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SEI WEBINAR SERIES | Keeping you informed of the latest solutions
Building Analytics for Network Flow Records

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Poll on Automated Analysis

How is your organization automating analysis for network situational awareness or network security?

• Uncertain: We don’t do network situational awareness
• Outsourced: We have a good managed security solution
• Feeds: We merge several external threat feeds to develop analytics (data-centric, not directed)
• Heroes: We hire good people and leave it in their hands
• Repeatable: We have a process, but have little management support
• Optimized: We have a process and a focus on continuing to improve it (mission-focused)
• Other (please explain)
Business Value Perspective

Present – current operational system
• Created
• Referenced / Modified
• Deleted

Past – data from repository

Future – proactive security

N. Sheikh, Implementing Analytics, Morgan Kaufmann, Boston, MA, 2013
What we won’t cover

Information security basics
• C.I.A. or Kill Chain or CAPEC
• Indicator analysis

Implementation details
• The basics of network flow analysis
• SiLK tool suite command syntax
• Scripting languages

Capability Maturity Models
Building Analytics for Network Flow Records

Analytic Development Process
Process

Explore
Model
Test
Analyze
Refine
Explore

Needs analysis – is there a prior analytic that addresses this?

Research analytic
  • vendor documentation
  • published papers
  • data feeds

Identify unique attributes
  • ports
  • protocols
  • associations
  • behaviors
Model

Lessons learned from prior analytics

Build model
  • identified behavior
  • similar behavior

Program model
  • Shell
  • Python
  • other
Test

Execute programmed model
• monitor progress
• debug

Save test results
• ‘raw’ files
• ‘set’ files
• ‘bag’ files
• other formats
Analyze

Review test results.
Reduce false positives.
Reduce false negatives.
Identify improvements.
Refine

Apply improvements
Update programs
Repeat
Mature the process
Maturing the process

Templates
• Common input / output options
• Documentation content
• Common style (and in-script documentation)
  - Invoking commonly-used tools in conventional way
  - Describing common aspects in conventional way

Test suite
• Data with known content
• Regression tests
• Example output for documentation

Source control with versioning (code and documentation)
Poll on Examples

Which analytic are you most interested in?

• Host characterization: what mix of services per address?
• Backwards: what hosts either send or receive traffic that appears reversed?
• Scanners: what external addresses are mapping our network?
• Profiling Popular Usage: what are our popular services and protocols?
• Profiling Active Talkers: what are the active addresses on our network?
• Profiling Inventory Assets: what assets are using/serving what services?
Building Analytics for Network Flow Records

Example Analytics
Understanding Host Roles

Explore: Characterize hosts that seem to act as email servers

• Of the hosts communicating on TCP port 25 (SMTP), how much non-SMTP traffic does each generate?
• Changes over time? After event?

Model:

• Input:
  - Assume small population of interesting hosts (specified as IP set)
  - Pre-retrieve traffic of interest (as rw file)
• Use rwfilter with rwuniq to pull out SMTP vs non-SMTP flow counts
• Output: Table of behavior per IP address

Test, Analyze, and Refine:

• Include test cases for addresses with known and unknown roles
• Reliability / performance / interpretable results
• How about non-SMTP email activity? (e.g., POP, IMAP)
• How about non-SMTP related to email? (e.g. DNS)
Initial Host Characterization Script

#!/bin/bash
rm -f more-mail-saddr.txt more-nomail-saddr.txt more-nomail.rw
rwfilter in_month.rw --sipset=interest.set --pass=stdout
    | rwfilter stdin --protocol=6 --aport=25
        | --fail=more-nomail.rw --pass=stdout
    | rwuniq --field=sIP --no-titles --ip-format=zero-padded
          | --sort-output --output-path=more-mail-saddr.txt
rwuniq more-nomail.rw --field=sIP --ip-format=zero-padded
    | --no-titles --sort-output --output-path=more-nomail-saddr.txt
echo '         sIP|     mail||  not mail|
            ; join more-mail-saddr.txt more-nomail-saddr.txt
            | sort -t'|' -nrk2,2
            | head -n 5

# Using SiLK for Network Traffic Analysis (Example 3.37)
Identifying Backwards Traffic

Explore: Identify hosts for which sensors record traffic that appears reversed (possible forged addresses).
  • Of the hosts sending or receiving TCP traffic, for which do sensors record traffic that is “inbound” but from local hosts, or “outbound” and going to local hosts?
  • Changes over time? Related to event?

Model:
  • Assume we have hosts of interest, expressed as IP set
  • Assume we have date/time range of interest, expressed as parameters
  • Use rwfilter to pull traffic into files for later analysis

Test, Analyze, and Refine:
  • Test against normal traffic and traffic engineered to be reverse
  • Reliability / Interpretable results
  • Traffic not completely reversed? Traffic observed in both groups?
Initial Backwards Traffic Script

#!/bin/bash
START=2009/4/20T12
END=2009/4/20T13
SENNAME=SEN1
rm -f strange_in.rw strange_out.rw
rwfilter --sensor=$SENNAME --type=in,inweb --start-date=$START \ 
    --end-date=$END --protocol=6 --bytes-per-packet=65- \ 
    --sipset=mynetwork.set --flags-all=SAF/SAFR,SAR/SAFR,SAFR/SAFR \ 
    --packets=4- --pass=strange_in.rw
rwfilter --sensor=$SENNAME --type=out,outweb --start-date=$START \ 
    --end-date=$END --dipset=mynetwork.set --not-sipset=mynetwork.set\ 
    --pass=strange_out.rw
exit 0

# Using SiLK for Network Traffic Analysis (Example 4.22)
Finding Scanners

Explore: Identify external addresses that are mapping our network
- Much existing work in literature (Gates, Jung, etc.)
- Simple approach exploits attacker workflow (minimal advance knowledge)
  - Of quick TCP traffic with relatively few bytes per packet, which have flags that could reflect scanning? Are the sources frequent enough?

Model:
- Assume a date of interest, expressed as parameters
- Use rwfilter to isolate TCP traffic with few bytes per packet, then to split out flag combinations.
- Use rwbag to count sources per bag combinations
- Use rwbagtool to manipulate counts and isolate frequent sources
- Use rwbagtool to produce set of IP addresses for sources

Test, Analyze, and Refine:
- Use test cases with known scans and without known scans
- False positives and false negatives
- Trends over time?

Initial Scanner Detection Script

#!/bin/bash
rm -f fastfile.rw fast-{low,high}.{set,bag} scan.set
rwfilter --start=2009/04/20 --sensor=S0 --type=in,inweb --bytes-per=40-65 \  --protocol=6 --duration=0-1199 --pass=fastfile.rw
rwfilter fastfile.rw --flags-all=S/SRF --packets=1-3 --pass=stdout \  | rwbag --sip-flows=fast-low.bag
rwfilter fastfile.rw --flags-all=SAF/SARF,SR/SRF --pass=stdout \  | rwbag --sip-flows=fast-high.bag
rwbagtool fast-high.bag --maxcounter=10 --coverset --output-path=fast-high.set
rwbagtool fast-low.bag --mincounter=10 --coverset --output-path=fast-low.set
rwsettool --difference fast-low.set fast-high.set --output-path=scan.set
exit 0

# Using SiLK for Network Traffic Analysis (Example 4.33)
Profiling Top Five Services and Protocols

Explore: Characterize traffic on our network by protocols and services
• What protocols are being used? What services are we requesting? What services are we providing?
• Changes over time? Anomalies?

Model:
• Input:
  - Pre-retrieve traffic for some time period, typically a full days worth.
• Use rwfilter with rwstats to generate top 5 statistics
• Output: Multiple tables containing summarizations of traffic

Test, Analyze, and Refine:
• Include test cases for how to handle large sets of data
• Reliability / performance / interpretable results
• Would a list of top 10’s provide more value for the performance hit?
• Is generating a table of all protocols and services then filtering text, rather than SiLK binary, feasible?
• Inbound vs. Outbound traffic?
Profiling Top Five Services and Protocols Script

#!/bin/bash

echo Initial dataset:

rwfilter --type=out, outweb --start-date=2011/09/28:00 \  
   --end-date=2011/09/28:23 --protocol=0- --pass=sample.rw

echo -e "\nTop protocols:" 

rwstats sample.rw --fields=protocol --count=5

echo -e "\nTop services being requested:" 

rwstats sample.rw --count=5 --fields=dport

echo -e "\nTop services being provided:" 

rwstats sample.rw --count=5 --fields=sport

# Network Profiling Using Flow (Section 3 Script)
Profiling Active Addresses

Explore: Identify addresses that have actively talked during a given time period

- How many active addresses are using TCP? What about other protocols? Are there addresses that are merely passing through our network (transiting)?
- Awareness of network address topology. Changes over time? Anomalies?

Model:

- Input:
  - Pre-retrieve traffic for some time period, typically a full day’s worth.
- Use rwfilter with rwset tools to generate and understand address lists
- Output: Multiple tables containing summarizations of active addresses, Multiple set files

Test, Analyze, and Refine:

- Include test cases for how to handle large sets of data
- Reliability / performance / interpretable results
- What about separating out UDP and ICMP from other IP protocols?
- What about traffic heading into the network from an internal host?
Profiling Active Addresses Script

#!/bin/bash

echo Number of TCP talkers:
rwfilter sample.rw --type=out,outweb --protocol=6 --packets=4- --ack-flag=1 \
   --pass=stdout | rwset --sip-file=tcp_talkers.set
rwsetcat tcp_talkers.set --count

echo -e "\nNumber of talkers on other protocols:"
rwfilter sample.rw --type=out --protocol=0-5,7- --pass=stdout \
   | rwset --sip-file=other_talkers.set
rwsetcat other_talkers.set --count
rwsettool --union tcp_talkers.set other_talkers.set --output-path=talkers.set
rwsetcat talkers.set --network-structure

echo -e "\nClass C network blocks:"
	rwsetcat talkers.set --network-structure=C

echo -e "\nTransit traffic:"

rwfilter sample.rw --type=out,outweb --not-sipset=talkers.set --pass=stdout \
   | rwtotal --sip-first-8 --summation --skip-zeroes --no-titles | cut -f 2 -d "|"
rwfilter sample.rw --type=out,outweb --dipset=talkers.set --pass=stdout \
   | rwtotal --sip-first-8 --summation --skip-zeroes --no-titles | cut -f 2 -d "|"

# Network Profiling Using Flow(Section 4 Script)
Profiling Assets by Service

Explore: Identify assets in our network by popular services

• What assets are running web servers? DNS Servers? Telnet servers? What assets are telnet clients?
• Changes over time? Policy Violations?

Model:

• Input:
  - Pre-retrieve traffic for some time period, typically a full day’s worth.
• Use rwfilter, rwstats, rwuniq, and rwset tools to generate asset lists and statistics
• Output: Multiple tables containing summarizations of traffic, Multiple set files

Test, Analyze, and Refine:

• Include test cases for how to handle large sets of data
• Reliability / performance / interpretable results
• What additional services are of interest?
• Do we have to limit our output in some manner? (e.g.: > 1% of packets)
# Network Profiling Using Flow (Section 5 Script)
Furthering Your SiLK Analysis Skills

SiLK tools site
• http://tools.netsa.cert.org

Using SiLK for Network Traffic Analysis

Tool Tips
• https://tools.netsa.cert.org/confluence/display/tt/Tooltips

Flow analysis research and advanced techniques
• http://www.cert.org/netsa

FloCon (January 2017, San Diego CA)
• http://www.cert.org/flocon