Defeating the PCAP Problem: Making a Mountain into a Molehill

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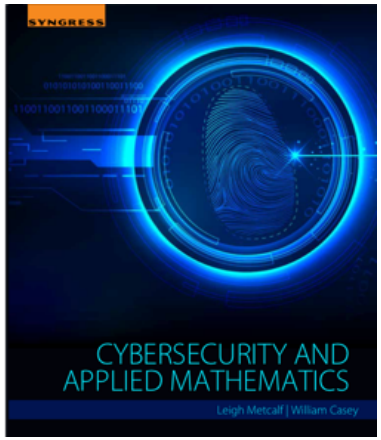
Who am I?

- PhD in Theoretical Mathematics, specializing in Algebraic Topology and Dynamical Systems
- Researcher at CERT for 9 years
- Primary Author of Applied Mathematics and Cybersecurity
- Co-EiC of the new journal ACM Digital Threats: Research and Practice
- My work is challenging assumptions made in Cybersecurity

and evidence based analysis



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Analysis Pipeline…

…is not a spiffy User Interface.

It was developed to drop files for spiffy user interfaces to read.

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What Can Analysis Pipeline Do?

- Narrow down where to look for bad guys
- Keep Inventory
- Network Profiling – Keep state
  - For example, suppose a system suddenly starts accepting web requests and it has never done that before
- It will only put actionable alerts into Security Information Management Systems
  - Can emit alerts in JSON for easy consumption
- Has thresholds for anomalies… custom thresholds even
- Can help you focus your analysis
- Analysis Pipeline uses SiLK concepts

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Analysis Pipeline

- On an order of magnitude better than an IPS in certain cases
  - For example, adding an IP to SNORT means writing a new rule
  - Adding an IP to the Analysis Pipeline monitoring is simple and efficient and doesn't change the inherent configuration
- For watchlists, it is incredibly efficient in processing speed and resource utilization. It costs almost nothing to add an indicator to a watchlist
- Works well in tandem with IPS

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What Can't Analysis Pipeline Do

- Still isn't a cute User Interface
- And isn't a SIM
- It's only limitation is the amount of memory and disk on your system
- It also isn't an AI/ML tool. You can use it to label data for AI/ML but it isn't a flow passthrough tool to label all data.

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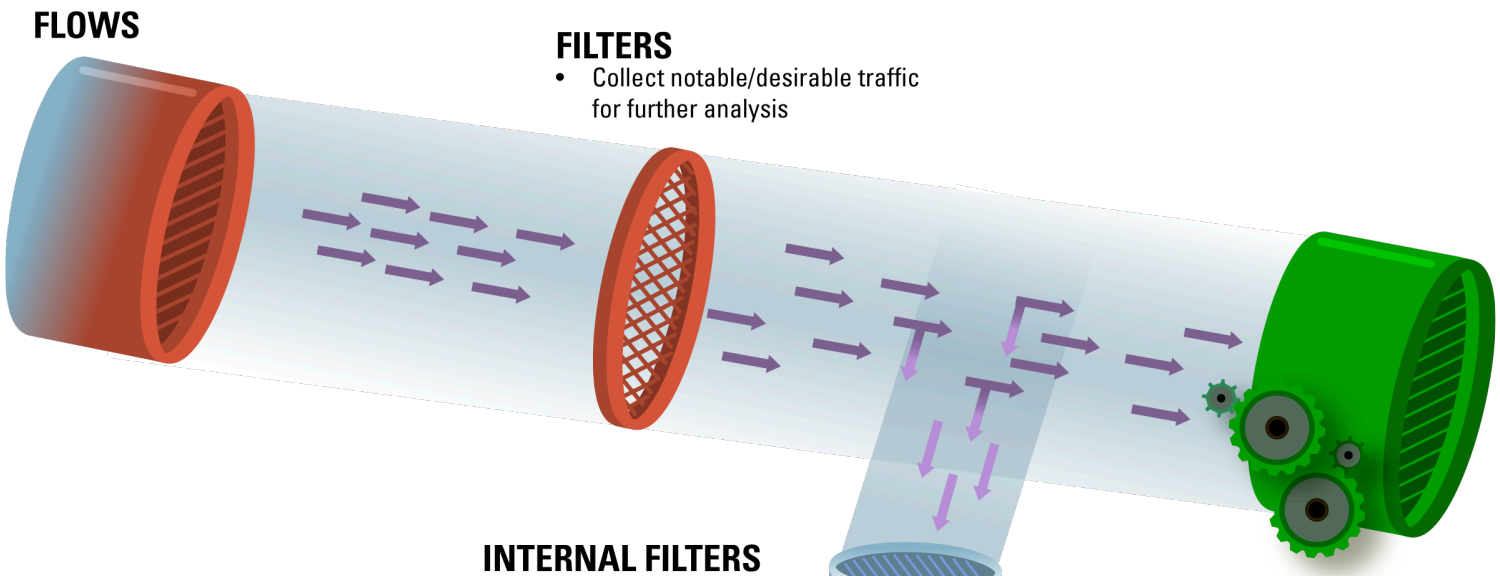
Analysis Pipeline



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Analysis Pipeline Configs

The configurations consist of two parts:

Filter – The step that determines if the record should be passed to an evaluation

Examples: dIP, sIP, Ports, Protocol, Domain names, etc

Evaluation – The step that does the work

Examples: statistics, thresh holds, moving time windows

Evaluation also handles the alerts

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Case Study #1

1) Only worry about tcp traffic
2) Identify IP addresses that send more than 1MB in 5 minutes

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Case Study #1

```
FILTER tcpFilter
      PROTOCOL == 6
END FILTER
EVALUATION CaseStudy1
      ALERT EVERYTHING
      FILTER tcpFilter
      CHECK THRESHOLD
            SUM BYTES > 1000000
            TIME_WINDOW 5 MINUTES
      END CHECK
END EVALUATION
```


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Complexifying…

Identify web servers

- Sends more than 20,000 bytes in 10 minutes
- Talks to more than 15 different DIPs in 15 minutes

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Configuration

```
FILTER ourNetwork
  SIP == 193.0.0.0/8 #arbitrarily chosen network
  SPORT IN LIST [80, 8080] #Yes, there are more ports, but 80 and 8080 keep it simple
END FILTER
```


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Configuration Continued

```
EVALUATION findWebServers
    SEVERITY 2
    OUTPUT_TIMEOUT 1 DAY
    OUTPUT_LIST SIP
webServerList
    CLEAR ALWAYS
    ALERT EVERYTHING
    ALERT 1 TIMES 1 HOUR
    FILTER ourNetwork
```

```
FOREACH SIP
  CHECK THRESHOLD
    DISTINCT DIP > 15
    TIME_WINDOW 15 MINUTES
  END CHECK
  CHECK THRESHOLD
    SUM BYTES > 20000
    TIME_WINDOW 10 MINUTES
  END CHECK
END EVALUATION
```


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Case Study #2 DDoS Detection

What is DDoS?

What are the characteristics of flows that participate in a DDoS attack?

What is the threshold event that causes us to say a DDoS attack is occurring?

Are there exceptions to the threshold?

Is this behavior ever expected and if so, what do we whitelist?

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DDoS DNS Reflection

Rather than finding if we're the victim of a DDoS

…Let's look at if we're the inadvertent part of one.

DNS Reflection attack detection

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DDoS DNS Reflection

```
FILTER dnsFlows
    PROTOCOL IN_LIST [6,17]
    ANY PORT == 53
    ANY IP IN_LIST "whiteListDns.set"
END FILTER
```


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DDoS DNS Reflection

```
EVALUATION dnsThreshold
 FILTER dnsFlows
 CHECK RATIO
   OUTGOING 27 TO 1
 END CHECK
 FOREACH SIP DIP
   CHECK THRESHOLD
    RECORD COUNT > 100
    TIME_WINDOW 5 MINUTES
   END CHECK
 OUTPUT_TIMEOUT 5 MINUTES
   ALERT ALWAYS
   CLEAR ALWAYS
END EVALUATION
```


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Another Example

```
EVALUATION beacon
    CLEAR NEVER
    SEVERITY 3
    ALERT JUST_NEW_THIS_TIME
    ALERT 1 TIMES 60 SECONDS
    FILTER all
    CHECK BEACON
        COUNT 5 CHECK_TOLERANCE 5 PERCENT
        TIME_WINDOW 300 SECONDS
    END CHECK
END EVALUATION
```


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Analysis Pipeline

These Examples look at Network Flow as the input.

Analysis Pipeline also takes input from YAF (IPFIX-based file format) and can operate on that as well. In fact, it works on all flat IPFIX Data

Analyzing:

- User agent strings
- Domain names
- URLs…
- ….anything you can put in IPFIX…

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Pipeline Can Also..

- Find system misconfigurations
- Find DNS Parking and Fast Flux
  - https://www.usenix.org/conference/laser2017/presentation/metcalf
- Watchlists
- Find Sensor Outages
- Passive FTP detection
- Network Profiling
- Baseball Statistics
- ….

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Analysis Pipeline Primitives

- Arithmetic Basics (Count / Sum / Average / # Distinct)
- Statistics Basics (Mean / Standard Deviation)
- Moving Average Windows
- Beacon Detection
- Persistence of Value Detection
- …And many more!

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Analysis Pipeline

Analysis Pipeline:

https://tools.netsa.cert.org/analysis-pipeline5/index.html

SiLK:

https://tools.netsa.cert.org/silk/index.html

YAF:

https://tools.netsa.cert.org/yaf/index.html

Email for help, requests, other: netsa-help@cert.org

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Thank you for your time!

Questions/Comments?

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