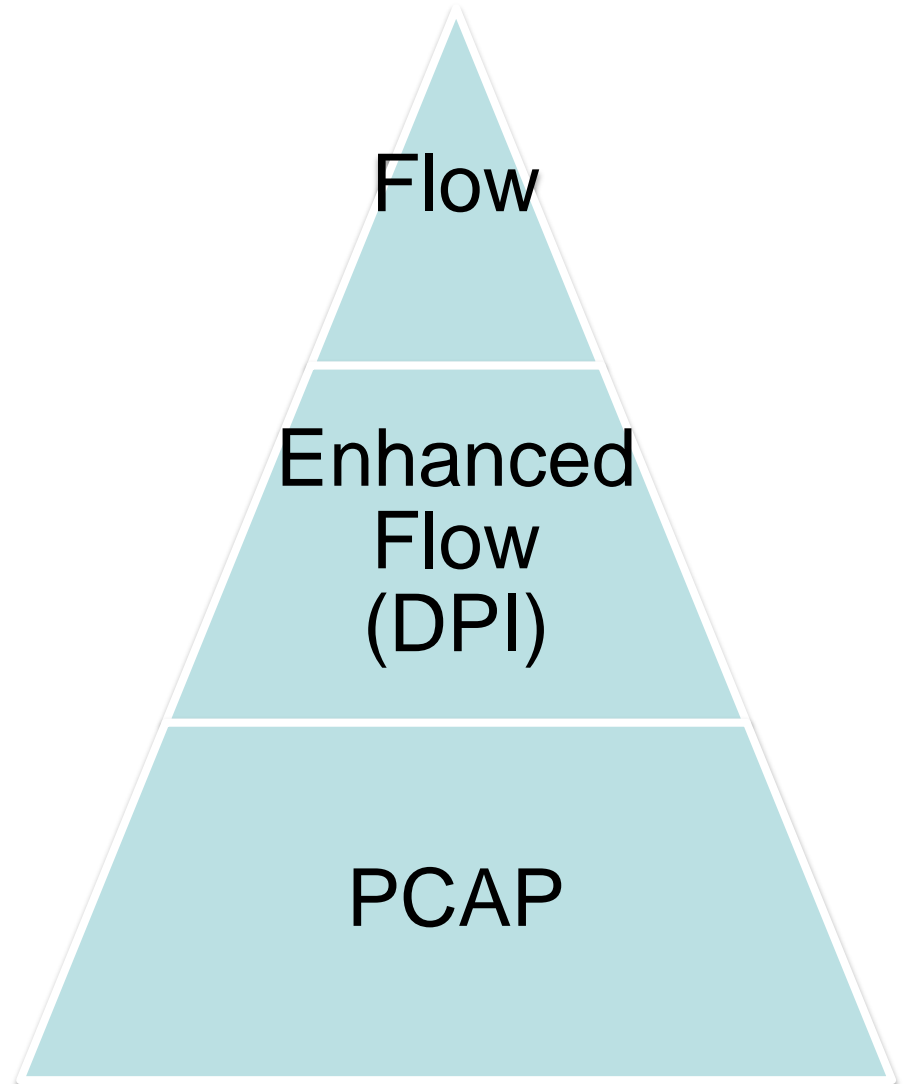
# Method

---

29,000 (15G) PCAP  
samples

Use YAF to index and  
produce flow, DPI

YAF Signatures





# Tool setup

```
src — ssh — 115x25
File Edit Options Buffers Tools Sh-Script Help
#! /bin/bash

PCAP_DIR=/storage/pcaps/*

flowcap --sensor-conf=/data/sensor.conf --destination-dir=/data/flow --max-file-size=20m --log-dest=/var/log/flowp\
ack.log

super_mediator -c /data/super_mediator.conf -d

i=0

for file in $PCAP_DIR
do

yaf --in $file --out localhost --ipfix tcp --ipfix-port=6789 --log=/var/log/yaf.log --verbose --applabel --max-pay\
load=1024 --plugin-name=/usr/lib64/yaf/dpacketplugin.la --flow-stats --no-stats --applabel-rules=/data/yafApplabel\
Rules.conf --noerror --pcap-meta-file=/data/pcapmeta/${basename $file}.txt --observation-domain=$i

i=$((i+1))

done

-UU-:----F1 test.sh All L1 (Shell-script[bash])-----
```

# Initial Results

---

```
(5) _____ $ rwstats --fields=29 --xargs=destroy-flow/silkfiles.txt --top --count 9
```

```
INPUT: 379068 Records for 10 Bins and 379068 Total Records
```

```
OUTPUT: Top 9 Bins by Records
```

appli	Records	%Records	cumul_%
0	260316	68.672639	68.672639
80	43263	11.412992	80.085631
139	38170	10.069433	90.155065
137	20324	5.361571	95.516636
53	16675	4.398947	99.915582
119	240	0.063313	99.978896
3306	68	0.017939	99.996834
1080	6	0.001583	99.998417
194	4	0.001055	99.999472

# YAF Signatures

---

Norman ASA 2012 Report identifies 85 Gh0st variants

```
9999 signature ^Gh0st
9998 signature ^LURK0
9997 signature ^7hero
9996 signature ^Adobe
9995 signature ^B1X6Z
9994 signature ^BEILa
9993 signature ^ByShe
9992 signature ^FKJP3
9991 signature ^FLYNN
9990 signature ^FWAPR
9989 signature ^FMKJG
9988 signature ^GWRAT
9987 signature ^GOLDt
9986 signature ^HEART
9985 signature ^HTTPS
9984 signature ^HXWAN
9983 signature ^Heart
9982 signature ^IM007
9981 signature ^ITore
9980 signature ^K0BBX
9979 signature ^KrisR
9978 signature ^LUCKK
9977 signature ^LYRAT
9976 signature ^Level
9975 signature ^Lover
9974 signature ^Lyyyy
9973 signature ^MFYB
9972 signature ^MaZhe
9971 signature ^MyRat
9970 signature ^OXXMM
9969 signature ^PCRat
9968 signature ^QWPOT
9967 signature ^Spidern
9966 signature ^Tyjhu
9965 signature ^URATU
9964 signature ^W0LFKO
9963 signature ^Wangz
9962 signature ^Winds
9961 signature ^World
9960 signature ^XRAT
9959 signature ^XDAPR
9958 signature ^Xjjhj
9957 signature ^ag0ft
9956 signature ^attac
9955 signature ^cb1st
9954 signature ^https
9953 signature ^whmhl
9952 signature ^xhjyk
9951 signature ^00000
```

[download01.norman.no/documents/ThemanyfacesofGh0stRat.pdf](http://download01.norman.no/documents/ThemanyfacesofGh0stRat.pdf)

# Results with YAF Signatures

```
(25) ____ $ rwstats --fields=29 --xargs=destroy-flow/silkfiles.txt --top --count=50
```

```
INPUT: 379068 Records for 31 Bins and 379068 Total Records
```

```
OUTPUT: Top 50 Bins by Records
```

appli	Records	%Records	cumul_%
0	138766	36.607152	36.607152
9969	52080	13.738960	50.346112
80	43263	11.412992	61.759104
139	38170	10.069433	71.828537
9999	32076	8.461806	80.290344
9989	27998	7.386010	87.676354
137	20324	5.361571	93.037925
53	16675	4.398947	97.436871
9962	2638	0.695917	98.132789
9991	2140	0.564543	98.697331
9955	950	0.250615	98.947946
9965	860	0.226872	99.174818
9960	724	0.190995	99.365813
9971	384	0.101301	99.467114
9974	378	0.099718	99.566832
9954	348	0.091804	99.658636
9942	344	0.090749	99.749385
9967	182	0.048012	99.797398
9952	172	0.045374	99.842772
119	160	0.042209	99.884981
9916	128	0.033767	99.918748
3306	68	0.017939	99.936687
9938	64	0.016884	99.953570
9944	62	0.016356	99.969926
9945	60	0.015828	99.985755
9950	28	0.007387	99.993141
9927	12	0.003166	99.996307
1080	6	0.001583	99.997890
194	4	0.001055	99.998945
9919	2	0.000528	99.999472
9979	2	0.000528	100.000000

# Super\_mediator

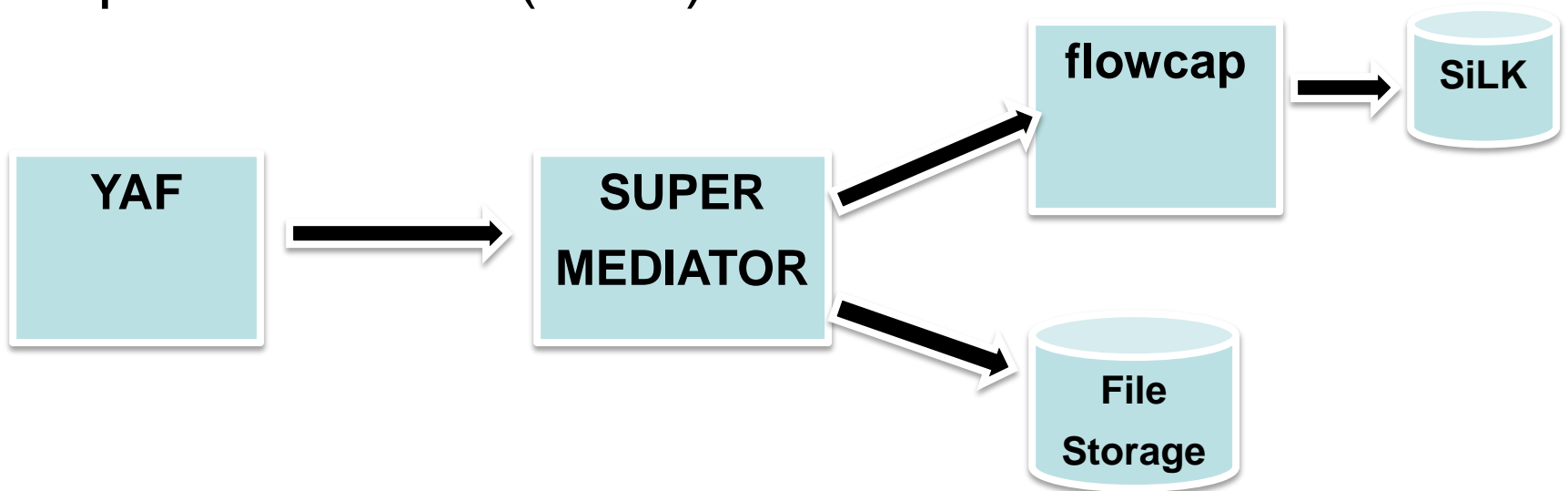
---

A very configurable IPFIX mediator

Collects every IPFIX information element YAF can export

Multiple exporters

Multiple collectors (v.1.0)



# Super\_mediator configuration

Listing application label first allowed for quick binning by variant.

## Super\_mediator Results:

- 227,833 Total Bi-flows
- 60,816 Bi-flows Gh0st
- 86,053 Unidentified

Application	Bytes
Hash	Rbytes
Stimems	Databytes
Domain	Rdatabytes
Sip	Smallpkts
Dip	Rsmallpkts
Sport	Largepkts
Dport	Rlargepkts
Protocol	Nonemptypkts
vlanint	Rnonemptypkts
Iflags	Maxsize
Uflags	Rmaxsize
Riflags	Firsteight
Ruflags	
Pkts,	
Rpkts	

# Finding a Pattern

```
src — ssh — 156x35
File Edit Options Buffers Tools Help
9969|2829634012|1342871176989|82|1060|80|6|0|S|APR|AS|AP|5|3|408|328|200|200|0|0|0|0|1|1|200|200|02
9969|2829699548|1342871187012|82|1061|80|6|0|S|APR|AS|AP|5|3|408|328|200|200|0|0|0|0|1|1|200|200|02
9969|2829765084|1342871197036|82|1062|80|6|0|S|APR|AS|AP|5|3|408|328|200|200|0|0|0|0|1|1|200|200|02
9969|2829830620|1342871207079|82|1063|80|6|0|S|APR|AS|AP|5|3|407|327|199|199|0|0|0|0|1|1|199|199|02
9969|2829371868|1342871217103|82|1064|80|6|0|S|APR|AS|AP|5|3|408|328|200|200|0|0|0|0|1|1|200|200|02
9969|2829437404|1342871227127|82|1065|80|6|0|S|APR|AS|AP|5|3|408|328|200|200|0|0|0|0|1|1|200|200|02
9969|2829502940|1342871237150|82|1066|80|6|0|S|APR|AS|AP|5|3|407|327|199|199|0|0|0|0|1|1|199|199|02
9969|2829568476|1342871247174|82|1067|80|6|0|S|APR|AS|AP|5|3|408|328|200|200|0|0|0|0|1|1|200|200|02
9969|2829109724|1342871257246|82|1068|80|6|0|S|APR|AS|AP|5|3|410|330|202|202|0|0|0|0|1|1|202|202|02
9969|2829175260|1342871267533|82|1069|80|6|0|S|AP|AS|AP|4|3|370|330|202|202|0|0|0|0|1|1|202|202|02
9999|209172020|1393593169945|84|2|1047|8008|6|0|S|APR|AS|AP|9|6|810|682|434|434|2|2|0|0|4|4|216|216|aa
9999|209303092|1393593193113|84|2|1049|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|209434164|1393593213385|84|2|1051|8008|6|0|S|APR|AS|AP|5|3|392|312|184|184|0|0|0|0|1|1|184|184|02
9999|209499700|1393593223507|84|2|1052|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|209565236|1393593233630|84|2|1053|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|209630772|1393593243752|84|2|1054|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|209696308|1393593253871|84|2|1055|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|205567540|1393593263994|84|2|1056|8008|6|0|S|APR|AS|AP|8|6|737|657|409|409|2|2|0|0|4|4|191|191|aa
9999|205633076|1393593274114|84|2|1057|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|205698612|1393593284235|84|2|1058|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|205764148|1393593294357|84|2|1059|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|205829684|1393593304477|84|2|1060|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|205895220|1393593314599|84|2|1061|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|205960756|1393593324721|84|2|1062|8008|6|0|S|APR|AS|AP|14|12|1070|990|502|502|8|8|0|0|10|10|191|191|aa
9999|206026292|1393593334851|84|2|1063|8008|6|0|S|APR|AS|AP|20|18|1403|1323|595|595|14|14|0|0|16|16|191|191|aa
9999|206091828|1393593344992|84|2|1064|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|206157364|1393593355113|84|2|1065|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|206222900|1393593365235|84|2|1066|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|206288436|1393593375355|84|2|1067|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|206353972|1393593385477|84|2|1068|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|206419508|1393593395598|84|2|1069|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
9999|206485044|1393593405720|84|2|1070|8008|6|0|S|APR|AS|AP|5|3|399|319|191|191|0|0|0|0|1|1|191|191|02
--UU-:----F1 9.txt 1% L202 (Text)
```

# Analysis Part 1

---

Remove unwanted flows from unidentified flows:

- Remove flows with source/destination port 138,139.
- Remove flows with initialTCPFlags = 'R'
- Remove flows with dataByteCount = 0

Find flows with pattern:

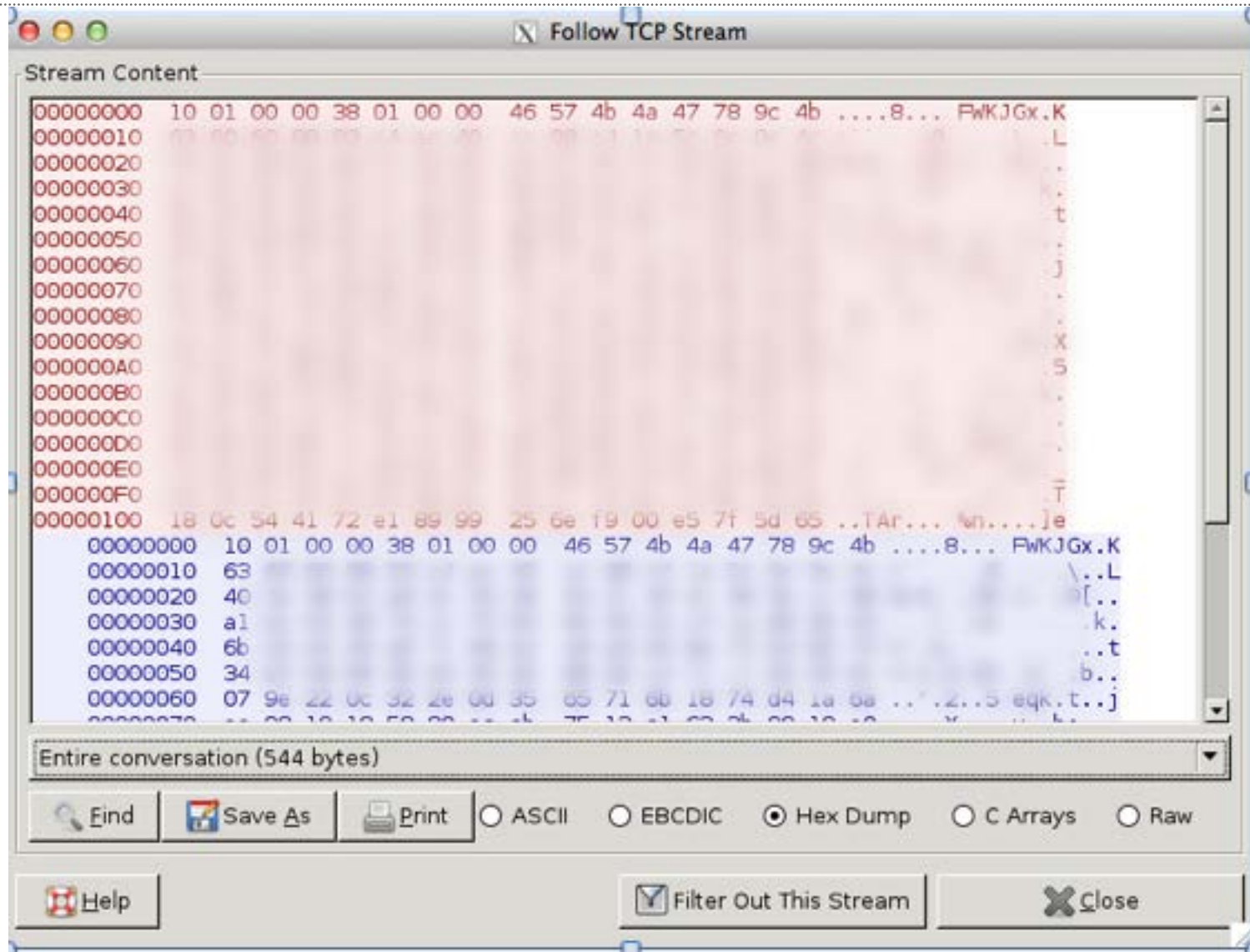
- No more than 1 small packet (forward), 0 reverse
- Non-empty packets = 1 or 2 (forward), 1 reverse
- maxPacketSize = reverseMaxPacketSize
- firstEightPacketDirection = 0x02

Results:

- 44,468 bi-flows removed
- 37,500 bi-flows with pattern
- 4,085 bi-flows did not follow pattern



# Finding Gh0st Variants and Signatures



# Analysis Part 2

Run unidentified PCAP files through YAF again and export first 100 bytes of payload

```
2013-09-03 08:44:25.385|2013-09-03 08:44:25.624| 0.239| 0.000| 6|
|██████████| 7678| 3| 564|00|00:00:00:00:00:00| S| AP| ██████████ 1042| 4| 604|00|00:00:00:00:00:00|
-> 0000: ae 01 00 00 b4 02 00 00 46 57 4b 4a 47 48 00 00 .....FWKJGH..
-> 0010: 00 00 00 78 9c 7d 52 3d 4b 03 41 10 7d 77 e2 67 ...x.}R=K.A.}w.g
-> 0020: 15 ae 10 44 c4 03 2d 44 44 62 b4 33 90 a4 ...D...Ddb.3..
<- 0000: ae 01 00 00 b4 02 00 00 46 57 4b 4a 47 48 00 00 .....FWKJGH..
<- 0010: 00 00 00 78 9c 7d 52 3d 4b 03 41 10 7d 77 e2 67 ...x.}R=K.A.}w.g
<- 0020: 15 ae 10 44 c4 03 2d 44 44 62 b4 33 90 a4 ...D...Ddb.3..
2014-08-26 22:16:12.999|2014-08-26 22:16:26.045| 13.046| 0.000| 6|
|██████████| 1478| 3| 383|00|00:00:00:00:00:00| S| APRS| ██████████ 1037| 6| 511|00|00:00:00:00:00:00|
-> 0000: ff 00 00 00 ██████████ 5c 01 00 00 7a 9a 4e ...██████████\....z.N
-> 0010: 60 17 63 98 c4 c8 c2 c6 0b cc 85 47 ae c8 c4 c4 \.c.....G....
-> 0020: c6 0d a7 8b 57 8a cf 3a 90 51 12 03 1a 95 ....W...:Q....
<- 0000: ff 00 00 00 ██████████ 5c 01 00 00 7a 9a 4e ...██████████\....z.N
<- 0010: 60 17 63 98 c4 c8 c2 c6 0b cc 85 47 ae c8 c4 c4 \.c.....G....
<- 0020: c6 0d a7 8b 57 8a cf 3a 90 51 12 03 1a 95 ....W...:Q....
```

# Results

---

Identified several signature variants of Gh0st

Found 55 new Gh0st variants

Created YAF Application Label for Gh0st

- Correctly identifies 97% of Gh0st traffic.

Collected over 3,000 unique domain names

- Correlated with Gh0st variants.



# Searching for Gh0st in DEFCON CTF PCAP

# DEFCON CTF PCAP Data

Goal: Test new Gh0st application label

Defcon CTF PCAP Data

- 409 GB
- Separated by team and day

```
(18) $ /usr/bin/rwstats --fields=29 --xargs=silk/silk
INPUT: 82586983 Records for 27 Bins and 82586983 Total Records
OUTPUT: Top 50 Bins by Records
```

appli	Records	%Records	cumul_%
0	47893534	57.991626	57.991626
53	19315635	23.388232	81.379857
80	7272364	8.805702	90.185560
143	4206068	5.092895	95.278454
443	3340463	4.044781	99.323236
427	504523	0.610899	99.934135
67	20009	0.024228	99.958363
22	10450	0.012653	99.971016
21	7420	0.008984	99.980000
137	5423	0.006566	99.986567
5004	3783	0.004581	99.991148
194	3122	0.003780	99.994928
6881	1988	0.002407	99.997335
139	642	0.000777	99.998112
119	360	0.000436	99.998548
554	290	0.000351	99.998899
161	247	0.000299	99.999198
389	153	0.000185	99.999384
5222	125	0.000151	99.999535
5060	114	0.000138	99.999673
69	114	0.000138	99.999811
902	40	0.000048	99.999860
9997	38	0.000046	99.999906
5190	38	0.000046	99.999952
25	28	0.000034	99.999985
110	8	0.000010	99.999995
5900	4	0.000005	100.000000

# Investigating “Gh0st” in DEFCON

```
src — ssh — 158x61
(23) $ /usr/bin/rwfilter --application=9997 --pass-dest=stdout --xargs=silk/silkfiles.txt | /usr/bin/rwsilk2ipfix | /analysis/ecoff/bin/getFlowKeyHash
sIP|          dIP|sPort|dPort|pro|  vlan|          hash|          ms
10.5.19.104| 10.5.18.2|53388| 8888| 6|  0|3498853266| 1407517727292
10.5.18.2| 10.5.19.104| 8888|53388| 6|  0| 582529446| 1407517727292
10.5.19.111| 10.5.1.2|52646| 8888| 6|  0|3450228885| 1407526153262
10.5.1.2| 10.5.19.111| 8888|52646| 6|  0| 582533003| 1407526153262
10.5.1.2| 10.5.18.2|53388| 8888| 6|  0|3498856952| 1407517727292
10.5.18.2| 10.5.1.2| 8888|53388| 6|  0| 582525900| 1407517727292
10.5.1.2| 10.5.11.111|59014|47989| 6|  0|3867595096| 1407622961660
10.5.11.111| 10.5.1.2|47989|59014| 6|  0|3145043115| 1407622961660
10.5.6.2| 10.5.11.113|59503|  80| 6|  0|3899616611| 1407623040275
10.5.11.113| 10.5.6.2|  80|59503| 6|  0|  5277020| 1407623040275
10.5.6.2| 10.5.11.117|59541| 9001| 6|  0|3902098974| 1407623048722
10.5.11.117| 10.5.6.2| 9001|59541| 6|  0| 589923746| 1407623048722
10.5.13.2| 10.5.11.113|59578| 443| 6|  0|3904530312| 1407623055575
10.5.11.113| 10.5.13.2| 443|59578| 6|  0|  29068937| 1407623055575
10.5.9.2| 10.5.11.113|59587| 2293| 6|  0|3905120966| 1407623058137
10.5.11.113| 10.5.9.2| 2293|59587| 6|  0| 150309616| 1407623058137
10.5.12.2| 10.5.11.117|59699| 8888| 6|  0|3912451471| 1407623093677
10.5.11.117| 10.5.12.2| 8888|59699| 6|  0|  582520324| 1407623093677
10.5.3.2| 10.5.11.120|59746| 143| 6|  0|3915540661| 1407623114721
10.5.11.120| 10.5.3.2| 143|59746| 6|  0|  9404760| 1407623114721
10.5.2.2| 10.5.9.2|57432| 8888| 6|  0|3763882488| 1407523627665
10.5.9.2| 10.5.2.2| 8888|57432| 6|  0|  582519576| 1407523627665
10.5.14.107| 10.5.11.111|59014|47989| 6|  0|3867598385| 1407622961660
10.5.11.111| 10.5.14.107|47989|59014| 6|  0|3145040834| 1407622961660
10.5.14.107| 10.5.11.113|59503|  80| 6|  0|3899614474| 1407623040275
10.5.11.113| 10.5.14.107|  80|59503| 6|  0|  5279029| 1407623040275
10.5.14.107| 10.5.11.117|59541| 9001| 6|  0|3902097015| 1407623048722
10.5.11.117| 10.5.14.107| 9001|59541| 6|  0|  589925835| 1407623048722
10.5.14.107| 10.5.11.113|59578| 443| 6|  0|3904529633| 1407623055575
10.5.11.113| 10.5.14.107| 443|59578| 6|  0|  29068768| 1407623055575
10.5.14.107| 10.5.11.113|59587| 2293| 6|  0|3905121711| 1407623058137
10.5.11.113| 10.5.14.107| 2293|59587| 6|  0| 150310297| 1407623058137
10.5.14.107| 10.5.11.117|59699| 8888| 6|  0|3912452070| 1407623093677
10.5.11.117| 10.5.14.107| 8888|59699| 6|  0|  582519917| 1407623093677
10.5.14.107| 10.5.11.120|59746| 143| 6|  0|3915539932| 1407623114721
10.5.11.120| 10.5.14.107| 143|59746| 6|  0|  9407537| 1407623114721
10.5.14.2| 10.5.1.2|52646| 8888| 6|  0|3450228216| 1407526153262
10.5.1.2| 10.5.14.2| 8888|52646| 6|  0|  582525670| 1407526153262
```

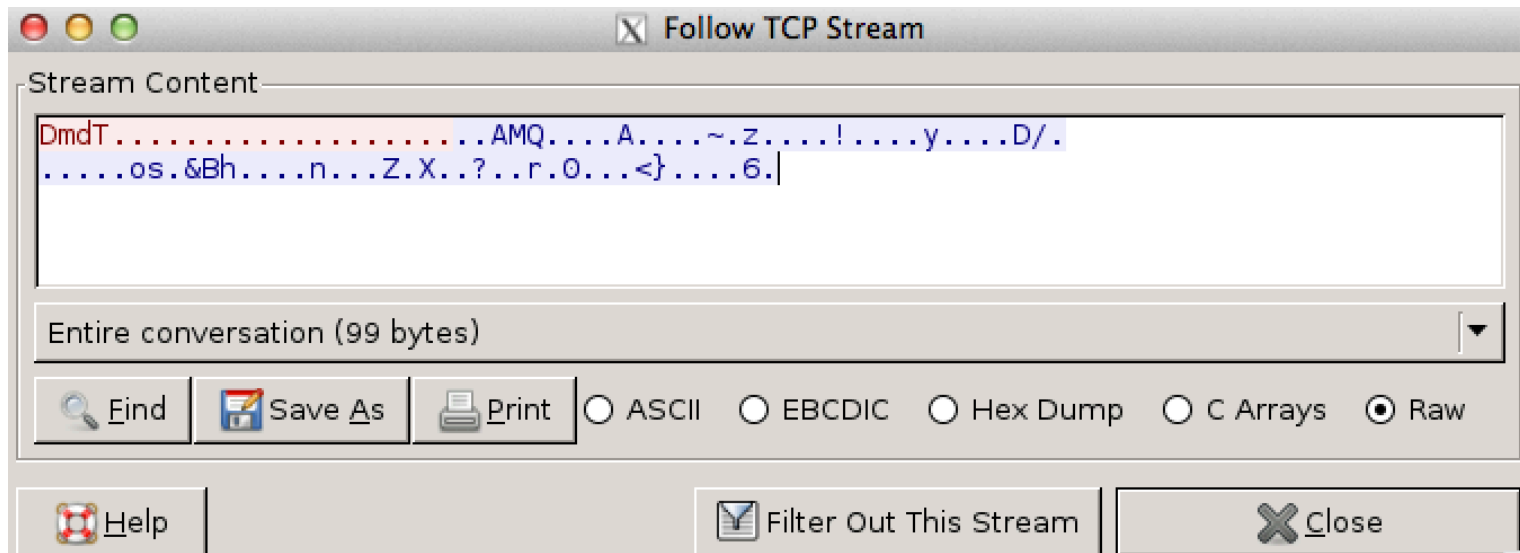
# YafMeta2Pcap

## Input:

- Large PCAP file or list of PCAP files
- PCAP meta file created by YAF
- Flow key hash and start time

## Output

- PCAP file with desired flow



# DEFCON Analysis

Used YAF signatures to determine other flows with “DmdT” and “eliza”

“eliza” was a text-based space economy simulator challenge at CTF

80% of DmdT traffic went to last place team.

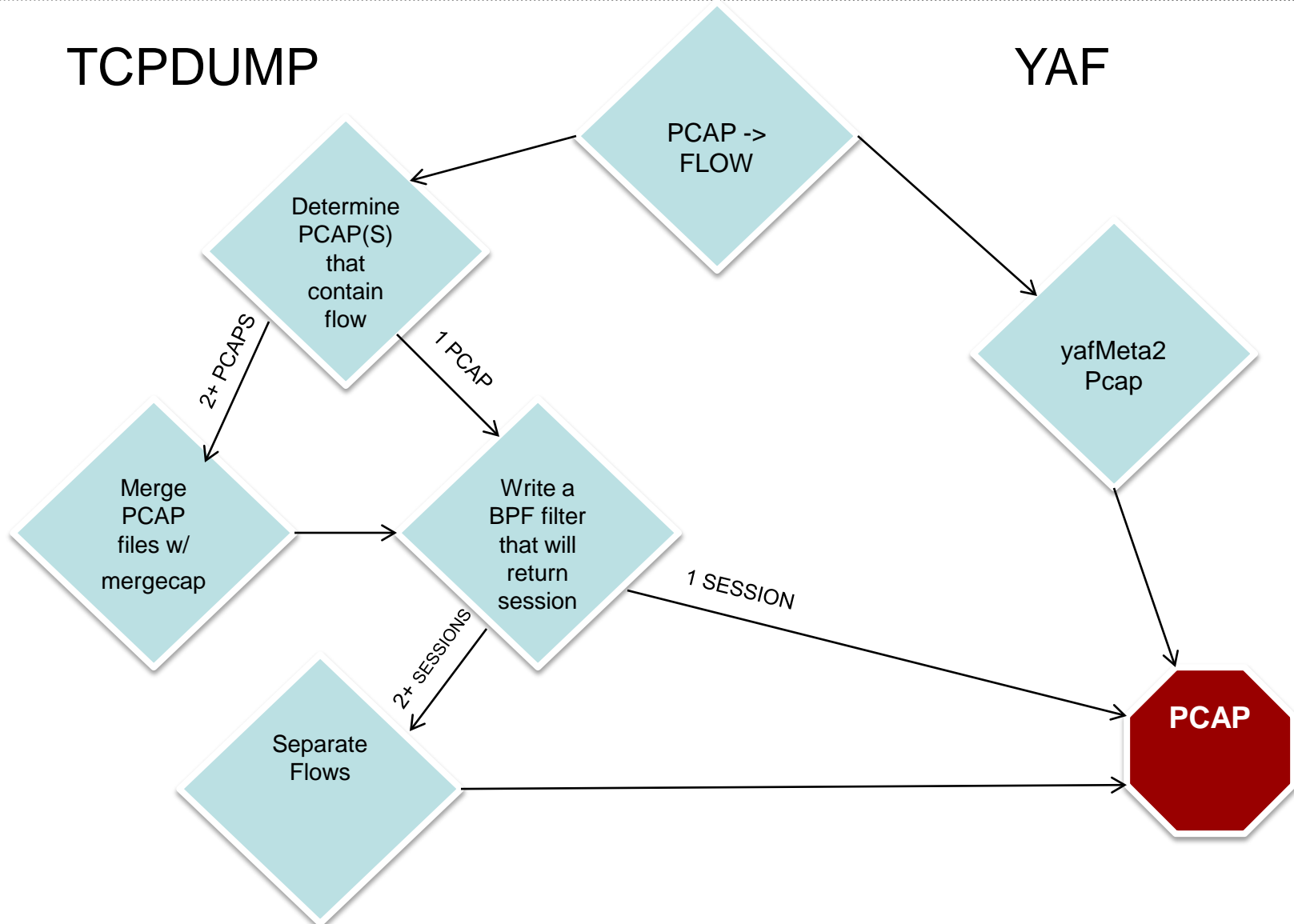
INPUT: 82586983 Records for 29 Bins and 82586983 Total Records

OUTPUT: Top 30 Bins by Records

appli	Records	%Records	cumul_%
0	40149632	48.614964	48.614964
52	19313391	23.388178	72.003142
6666	7757938	9.393657	81.396800
80	7255528	8.785317	90.182116
143	4206068	5.092895	95.275011
443	3340449	4.044765	99.319775
427	504523	0.610899	99.930674
67	20009	0.024228	99.954902
22	10450	0.012653	99.967555
21	7420	0.008984	99.976540
137	5423	0.006566	99.983106
5004	3783	0.004581	99.987687
119	3206	0.003882	99.991569
194	3122	0.003780	99.995349
6881	1988	0.002407	99.997756
139	628	0.000760	99.998517
554	276	0.000334	99.998851
161	247	0.000299	99.999150
389	139	0.000168	99.999318
5222	125	0.000151	99.999470
8888	118	0.000143	99.999613
3050	100	0.000121	99.999734
69	100	0.000121	99.999855
902	40	0.000048	99.999903
5190	38	0.000046	99.999949
25	28	0.000034	99.999983
110	8	0.000010	99.999993
5900	4	0.000005	99.999998
3306	2	0.000002	100.000000



# Method Comparison



# Questions?

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CERT NetSA tools website:

[tools.netsa.cert.org](http://tools.netsa.cert.org)

Contact:

[ecoff@cert.org](mailto:ecoff@cert.org)

[netsa-tools-discuss@cert.org](mailto:netsa-tools-discuss@cert.org)

[netsa-help@cert.org](mailto:netsa-help@cert.org)