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Troubleshooting Firepower Threat Defense like a TAC Engineer

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TECSEC-3004

CISCO *Live!*

Barcelona | January 27-31, 2020



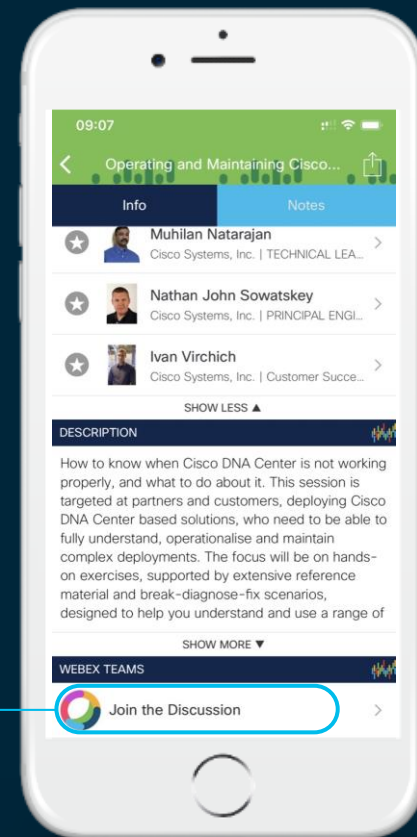
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Use Cisco Webex Teams to chat with the speaker after the session

How

- 1 Find this session in the Cisco Events Mobile App
- 2 Click “Join the Discussion”
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- 4 Enter messages/questions in the team space



Why is FTD troubleshooting so important?

- ASA and Firepower technologies have merged into a unified solution: FTD
- FTD is more complex to troubleshoot; an understanding of both ASA and Firepower technologies is needed.
- Without expertise, there is more risk of network downtime or security breaches. Both are frustrating and impact the business.

Presentation Objectives and Outcomes

- To combat this, today we're going to arm you with knowledge, skills, and tools to more effectively troubleshoot and resolve incidents on the Cisco FTD platform
- We encourage you to think about past or potential future experiences where you can apply these skills

Goal: Fewer late night
troubleshooting calls



Agenda

- Introduction
- Architecture Overview
- Path of the Packet
- Troubleshooting Tools
- Interactive Troubleshooting
- Q&A

Abstract

The Cisco Firepower Threat Defense (FTD) next-generation firewall (NGFW) solution combines battle-proven ASA firewall functionality with industry leading Firepower IDS/IPS, malware detection, and content filtering capabilities. Because of this substantial increase in security capacity, a familiarity with both Firepower and ASA technologies is important when troubleshooting the solution. In addition, a proper understanding of platform and datapath architecture is essential in order to properly isolate various components when troubleshooting connectivity issues through an FTD device.

This session will leverage the knowledge of senior engineers from Cisco TAC with both ASA and Firepower backgrounds to instruct participants on how to more effectively troubleshoot the converged FTD platform. The session will primarily focus on FTD architecture, packet flow, and troubleshooting tools. It will also feature live and/or recorded demos along with real-world problem scenarios to help attendees see how they can apply these skills to everyday issues in the field.

The target audience is network security operators who have a working knowledge of ASA and/or Firepower technologies. For those who want to learn more about FTD and how to integrate Cisco NGFW in other Security products, consider attending TECSEC-2600 - Next Generation Firewall Platforms and Integrations.

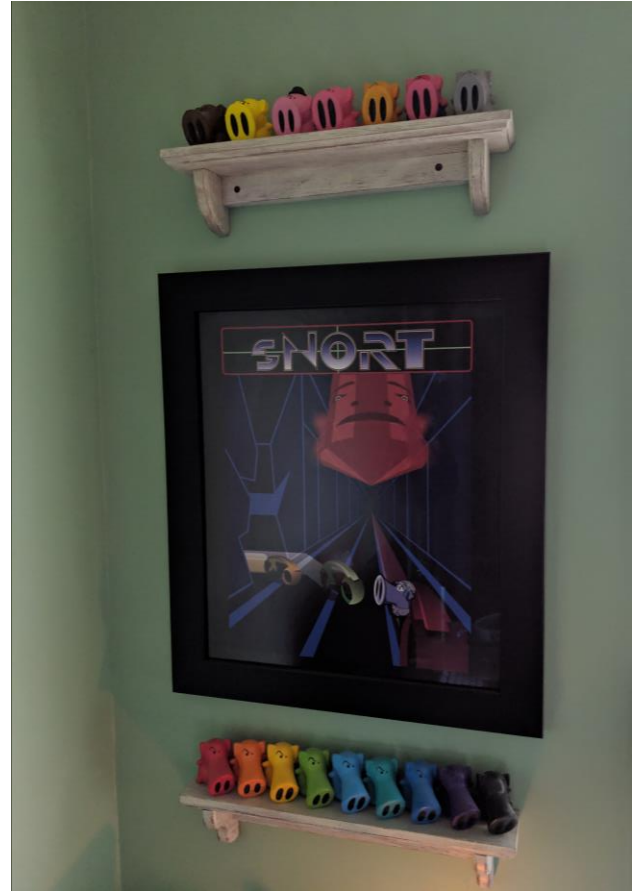
Your Presenters

Justin Roberts

- Technical Leader CX Security
- 5 years in Cisco Firepower TAC
- Before Cisco, Solaris 10/11 Administrator
- Snort collector
- Python enthusiast



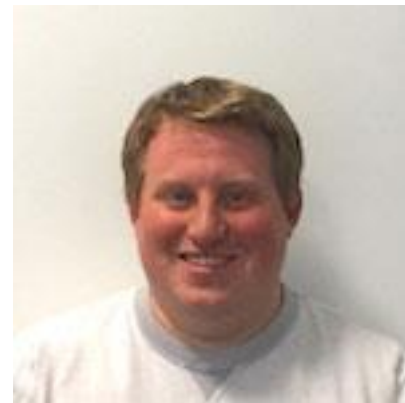
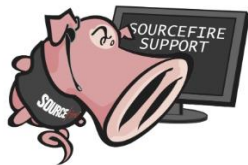
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Your Presenters

Foster Lipkey

- Firepower TAC TL
- Snort Expert
- Sourcefire Veteran
- Automation Enthusiast

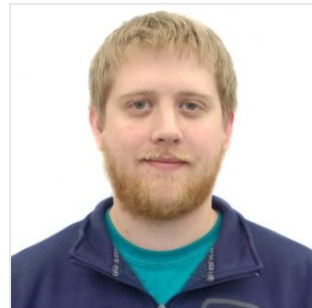


Foster Lipkey

Your Presenters

John Groetzinger

- Technical Leader for Firepower TAC
- 7+ Years experience with Firepower and Snort
- Original Sourcefire employee
- Network security and Linux enthusiast



Your Presenters

Kevin Klous

- Focused on Firewalls/NGFW in Cisco TAC since 2012
- Cisco Certified Internetwork Expert (Security – CCIE #43604)
- TAC Security Podcast host & panelist
- Pursuing M.S. in I.S. Engineering – Cybersecurity at JHU
- Serves as a Spanish translator for Guatemala missions

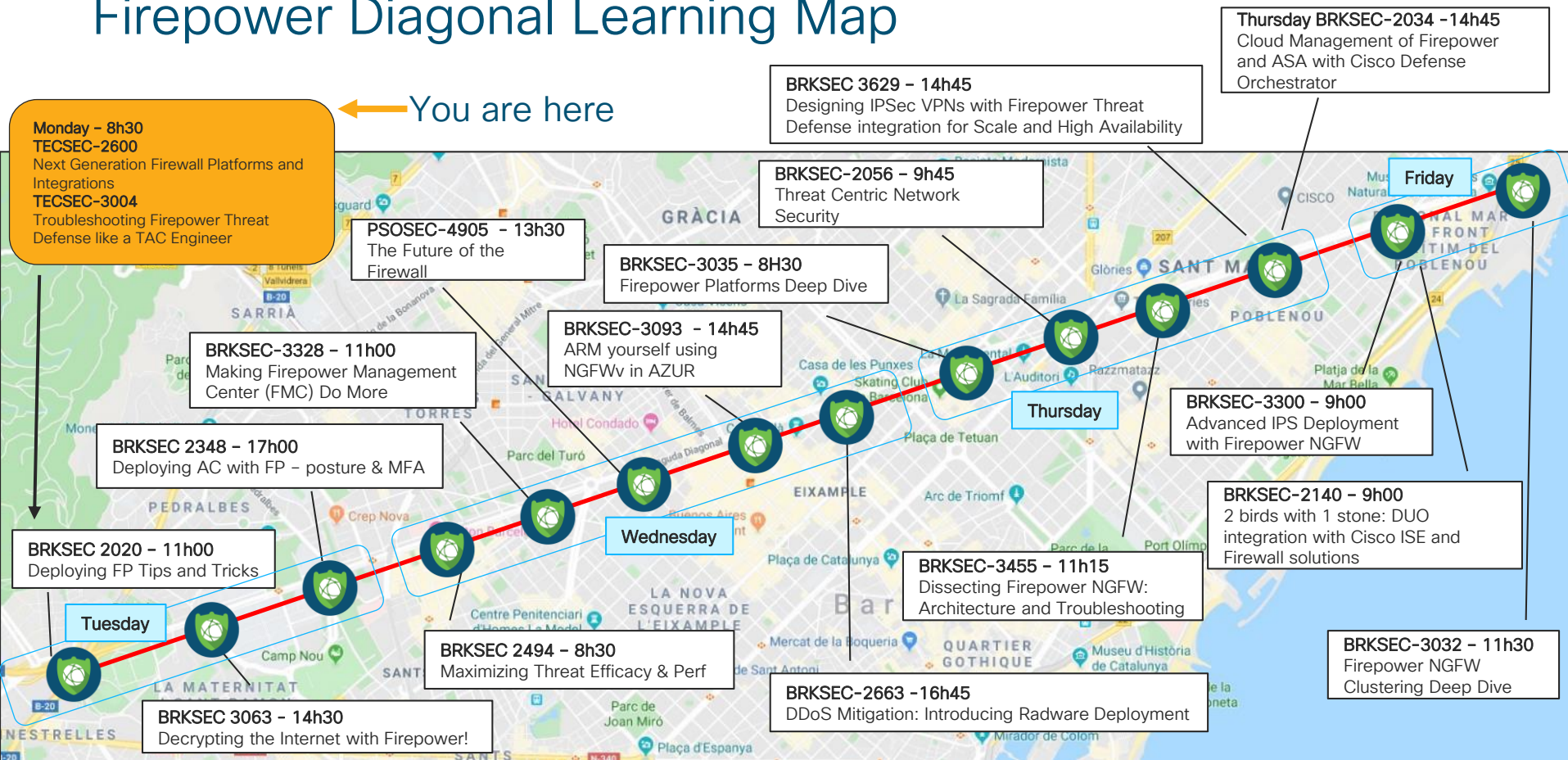


Introduction

Introduction – Presentation Focus Areas

- This is not an introductory session! General familiarity with either ASA or Firepower is assumed. If you do not have knowledge of the product you may want to consider attending TECSEC-2600 instead.
- Other Cisco Live presentations cover FTD features, design, deployment, and configuration. We are focused on product functionality and troubleshooting.
- Configuration and troubleshooting of the FXOS platform is out of scope although it will be referenced as needed.

Firepower Diagonal Learning Map



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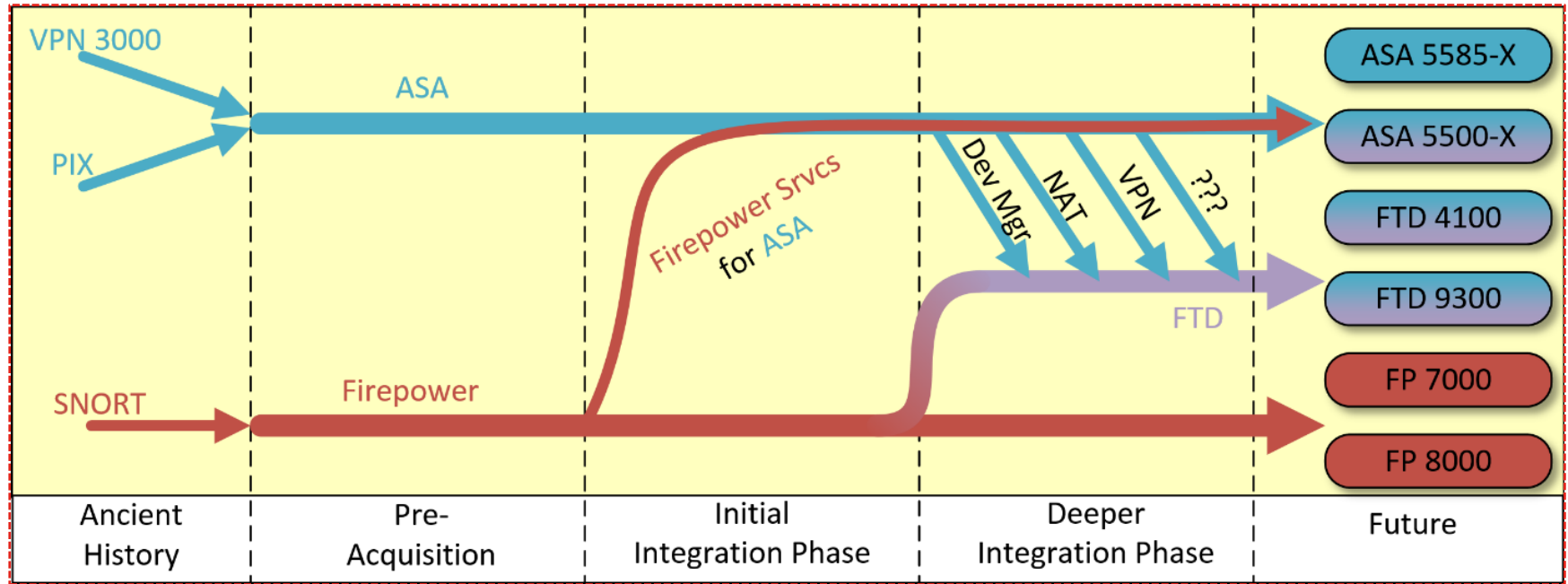
Introduction – Key Terminology



These terms are within the context of Firepower Threat Defense.

Term	Definition
Lina	Underlying ASA-derived process that is integrated into the FTD product
Snort	Components of the Firepower product integrated into FTD
FMC	Firepower Management Center – Off-box GUI used to manage FTD devices (Configuration, reporting, monitoring, etc.). Formerly the Firesight Management Center or Defense Center.
FDM	Firepower Device Manager – Web-based, on-box management option for low to mid-range platforms
FXOS	Firepower Extensible Operating System – System that manages the hardware platforms for Firepower 9300, 4100, and 2100 series products
FCM	Firepower Chassis Manager – On-box GUI used to manage FXOS platforms (Logical device configuration, interface assignments, monitoring, etc.)

NGFW evolution



Introduction – How did we get here?

2005

ASA 7.x introduced

2013

Cisco acquired
Sourcefire on
October 7, 2013



2014

ASA w/ Firepower
Services replaced ASA w/
CX

ASA 9.2(2)4+

Firepower 5.3.1+

2016

Firepower Threat Defense
6.0.1 introduced as
integrated solution

Hardware Platforms:



ASA 5500 Series



ASA 5500-X Series

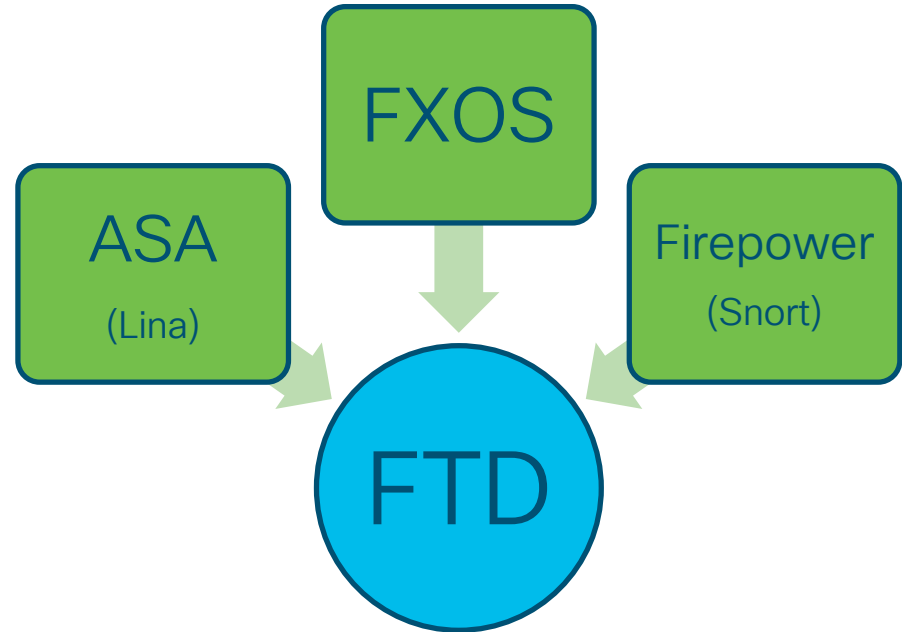


ASA 5500-X, Firepower
2100, 4100, 9300 Series

Architecture Overview: Software Functions

Introduction – What is Firepower Threat Defense?

- ASA and Firepower functionality wrapped into a single, unified image
- All processes run within single operating system
- Latest hardware platforms introduce Firepower Extensible Operating System (FXOS) as platform layer beneath the FTD application



Functional Overview – A Layered Approach

OSI Layer	Component	Examples
L1 - Physical	FXOS, 5500-X, Virtual platforms	Interface allocation, L1 configuration
L2 - Data Link	Lina (FXOS handles LACP on Firepower platforms - 2100, 4100, 9300)	Interface MAC Addressing, ARP
L3 - Network	Lina	IP Address assignment, Routing, NAT
L4 - Transport	Lina	TCP State checking, L4 ACLs
L5-7 - Session, Presentation, and Application Layers	Snort (Lina L7 inspection via MPF)	AppID, URL Filtering, IPS, SSL Decryption, User Awareness

Firepower Threat Defense - Functional Diagram

Platform (Virtual, 5500-X*, FPR 2100**, 4100, 9300)

Physical
Layer,
Interface
allocation,
HW
redundancy

Lina



Internal, DMA-based packet transport system

ARP, NAT,
Routing, L3
ACLs, TCP
State
Checking

Snort

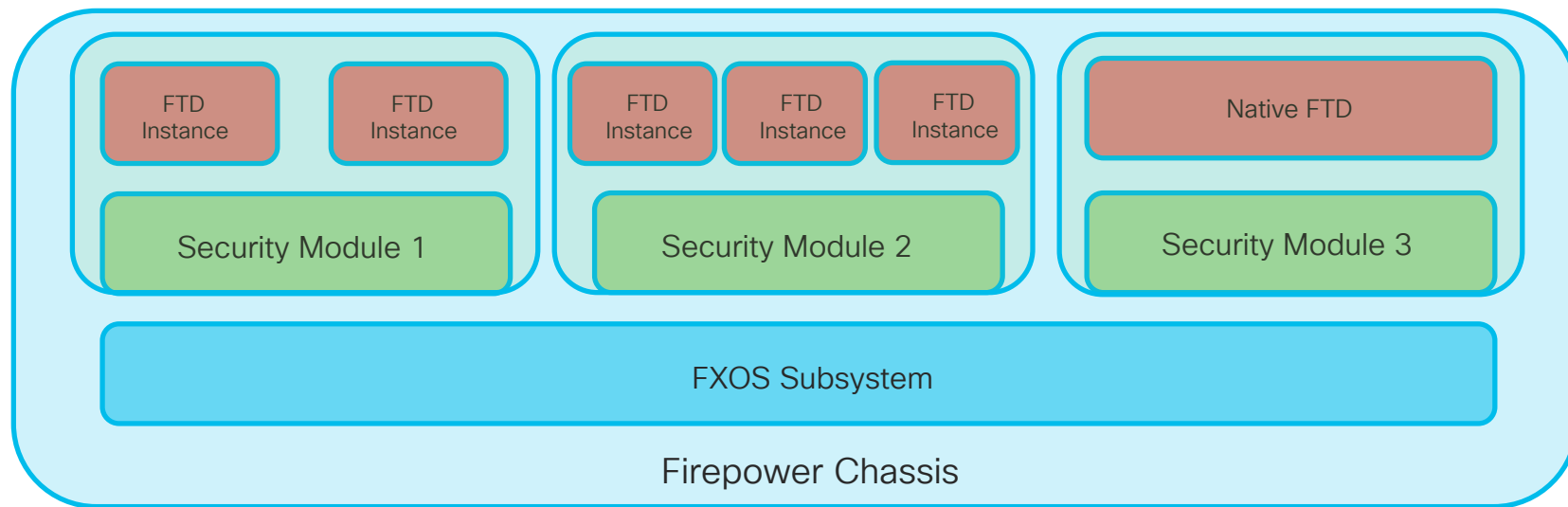
AppID, URL Filtering, IPS, SSL Decryption, User
Awareness, Geolocation, Security Intelligence

Multi-Instance FTD on FXOS Platforms

- MI feature was released in FTD 6.3 (December 2018)
- Similar to ASA multi-context feature but implementation is different:
 - Docker container instances instead of a single, partitioned application provides better tenant separation
 - Enables reboot/upgrade of individual instances without affecting other instances (FTD version of instances can be different)
 - Improved hardware resource separation since each instance has its own dedicated CPU cores, disk space, and memory
 - Instances sizes can be changed according to throughput/resource requirements

Multi-Instance Architecture

Firepower 9300 Example:



FTD – Navigating between the CLIs



FXOS (2100, 4100, 9300 platforms)

```
FPR9300#
```

Blade CLI (4100, 9300 platforms) ↓ connect module 1 console ↑ ~ then ENTER, then 'quit' then ENTER at telnet> prompt

```
Firepower-module1>
```

FTD Unified CLI (CLISH) ↓ connect ftd ↑ exit ('connect fxos' on FPR2100)

```
>
```

expert

Expert shell (BASH)

```
admin@Firepower-module1:/opt/bootcli/cisco/cli/bin$
```

exit

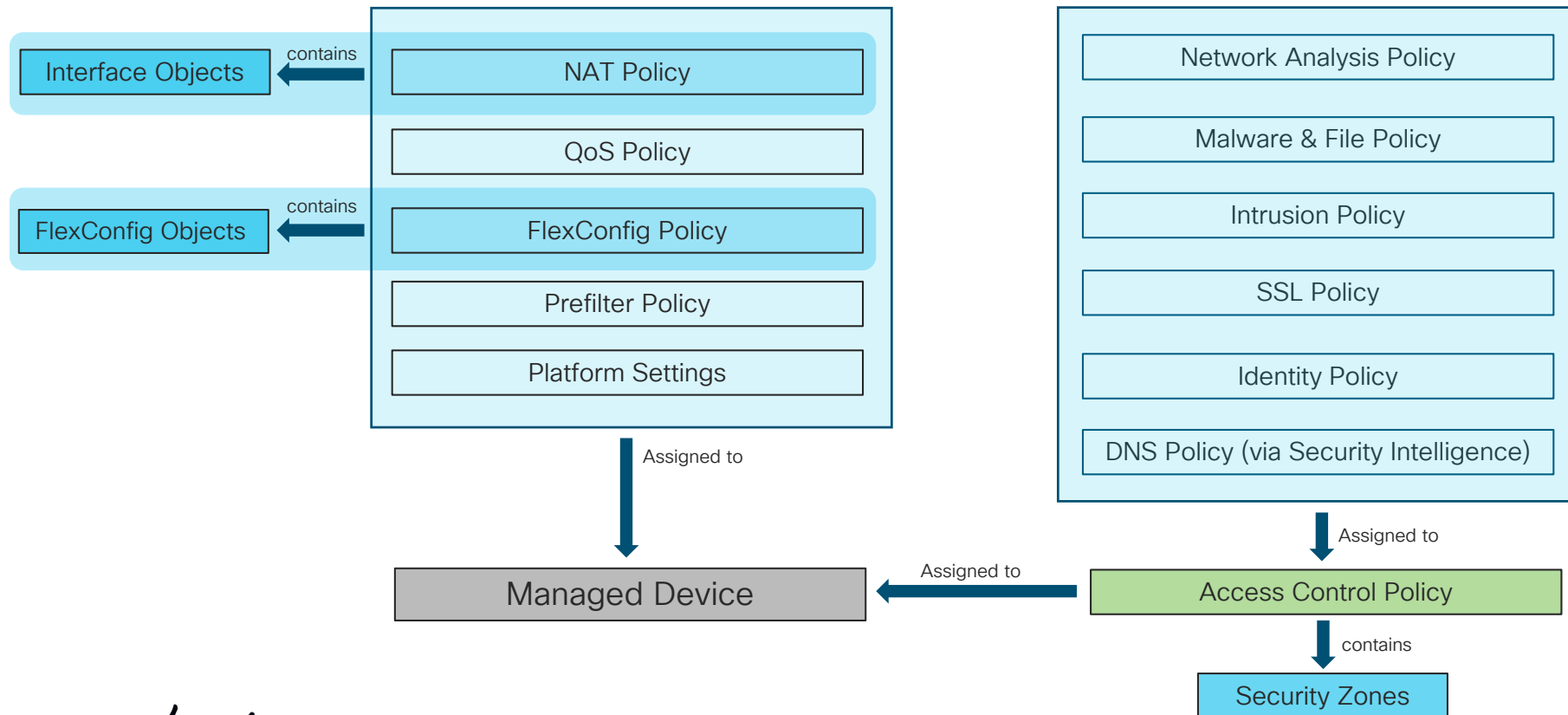
system support diagnostic-cli

Lina shell

```
firepower#
```

CTRL+a then d

FMC – Object Relationship Diagram



Functional Overview – Physical Layer (L1)

On FXOS platforms, interface allocation is handled via Firepower Chassis Manager (FCM) or the FXOS CLI. FCM example:

Hardware Bypass

Interface	Type	Admin Speed	Operational Speed	Application	Operation State	Admin State
MGMT	Management					Enabled
Port-channel1	data	1gbps	1gbps	FTD	failed	Enabled
Ethernet1/1					Individual	
Ethernet1/2					down	
Port-channel3	data	1gbps	indeterminate	FTD	failed	Enabled
Ethernet1/5					down	
Ethernet1/6					down	
Port-channel48	cluster	10gbps	indeterminate		failed	Enabled

Functional Overview – Physical Layer (L1)

Performing interface allocation in FXOS CLI:

```
FPR9300-A# scope ssa
FPR9300-A /ssa # show logical-device
```

Logical Device:

Name	Description	Slot ID	Mode	Operational	State
Template Name					
-----	-----	-----	-----	-----	-----
FTD			1	Standalone	Ok

```
ftd
```

```
FPR9300-A /ssa #
```

```
FPR9300-A /ssa # scope logical-device FTD
```

```
FPR9300-A /ssa/logical-device # show configuration
```

```
enter logical-device FTD ftd 1 standalone
```

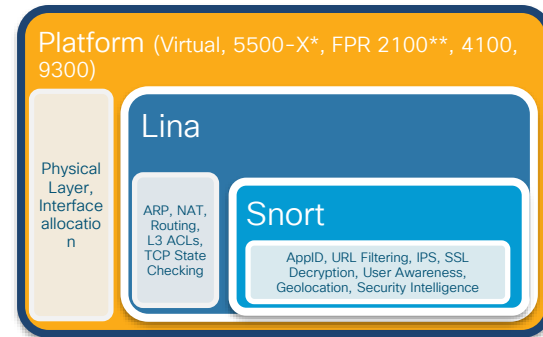
```
enter external-port-link Ethernet13_ftd Ethernet1/3 ftd
```

```
set decorator ""
```

```
set description ""
```

```
set port-name Ethernet1/3
```

```
exit
```

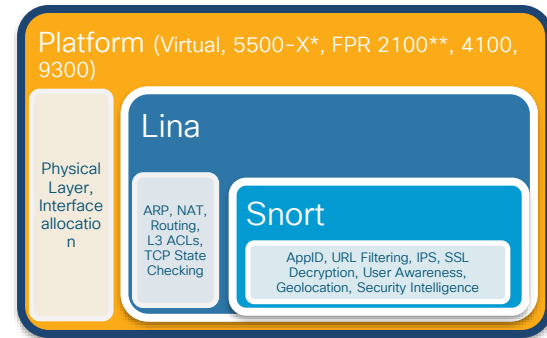


Functional Overview – Physical Layer (L1)

Viewing interface statistics in FXOS CLI:

```
FPR9300-A# scope eth-uplink
FPR9300-A /eth-uplink # scope fabric a
FPR9300-A /eth-uplink/fabric # show interface detail

Interface:
    Port Name: Ethernet1/3
...
FPR9300-A /eth-uplink/fabric # scope interface 1 3
FPR9300-A /eth-uplink/fabric/interface # show stats
...
Ether Rx Stats:
    Time Collected: 2017-04-17T23:45:33.906
    Monitored Object: sys/switch-A/slot-1/switch-ether/port-3/rx-
stats
    Suspect: No
    Total Packets (packets): 8968254
    Total Bytes (bytes): 1798297716
    Unicast Packets (packets): 1098012
    Multicast Packets (packets): 2480578
    Broadcast Packets (packets): 5389664
```



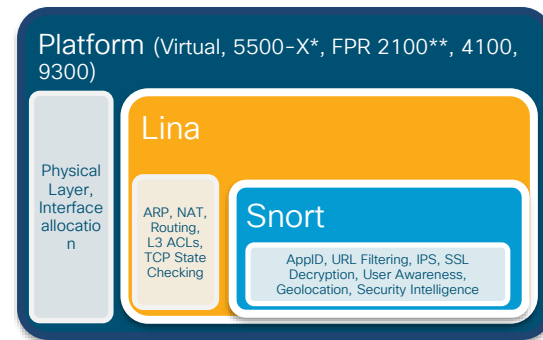
Functional Overview – Data/Network Layer (L2/3)

You can see L2 and L3-related interface information in the Unified CLI:

```
> show interface Ethernet1/3
Interface Ethernet1/3 "diagnostic", is up, line protocol is up
  Hardware is EtherSVI, BW 1000 Mbps, DLY 1000 usec
    MAC address b0aa.772f.849c, MTU 1500
    IP address 10.10.1.1, subnet mask 255.255.255.0
  Traffic Statistics for "diagnostic":
    4380985 packets input, 201525318 bytes
    0 packets output, 0 bytes
    162 packets dropped
    1 minute input rate 9 pkts/sec, 437 bytes/sec
    1 minute output rate 0 pkts/sec, 0 bytes/sec
    1 minute drop rate, 0 pkts/sec
    5 minute input rate 9 pkts/sec, 446 bytes/sec
    5 minute output rate 0 pkts/sec, 0 bytes/sec
    5 minute drop rate, 0 pkts/sec
  Management-only interface. Blocked 0 through-the-device packets
```

*Note that the above interface is a management-only interface

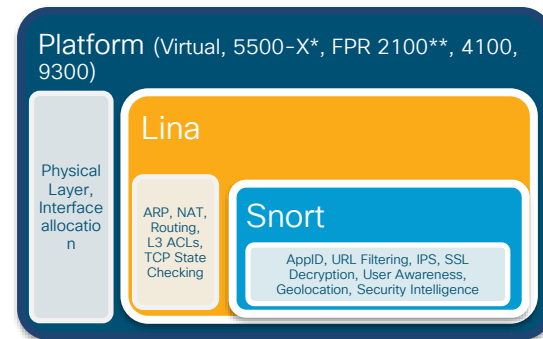
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Functional Overview – Network Layer (L3)

You can also view NAT configuration and active routes in the Unified CLI:

```
> show running-config nat
nat (inside,outside) source dynamic INSIDE_NETS interface
!
object network SRV-10.10.1.100-REAL
  nat (inside,outside) static SRV-10.10.1.100-GLOBAL
!
> show route
...
S*      0.0.0.0 0.0.0.0 [1/0] via 172.18.249.1, outside
C      169.254.1.0 255.255.255.252 is directly connected, nlp_int_tap
L      169.254.1.1 255.255.255.255 is directly connected, nlp_int_tap
>
```



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All legacy ASA show and debug commands are still available in FTD via the 'system support diagnostic-cli' command

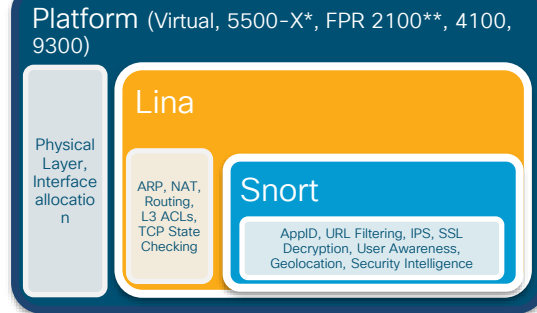
Functional Overview – Network/Transport (L4)

TCP state and L3/L4 ACL checking are performed by the Lina process

```
> show conn protocol tcp
165 in use, 54084 most used

TCP outside 10.106.45.60:443 inside38 14.38.104.110:56946, idle 0:00:18...
TCP outside 108.171.133.146:8080 inside38 14.38.104.1:25148, idle 0:00:03...
TCP outside 108.171.133.146:8080 inside38 14.38.104.1:13080, idle 0:00:21...
>
```

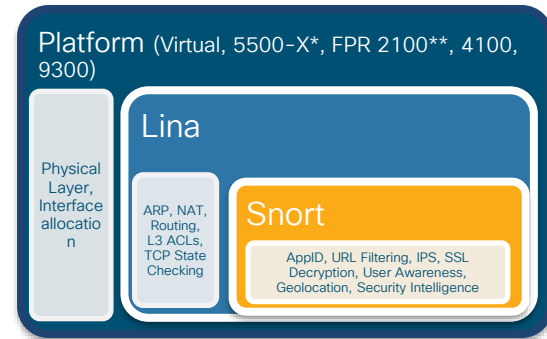
```
> show running-config access-list
access-list CSM_FW_ACL_ remark rule-id 268445405: PREFILTER POLICY: Default Prefilter Policy_1
access-list CSM_FW_ACL_ remark rule-id 268444672: ACCESS POLICY: FTD-ACPolicy-201703230950 - Default/1
access-list CSM_FW_ACL_ remark rule-id 268444672: L7 RULE: from_outside_#1
access-list CSM_FW_ACL_ advanced permit udp ifc outside 10.2.2.0 255.255.255.0 host 10.1.1.100 eq syslog
rule-id 268444672
...
```



Functional Overview – Upper Layers (5–7)

Snort-handled functions that occur at upper OSI layers:

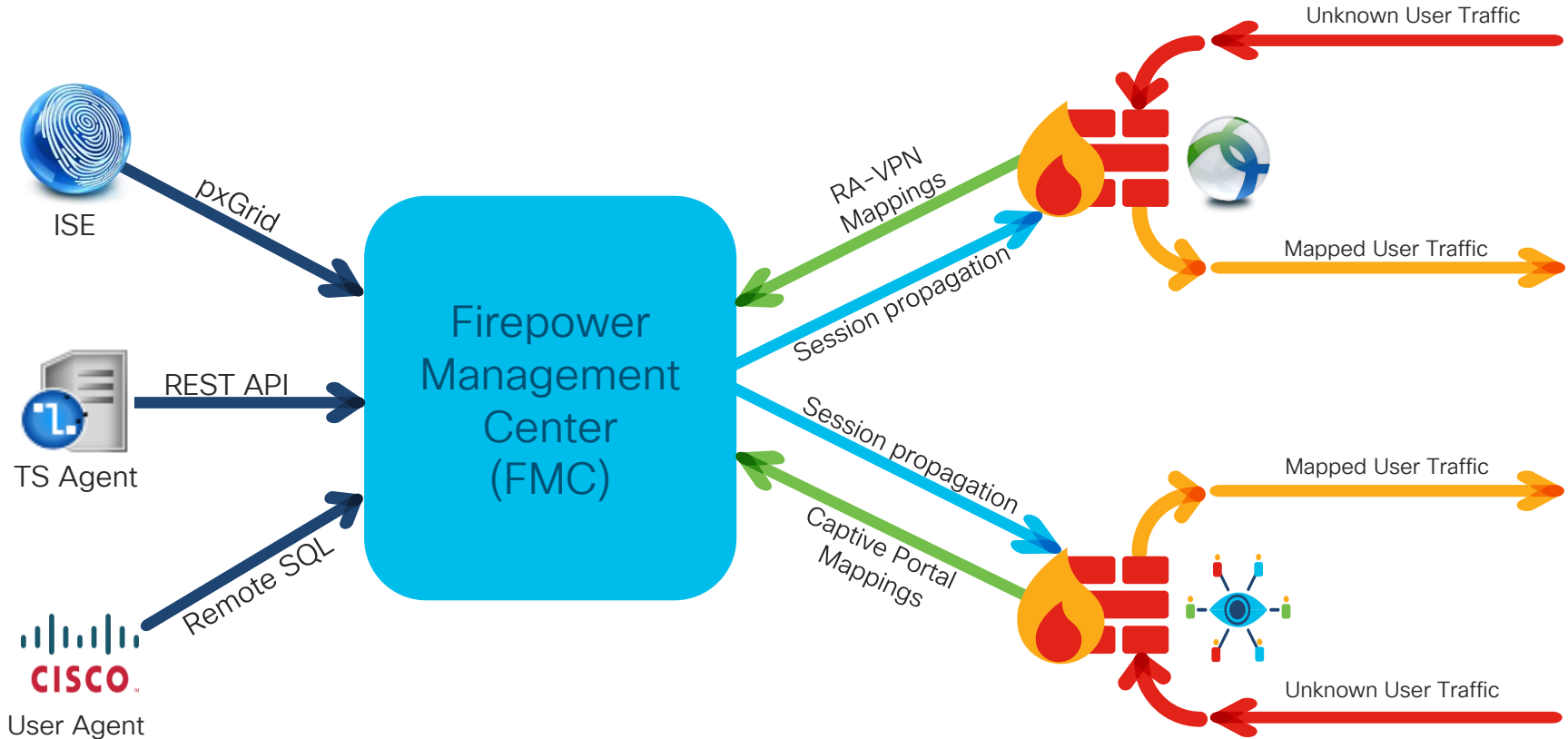
- Intrusion Prevention System (IPS)
- App Detection and OpenAppID
- URL Filtering
- SSL/TLS Decryption
- User Identity Awareness
- File and malware inspection



User Identity Overview

- Allows for auditing of user activity
- Allows for User and Group based access control
- Types of authentication
 - Active:
 - Captive Portal
 - Remote Access VPN (RA-VPN)
 - Passive:
 - Cisco Firepower User Agent (CFUA)
 - Terminal Services Agent (TSAgent)
 - Identity Services Engine (ISE / ISE-PIC)

Identity Architecture



Architecture Overview: CPU and Memory Allocation

FTD CPU and Memory Allocation

- CPU and memory are allocated to Lina and Snort via the use of Linux cgroups
- This resource pool (cgroup) separation limits scope of problem impact
- Troubleshooting approach depends on where issue resides

Example of Lina
and Snort CPU
allocations on a
Firepower 9300

```
firepower# show kernel cgroup-controller cpuset | begin lina
group "restricted/lina" ← Lina
cpuset.cpus: 1-8,18-25,37-44,54-61
cpuset.mems: 0-1
tasks:
    12507  12794  12803  12804
    12805  15917  15918  15943

group "restricted/qemu" ← Snort
cpuset.cpus: 9-17,26-35,45-53,62-71
cpuset.mems: 0-1
```


Lina Memory – Overview



- Lina memory is broken into two categories: Shared memory and DMA memory

```
firepower# show memory
Free memory:      250170904 bytes (47%)
Used memory:      286700008 bytes (53%)
-----
Total memory:     536870912 bytes (100%)
```

- If available memory trends down over time, call Cisco TAC

```
%ASA-3-211001: Memory allocation Error
```

- Use CISCO-ENHANCED-MEMPOOL-MIB.my for accurate SNMP counters
- Free memory may not recover immediately after conn spike due to caching

Lina Memory Blocks (Direct Memory Access)

- DMA memory involves fixed-size blocks allocated at startup
- Used for packet processing, VPN, etc.

firepower# show blocks			
SIZE	MAX	LOW	CNT
0	400	397	400
4	100	99	99
80	403	379	401
256	1200	1190	1195
1550	6511	803	903
2048	1200	1197	1200
2560	264	264	264
4096	100	100	100
8192	100	100	100
9344	2000	2000	2000
16384	102	102	102
65536	16	16	16
firepower#			

Current number of
free blocks available

1550, 2048, and 9344 byte blocks are
used for processing Ethernet frames

When DMA memory for a specific block
size runs low, the following syslog will
be generated for the specific block size:

```
%ASA-3-321007: System is low on free memory blocks of size 1550 (10 CNT out of 7196 MAX)
```

Lina CPU Utilization by Processes

- **show processes cpu-usage** command displays the amount of CPU used on a per-process basis for the last 5 sec, 1 min, and 5 min

```
> show process cpu-usage sorted non-zero
```

PC	Thread	5Sec	1Min	5Min	Process
0x08dc4f6c	0xc81abd38	14.4%	8.2%	8.0%	SNMP Notify Thread
0x081daca1	0xc81bcf70	1.3%	1.1%	1.0%	Dispatch Unit
0x08e7b225	0xc81a28f0	1.2%	0.1%	0.0%	ssh
0x08ebd76c	0xc81b5db0	0.6%	0.3%	0.3%	Logger
0x087b4c65	0xc81aaaf0	0.1%	0.1%	0.1%	MFIB
0x086a677e	0xc81ab928	0.1%	0.1%	0.1%	ARP Thread

Heavy CPU load from
SNMP traps.

If you have high CPU utilization for a generic process such as DATAPATH, contact the TAC as there are more granular CPU profiling tools available for deeper investigation

Snort, Lina, and the Firepower ecosystem

- Many processes run on Linux to support event collection and other management, including:

Process	Primary Purpose
Lina	ASA-like functions: L4 ACLs, ALG, Routing, Failover, Clustering, etc
Snort	Inspects traffic and writes events to unified log files
SFDataCorrelator	Read unified logs written by snort, and send events to FMC
sftunnel	Manage an encrypted connection back to the FMC over TCP/8305
ids_event_alerter	Sends syslogs and SNMP traps from sensor for intrusion events

- Process status can be verified with: **> pmtool status**
- Standard Linux troubleshooting tools, such as “**top**,” can be used to verify CPU and memory

Expert Mode – CPU Utilization by Processes

Open “**top**” program from BASH (Sorting by CPU is the default)

```
> expert
```

```
admin@firepower:~$ top
```

Processes sorted
by CPU

```
Cpu(s): 15.3%us,  5.8%sy,  0.0%ni, 78.4%id,  0.0%wa,  0.0%hi,  0.5%si,  0.0%st
Mem:  12321960k total,  5605756k used,  6716204k free,  148992k buffers
Swap:  3998716k total,    780k used,  3997936k free,  1222064k cached
```

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
12221	root	0	-20	1896m	299m	75m	S	100	2.5	2733:37	lina
22420	root	20	0	618m	8048	2980	S	42	0.1	1539:57	sftunnel
14777	root	20	0	2185m	60m	12m	S	0	0.5	8:11.23	SFDataCorrelator
25979	root	20	0	1893m	347m	12m	S	0	2.9	2:15.42	snort

- Lina handles its own resources. Disregard high CPU and memory readings for Lina in “top”
- Occasional high CPU for Snort is determined by current flow

Expert Mode – Memory Utilization by Processes

```
> expert
admin@firepower:~$ top
```

1. Open “top” program
2. Type “shift + f” to choose sorting field
3. Type “n” to select resident memory

```
Current Sort Field:  N  for window 1:Def
Select sort field via field letter
  k: %CPU           = CPU usage
  l: TIME           = CPU Time
  m: TIME+         = CPU Time, hundredths
*  N: %MEM          = Memory usage (RES)
  o: VIRT          = Virtual Image (kb)
```

Tasks: 465 total, 1 running, 464 sleeping, 0 zombie
Cpu(s): 41.6%us, 0.3%sy, 0.0%ni, 58.1%id, 0.0%wa, 0.0%hi, 0.0%si, 0.0%st
Mem: 132166192k total, 43796884k used, 86636864k free, 252k buffers
Swap: 7810780k total, 0k used, 7810780k free, 1732192k cached

PID	USER	PR	NI	VIRT	RES	SHR	S	%CPU	%MEM	TIME+	COMMAND
12506	root	0	-20	26.1g	1.1g	643m	S	1993	0.8	97328:59	lina
11949	root	1	-19	7813m	671m	37m	S	2	0.5	6:15.66	snort
12902	root	20	0	4129m	68m	16m	S	2	0.1	41:54.55	SFDataCorrelator

Processes sorted by
resident memory

Expert Mode – Memory Management Example

- Snort is the primary memory consumer, and will use more memory over time
- Low system memory is not necessarily a sign of a problem

Round numbers used to
simplify example

"System" cgroup
Limit: 5 GB

Memory	Process
1 GB	lina
1 GB	SFDataCorrelator
1 GB	Database
1 GB	DiskManager
1 GB	ids_event_alerter

"Detection" cgroup
Limit: 10 GB

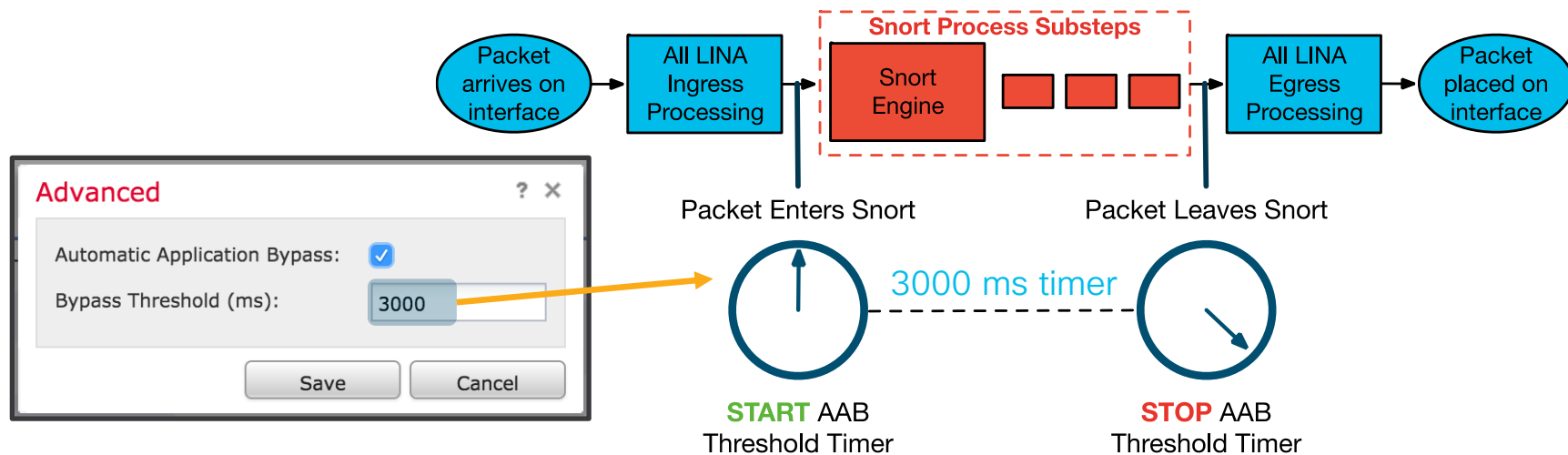
Memory	Process
2 GB	snort
2 GB	snort
2 GB	snort
2 GB	snort
2 GB	snort
2 GB	snort

Errors in /var/log/messages

```
kernel: SFDataCorrelator invoked oom-killer: gfp_mask=0xd0, order=0, oom_adj=0  
kernel: Task in /System killed as a result of limit of /System
```

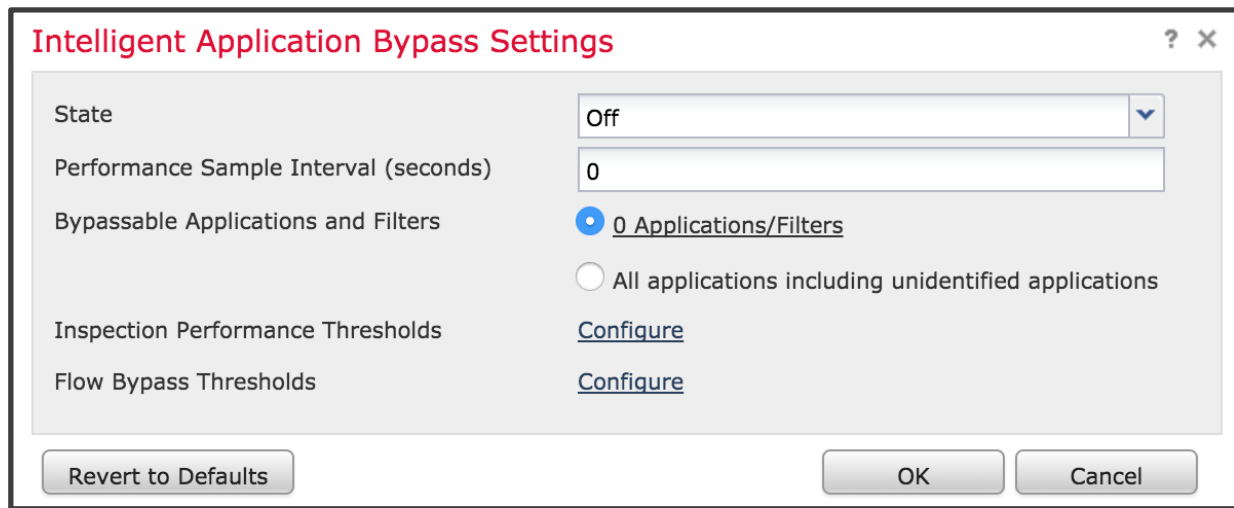
- Snort is protected from low-memory issues caused by processes in other cgroups

Snort - Automatic Application Bypass



- AAB is a per packet timer for snort
- A snort instance is killed if a packet fails to egress before the threshold
- A snort core file is collected for root cause analysis
- The process manager will respawn snort
- Do not go below 3000 milliseconds threshold unless recommended by TAC

Snort - Intelligent Application Bypass



The image shows a dialog box titled "Intelligent Application Bypass Settings" with a red title bar and a close button. The dialog contains several configuration options:

- State:** A dropdown menu currently set to "Off".
- Performance Sample Interval (seconds):** A text input field containing the value "0".
- Bypassable Applications and Filters:** Two radio button options:
 - ☒ 0 Applications/Filters
 - ☐ All applications including unidentified applications
- Inspection Performance Thresholds:** A link labeled Configure.
- Flow Bypass Thresholds:** A link labeled Configure.

At the bottom of the dialog, there are three buttons: "Revert to Defaults", "OK", and "Cancel".

- IAB is a performance optimization tool for elephant flows
- Invoked in a simple 2-step process:
 1. Does snort exceed the "Inspection Performance Thresholds" (high CPU, % dropped traffic, etc)?
 2. If yes, then dynamically Trust flows which match "Flow Thresholds" (bytes/sec, packets/flow, etc).
- Configured under Access Control Policy > Advanced tab

Snort – AAB vs IAB

- Automatic Application Bypass (AAB) mitigates dataplane impact of:
 - Out of memory situations impacting snort
 - Snort brownout / deadlock scenarios
 - Misconfiguration or over-subscription of IPS*
 - Always enable AAB at the default 3000 ms threshold – NOT enabled by default!

Advanced



Application Bypass:	No
Bypass Threshold:	3000 ms

* AAB is occasionally invoked when too many snort rules are enabled, or too much traffic is inspected

- Intelligent Application Bypass addresses large flow performance, whereas AAB is a stability feature
- Enable IAB on a case-by-case basis where prefilter and Trust rules do not fit requirements

Expert Mode – Core Files

- If a process on Linux exits unexpectedly, a core file may be written to the file system

FTD on FP2100, FP4100, FP9300	FTD on ASA and Virtual Platforms (VMware, KVM, AWS, Azure)
<ul style="list-style-type: none">Cores written to <code>/opt/cisco/csp/cores/</code>Core automatically compressed and moved to <code>/ngfw/var/data/cores/</code>	<ul style="list-style-type: none">Cores written uncompressed to <code>/ngfw/var/common/</code>
<code>core.snort.6.5373.1496879772.gz</code>	<code>core_1496879772_sensor_snort_6.5373</code>

Process name

POSIX
kill signal

Process
ID

Unix Epoch Timestamp
(Secs since 1970-Jan-01)

Hostname

Expert Mode – Disk Management

- The DiskManager process manages collections of files called “silos”
- If space is low, DiskManager will prune each silo based on a preconfigured threshold

```
> show disk-manager
```

Silo	Used	Minimum	Maximum
Temporary Files	0 KB	584.291 MB	2.282 GB
Backups	0 KB	4.565 GB	11.412 GB
Updates	0 KB	6.847 GB	17.118 GB
Archives & Cores & File Logs	0 KB	4.565 GB	22.824 GB
RNA Events	0 KB	4.565 GB	18.259 GB
File Capture	0 KB	11.412 GB	22.824 GB
Connection Events	0 KB	413.320 MB	826.642 MB
IPS Events	0 KB	13.694 GB	34.236 GB
[lines_removed]			

Expert Mode – Disk Management

- The Lina file system is accessible from expert mode via /mnt/disk0

```
# Create a capture from the unified CLI
> capture CAPTURE match ip any host 8.8.8.8

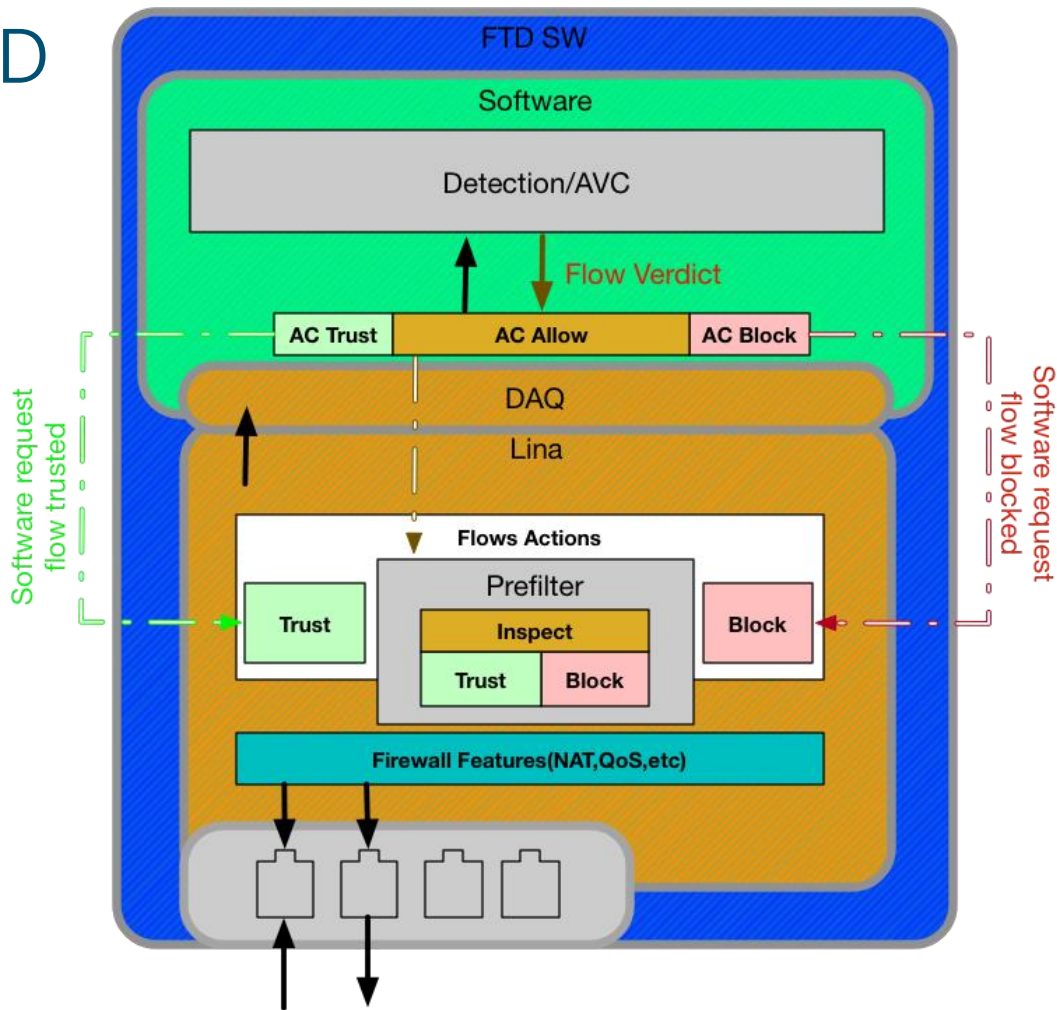
# Enter the diagnostic (lina-only) CLI
> system support diagnostic-cli
firepower# copy /pcap capture:CAPTURE disk0:CAPTURE.pcap

# Enter expert mode and browse to /mnt/disk0
> expert
admin@FPR4100:/mnt/disk0 $ ls
CAPTURE.pcap
[lines_removed]
```

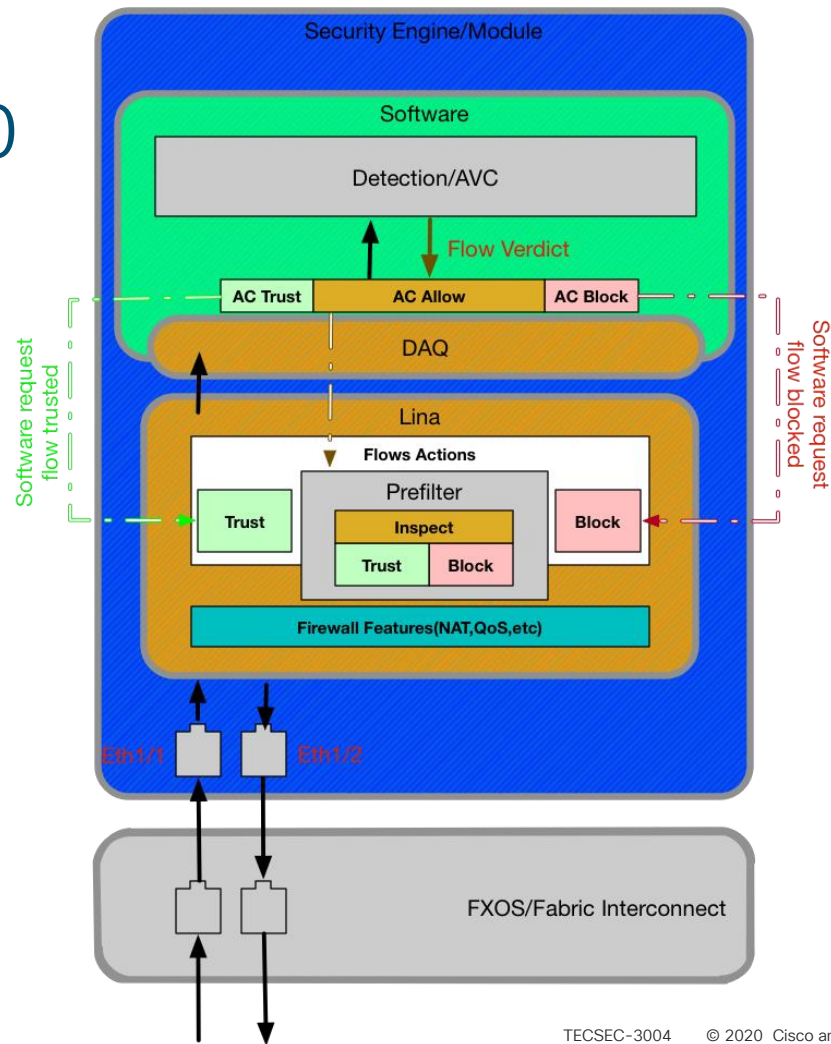
The Path of the Packet (Platform Architecture)

Virtual FTD

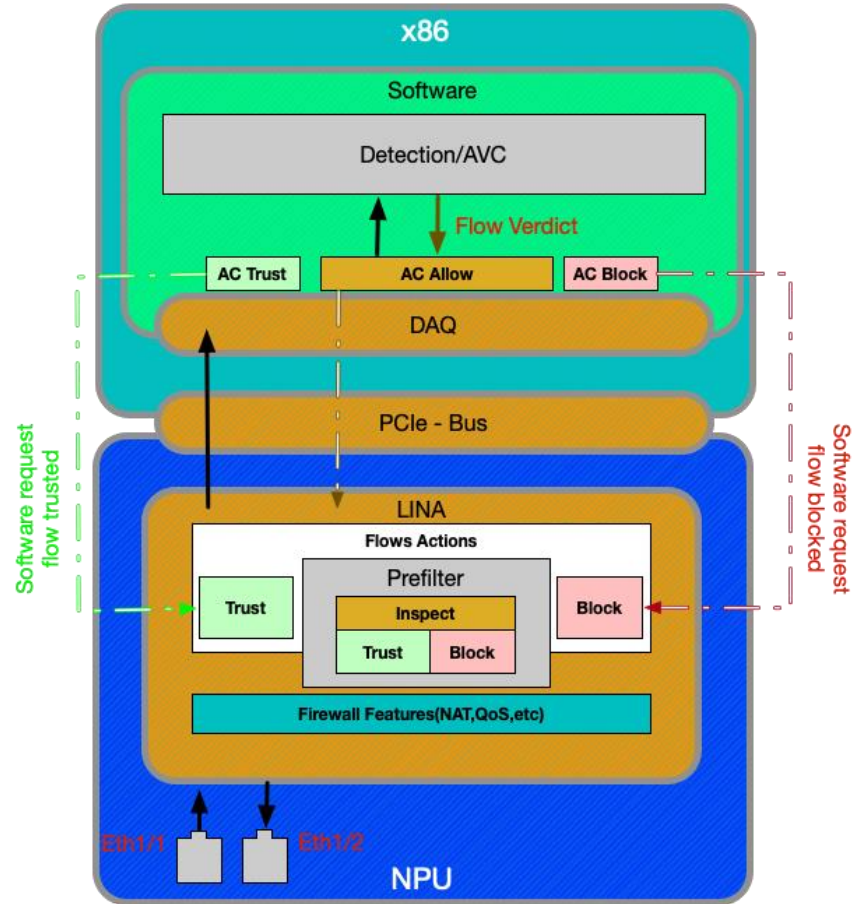
VMWare
AWS
Azure
KVM
Hyper-V



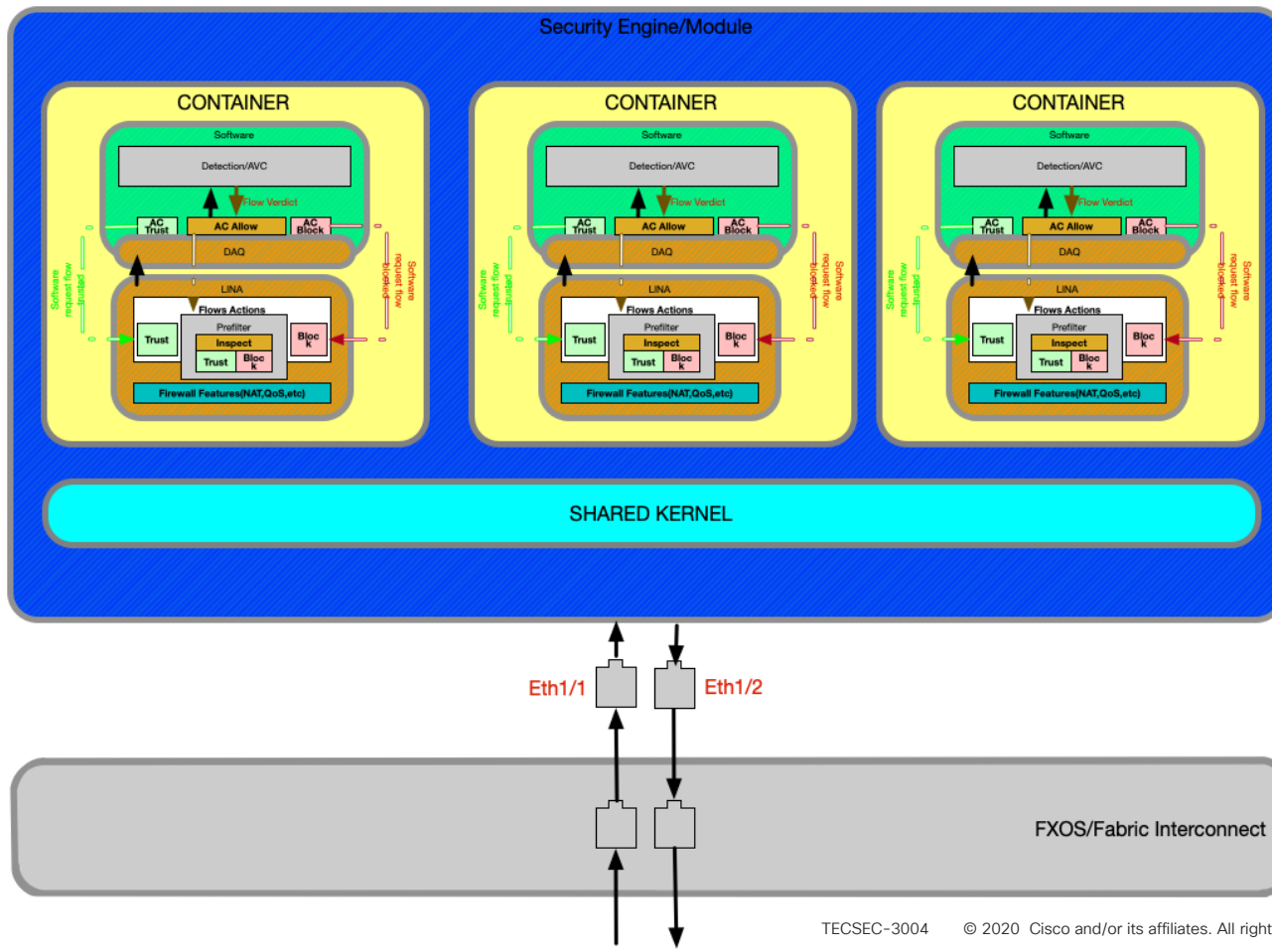
Firepower 4100 & 9300



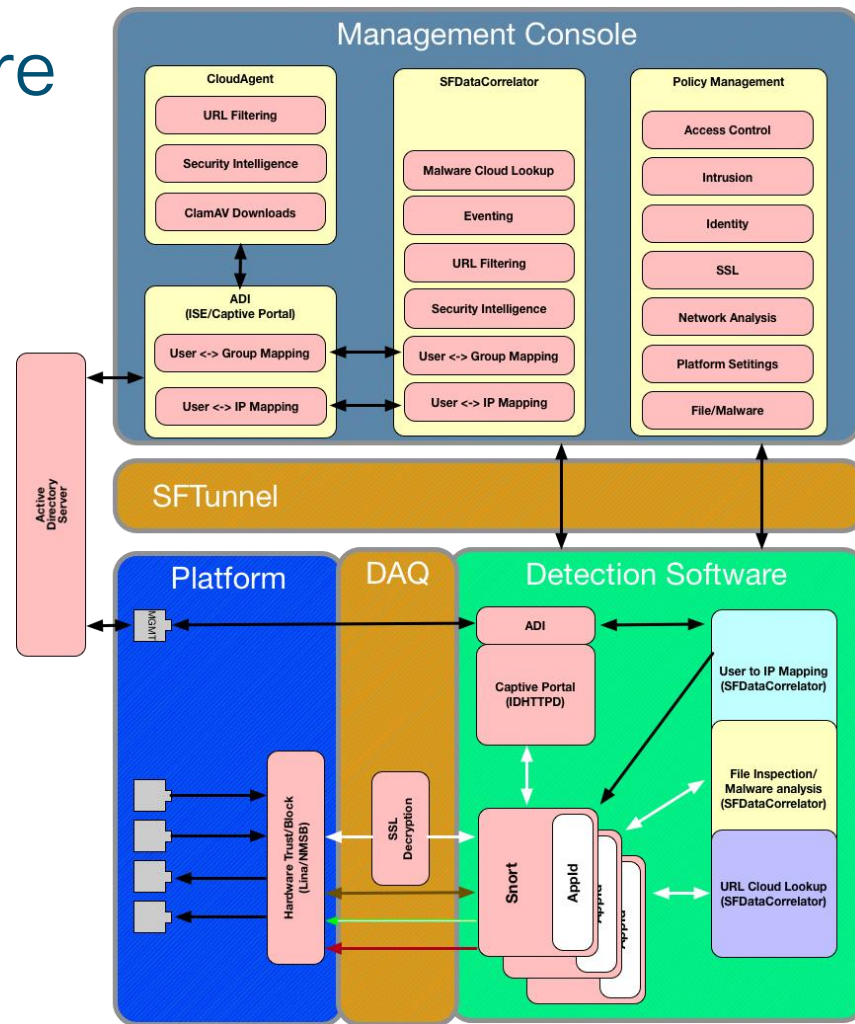
Firepower 2100



Multi-Instance architecture overview(9300/4100)



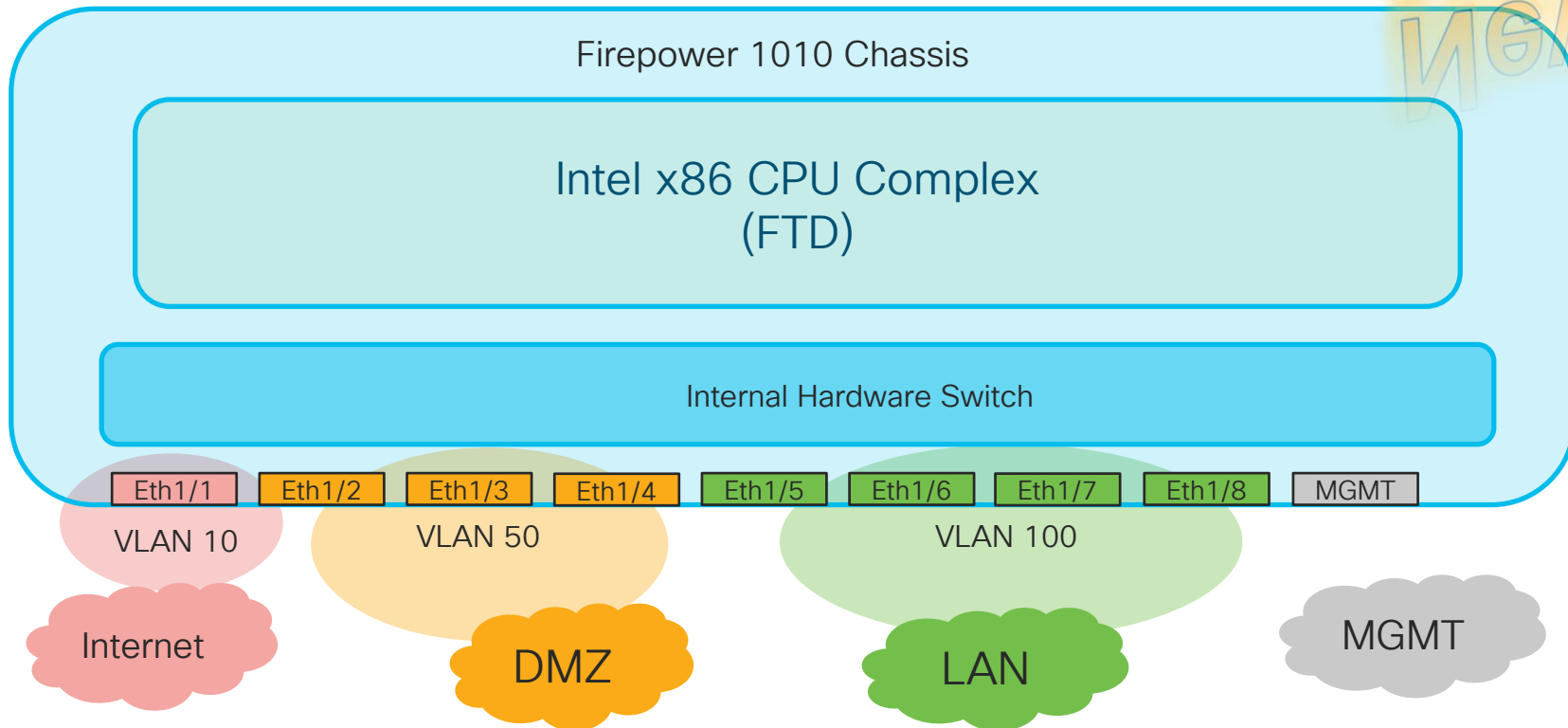
Virtual/Software diagram



Firepower 1010 – L2 Switching Overview

New!
MGMi

- New in 6.5 - Eliminates the need for an external switch in SOHO environments



The Path of the Packet (Software / Logical Flow)

Understanding Packet Flow

Effective troubleshooting requires an understanding of the packet path in network

1. Attempt to isolate the problem down to a single device
2. Perform a systematic walk of the packet through device to identify problem

For problems relating to FTD, always

- Determine the flow: Protocol, Source IP, Destination IP, Source Port, Destination Port
- Determine the logical (named) interfaces through which the flow passes

```
TCP outside 172.16.164.216:5620 inside 192.168.1.150:50141, idle 0:00:00, bytes 0, flags saA
```

All firewall connectivity issues can be simplified to two interfaces (ingress and egress) and the policies tied to both

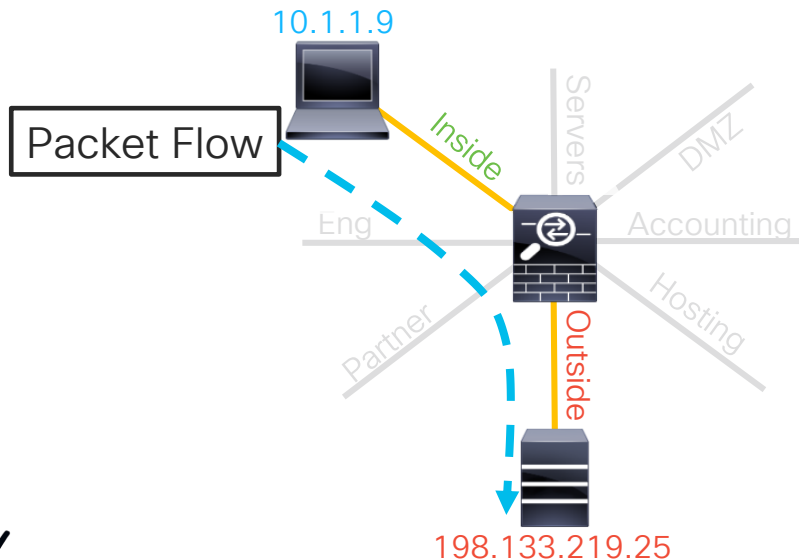
Example Flow

- TCP Flow

- Source IP : 10.1.1.9 Source Port : 11030
- Destination IP : 198.133.219.25 Destination Port : 80

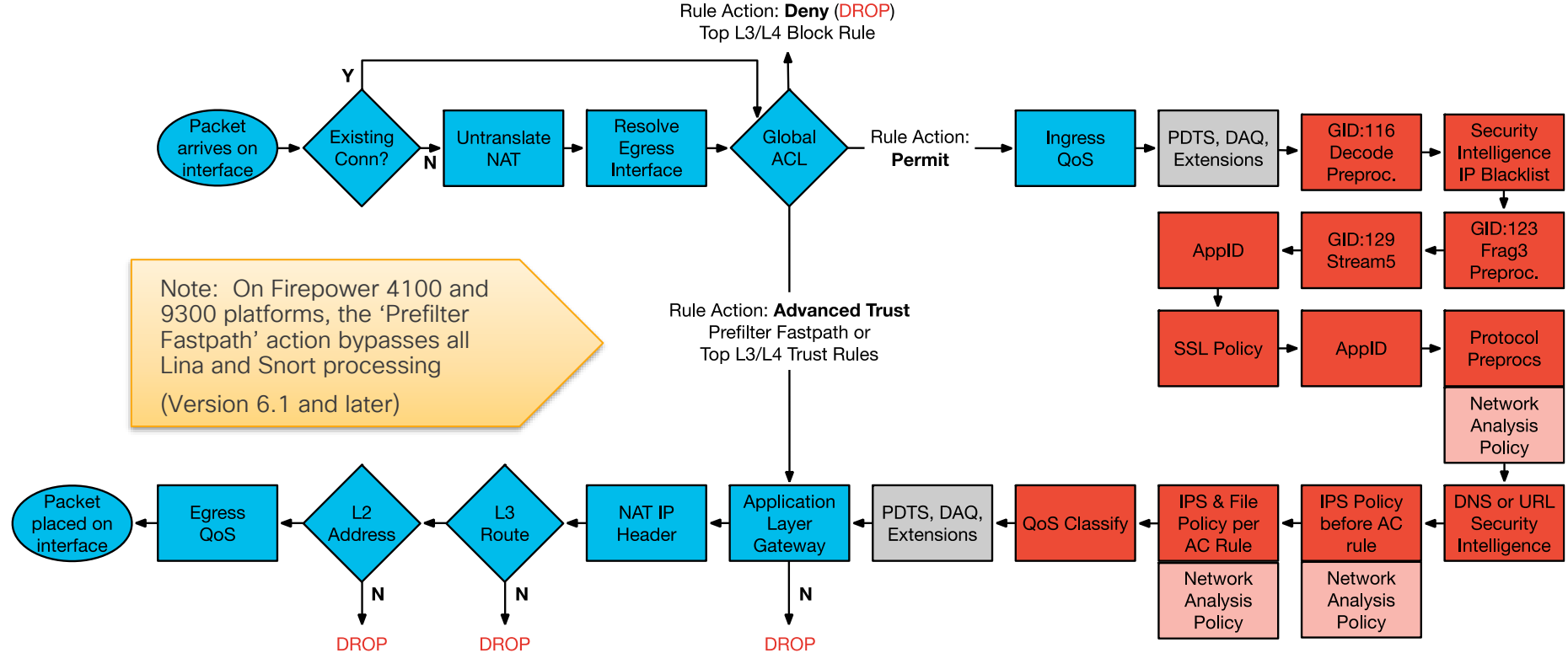
- Interfaces

- Source: **Inside** Destination: **Outside**



With the Flow defined, examination of configuration issues boils down to just the two Interfaces: **Inside** and **Outside**

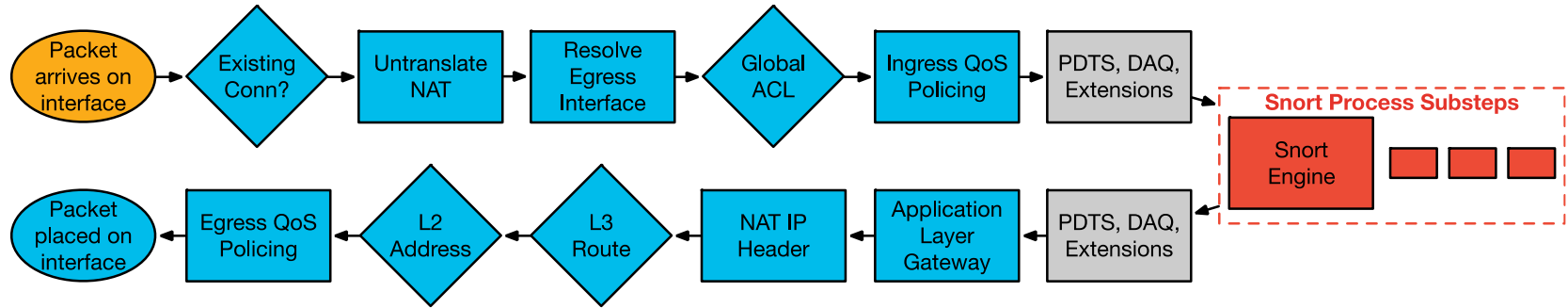
Reference Slide: Routed FTD Path of Packet



LINA ASA Engine = BLUE

Snort Engine = RED

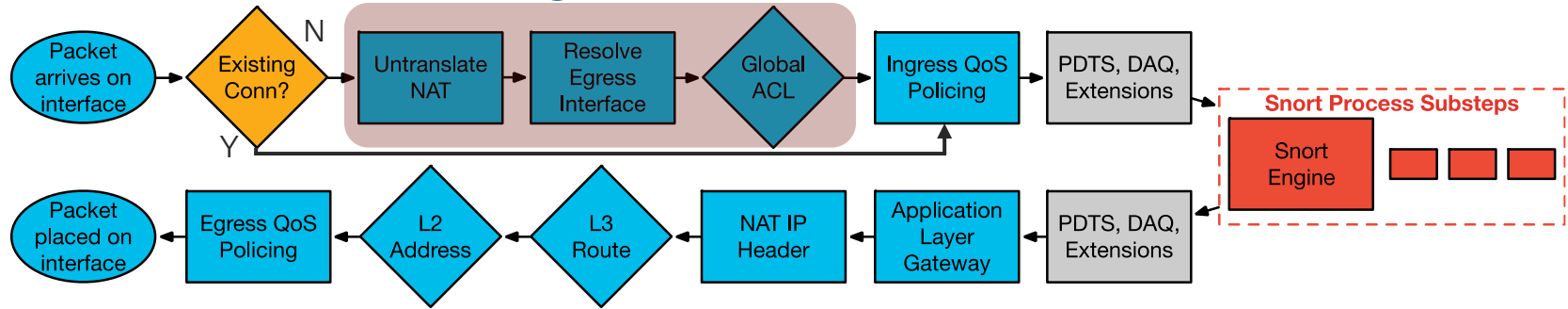
Packet Processing: Ingress interface



- Packet arrives on ingress interface
- Input counters incremented by NIC and periodically retrieved by CPU
- Software input queue (RX ring) is an indicator of packet load
- **Overrun** counter indicates packet drops (usually packet bursts)

```
> show interface outside
Interface GigabitEthernet0/3 "outside", is up, line protocol is up
  Hardware is i82546GB rev03, BW 1000 Mbps, DLY 10 usec
[...
    IP address 148.167.254.24, subnet mask 255.255.255.128
    54365986 packets input, 19026041545 bytes, 0 no buffer
    Received 158602 broadcasts, 0 runts, 0 giants
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
[...
    input queue (blocks free curr/low): hardware (255/230)
    output queue (blocks free curr/low): hardware (254/65)
```

Packet Processing: Locate Connection



- Check for existing connection in conn table

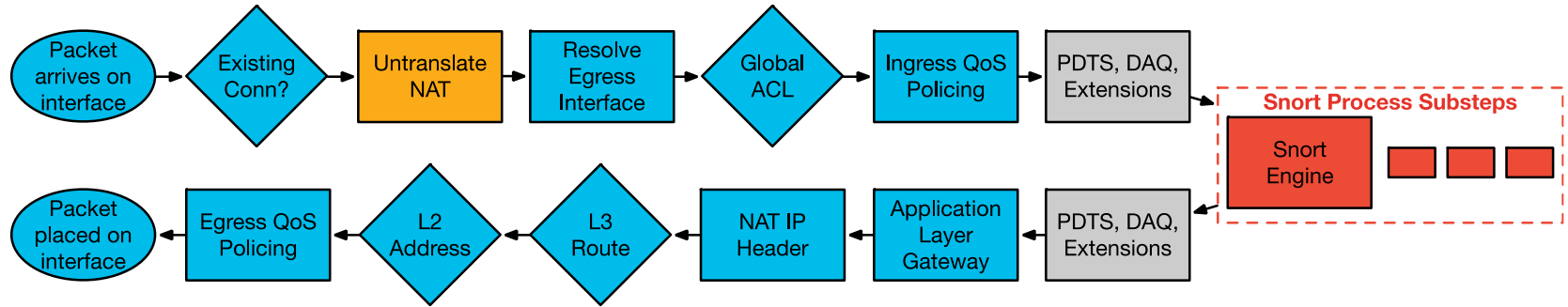
```
> show conn
TCP out 198.133.219.25:80 in 10.1.1.9:11030 idle 0:00:04 Bytes 1293 flags UIO
```

- If no existing connection
 - TCP SYN or UDP packet, pass to ACL and other policy checks in Session Manager
 - TCP non-SYN packet, drop and log

```
ASA-6-106015: Deny TCP (no connection) from 10.1.1.9/11031 to 198.133.219.25/80 flags PSH ACK on interface inside
```

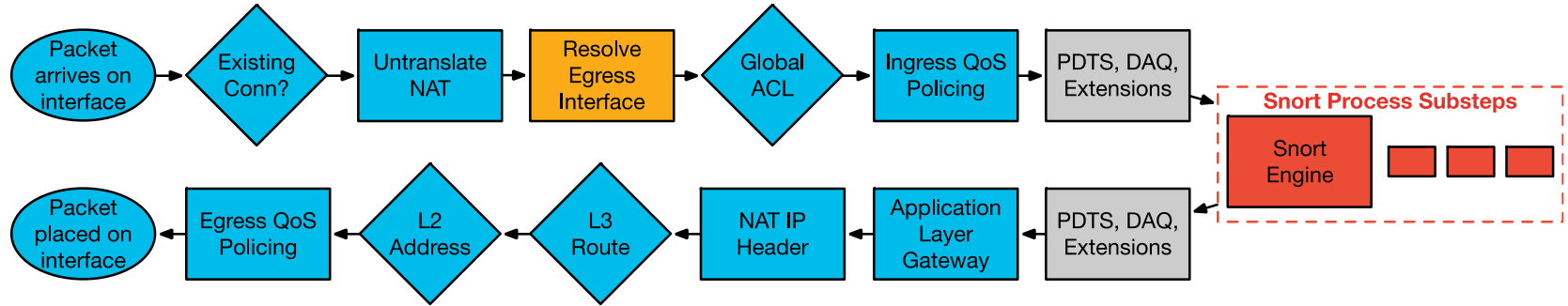
If connection entry exists, bypass ACL check and process in Lina fastpath

Packet Processing: NAT Un-Translate

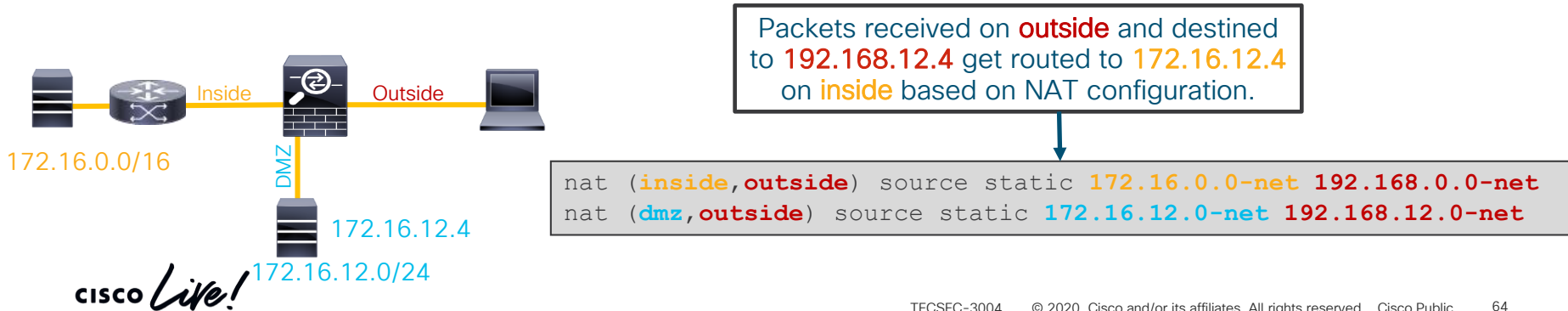


- Incoming packet is checked against NAT rules
- Packet is un-translated first, before ACL check
- NAT rules that translate the destination of the packet can override the routing table to determine egress interface (NAT divert)
 - Could also override policy-based routing (PBR)

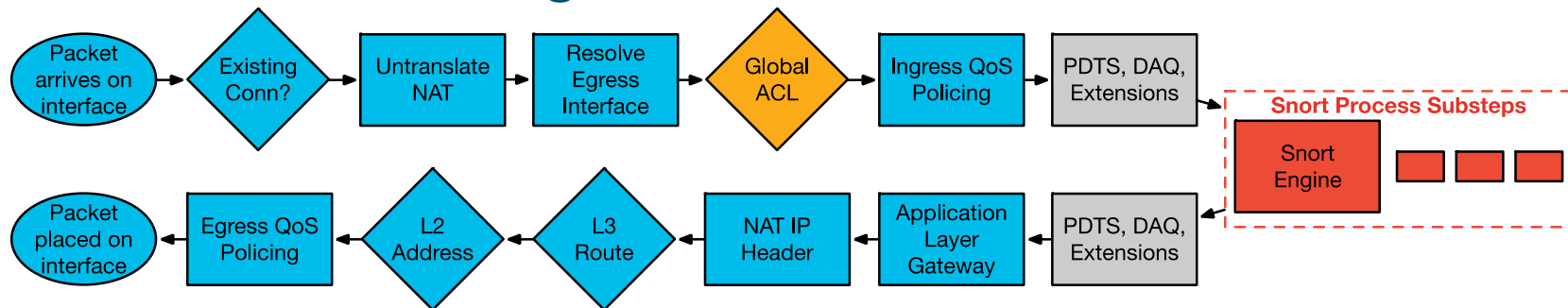
Packet Processing: Egress Interface



- Egress interface is determined **first** by translation rules or existing conn entry
- If NAT does not divert to the egress interface, the global routing table is consulted to determine egress interface



Packet Processing: Global ACL Check



- First packet in flow is processed through ACL checks
- ACLs are **first configured** match
- First packet in flow matches ACE, incrementing hit count by one

```
> show access-list
...
CSM_FW_ACL_ line 5 advanced permit tcp any any rule-id 9998 (hitcnt=5) 0x52c7a066

> show running-config access-group
access-group CSM_FW_ACL_ global
```

Packet Processing: Global ACL Check

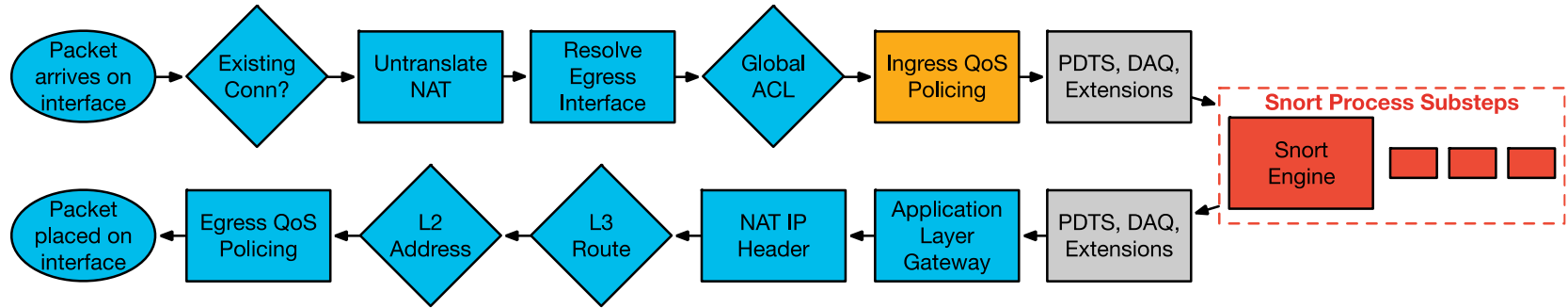
- All L4 access control entries are in one global ACL
- Prefilter Fastpath rules skip snort and show up as “**Advanced Trust**” in Lina global ACL

#	Name	Rule Ty...	Source Interface...	Destinati... Interface...	Source Networks	Destinati... Networks	Source Port	Destinati... Port	VLAN Tag	Action
1	Fastpath 10.1.2.3	Prefilter	any	any	10.1.2.3	any	any	any	any	→ Fastpath

```
> show running-config access-group
access-group CSM_FW_ACL_ global

> show access-list
[lines_removed]
access-list CSM_FW_ACL_ line 1 remark rule-id 268435484: PREFILTER POLICY: FPR4100_Prefilter
access-list CSM_FW_ACL_ line 2 remark rule-id 268435484: RULE: Fastpath 10.1.2.3
access-list CSM_FW_ACL_ line 3 advanced trust ip host 10.1.2.3 any rule-id 268435484 event-
log flow-end (hitcnt=0) 0x98824a05
```

Packet Processing: Ingress QoS Policing

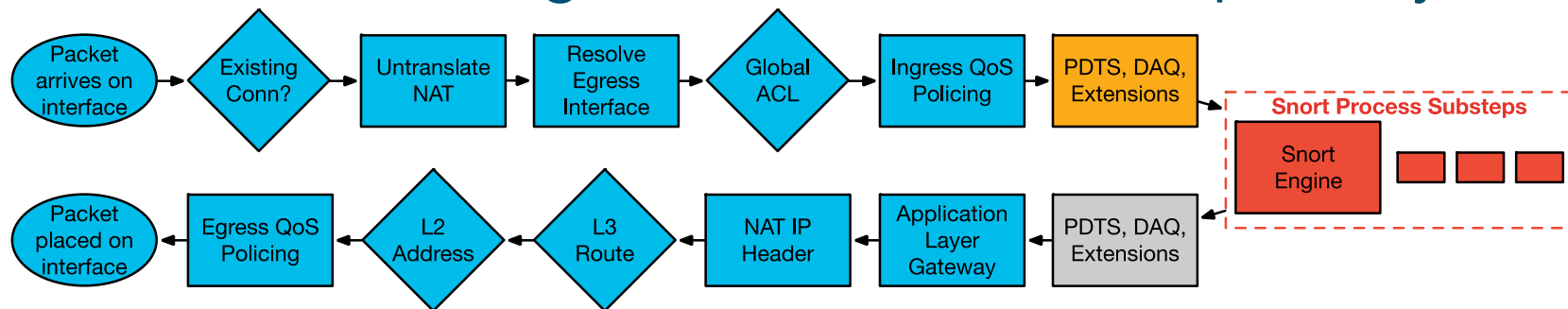


- QoS policing is enforced within the Lina process

```
> system support diagnostic-cli

firepower# show service-policy interface inside
Interface inside:
  Service-policy: policy_map_inside
  Flow-rule QoS id: 268435467
  Input police Interface inside:
    cir 1000000 bps, bc 31250 bytes
```

Packet Processing: Packet Data Transport System



The Packet Data Transport System sends packets to Snort after initial Lina inspections

```
show asp inspect-dp snort
```

Displays conns and packets sent to each snort instance and process ID, as well as snort status

```
show asp inspect-dp snort counters summary
```

Display frames, bytes, and conns for snort instances

```
show asp inspect-dp snort queues
```

Display rx and tx queue utilization for snort instances

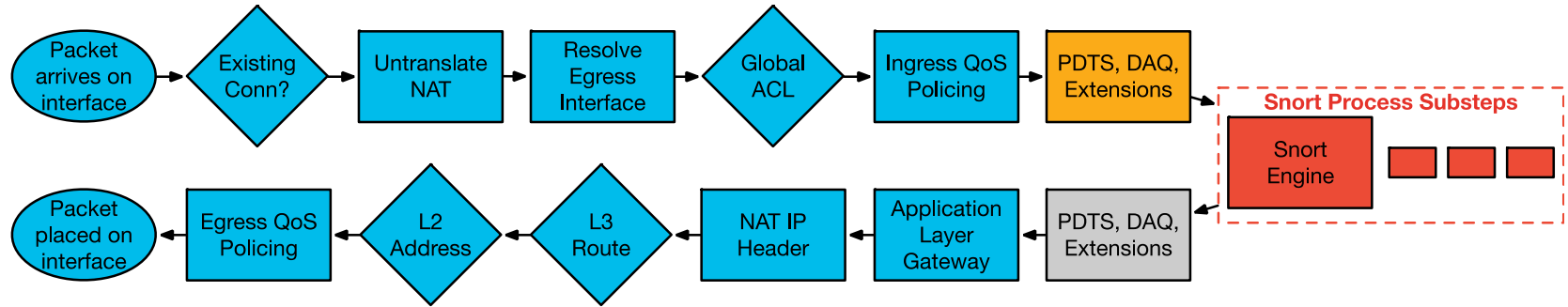
```
clear asp inspect-dp snort
```

Clear all of the above PCTS counters

```
show asp inspect-dp snort queue-exhaustion
```

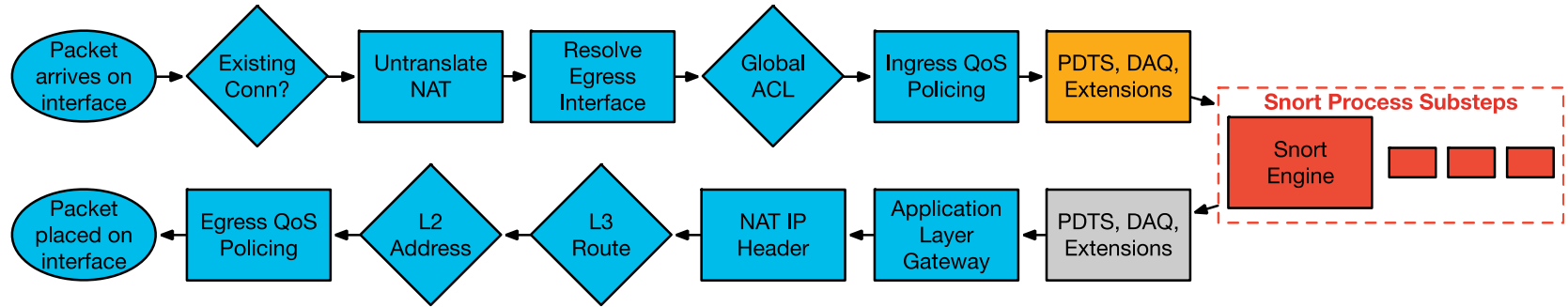
Display automatic capture of PCTS ring when snort is unable to service queue

Packet Processing: Data Acquisition Library



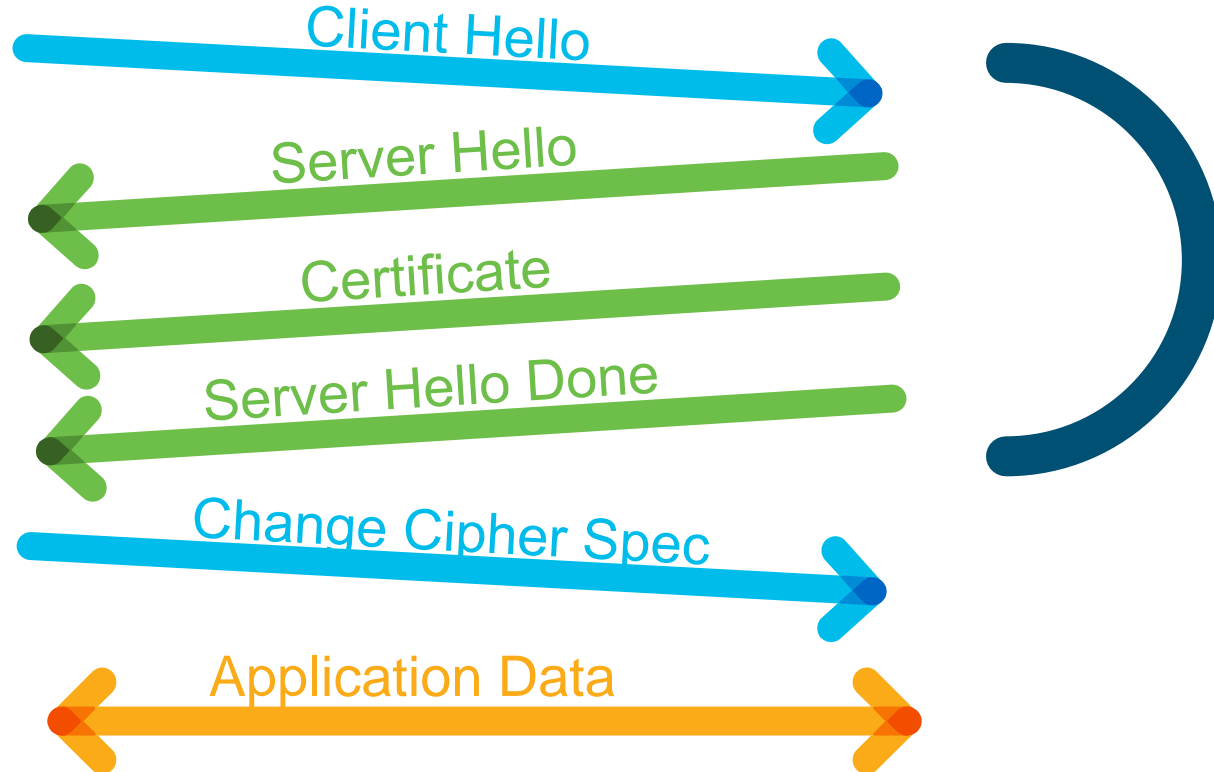
- The Data Acquisition Library (DAQ) enables snort to run on different hardware and software platforms
- Platform-specific changes are made in the DAQ
- DAQ extensions facilitate TLS decryption and a TCP proxy
- Decrypted flows are sent to snort for inspection
- Packets should not be dropped by the DAQ

Packet Processing: SSL Decryption

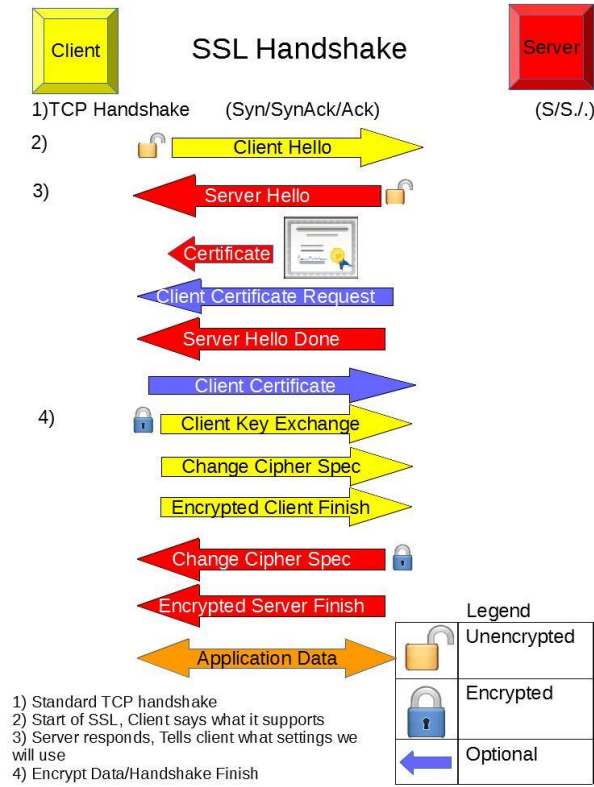


- SSL Decryption touches Lina, DAQ, and Snort
- Lina and DAQ:
 - Proxy TCP sessions
 - Track keys/sessions
 - Decrypt (software) / send to crypto chip to decrypt
- Snort:
 - Enforces policies
 - Makes decisions on whether to decrypt flow or not

Abbreviated SSL handshake



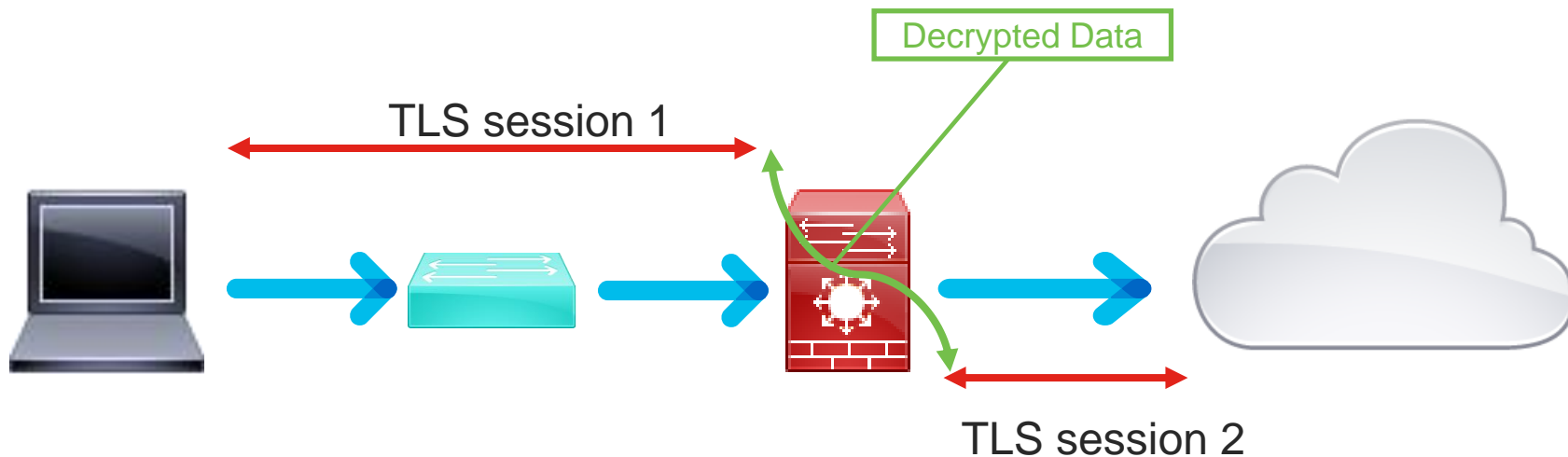
Standard SSL handshake for HTTPS



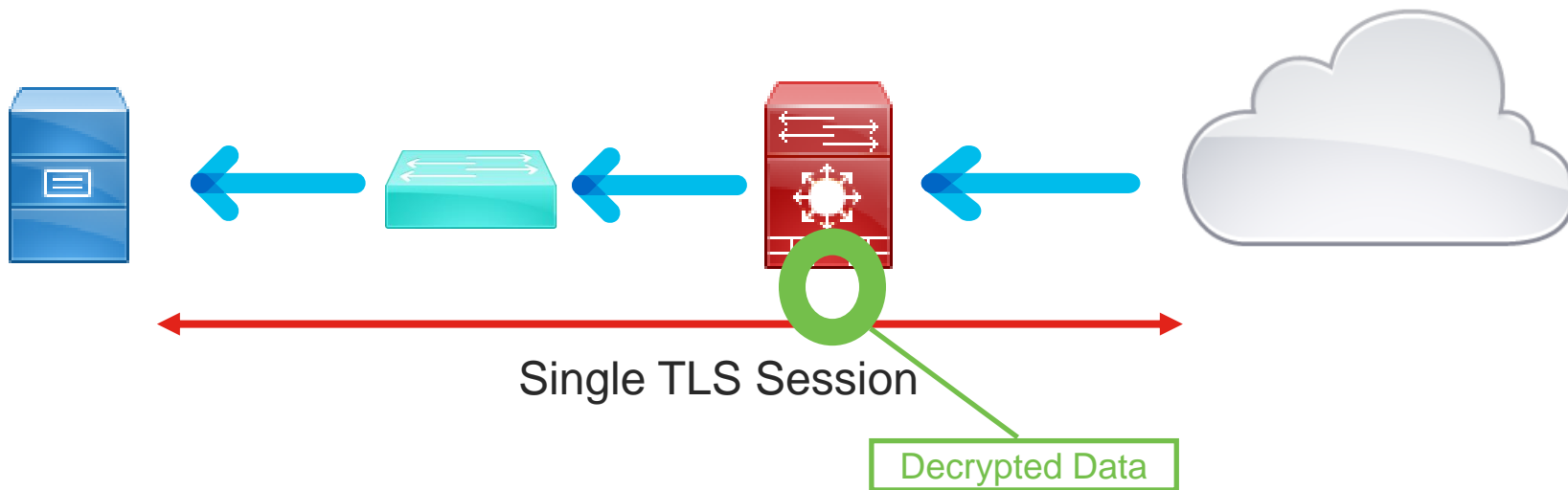
Excellent Reference

<https://tls.ulfheim.net/>

Typical deployment: Decrypt Resign

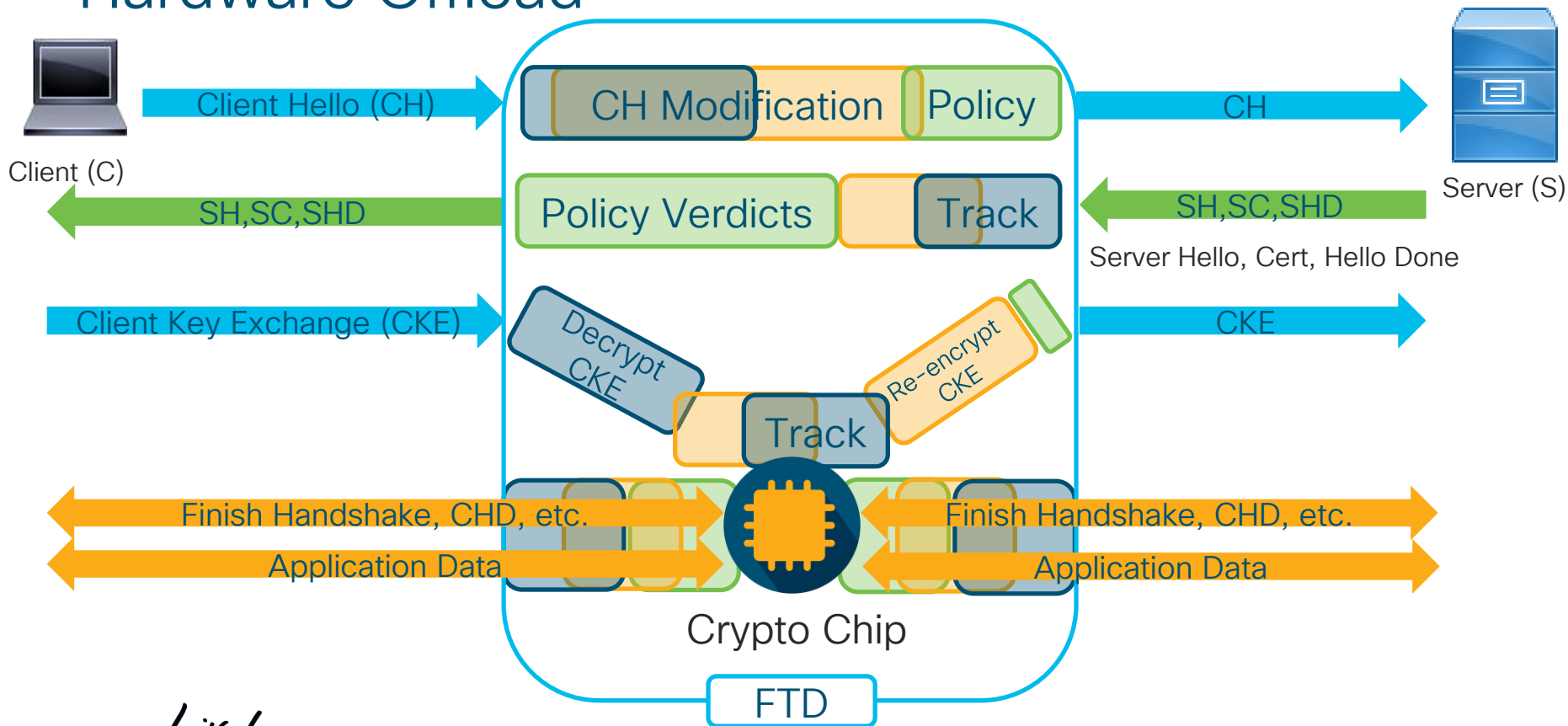


Typical deployment: Decrypt Known-key



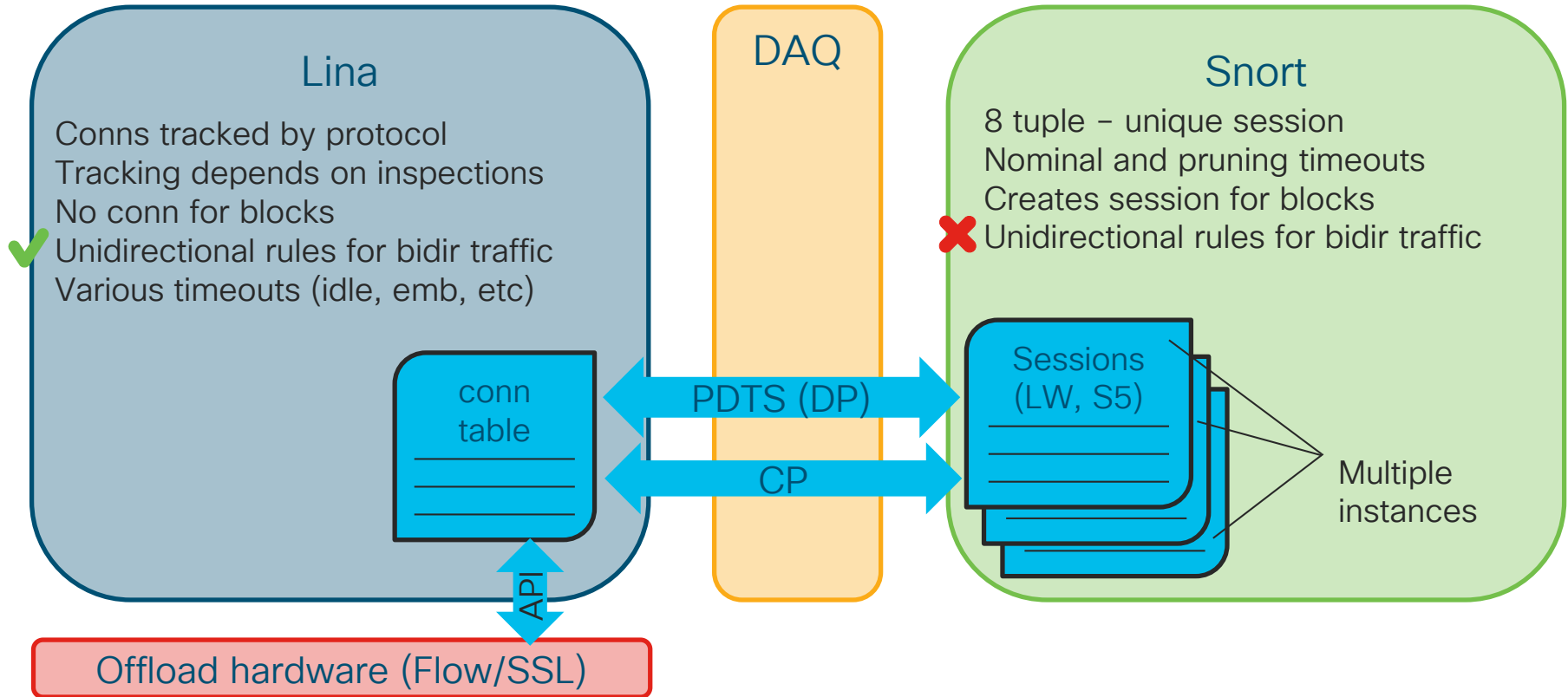
Packet Processing: SSL Hardware Offload

Lina DAQ Snort

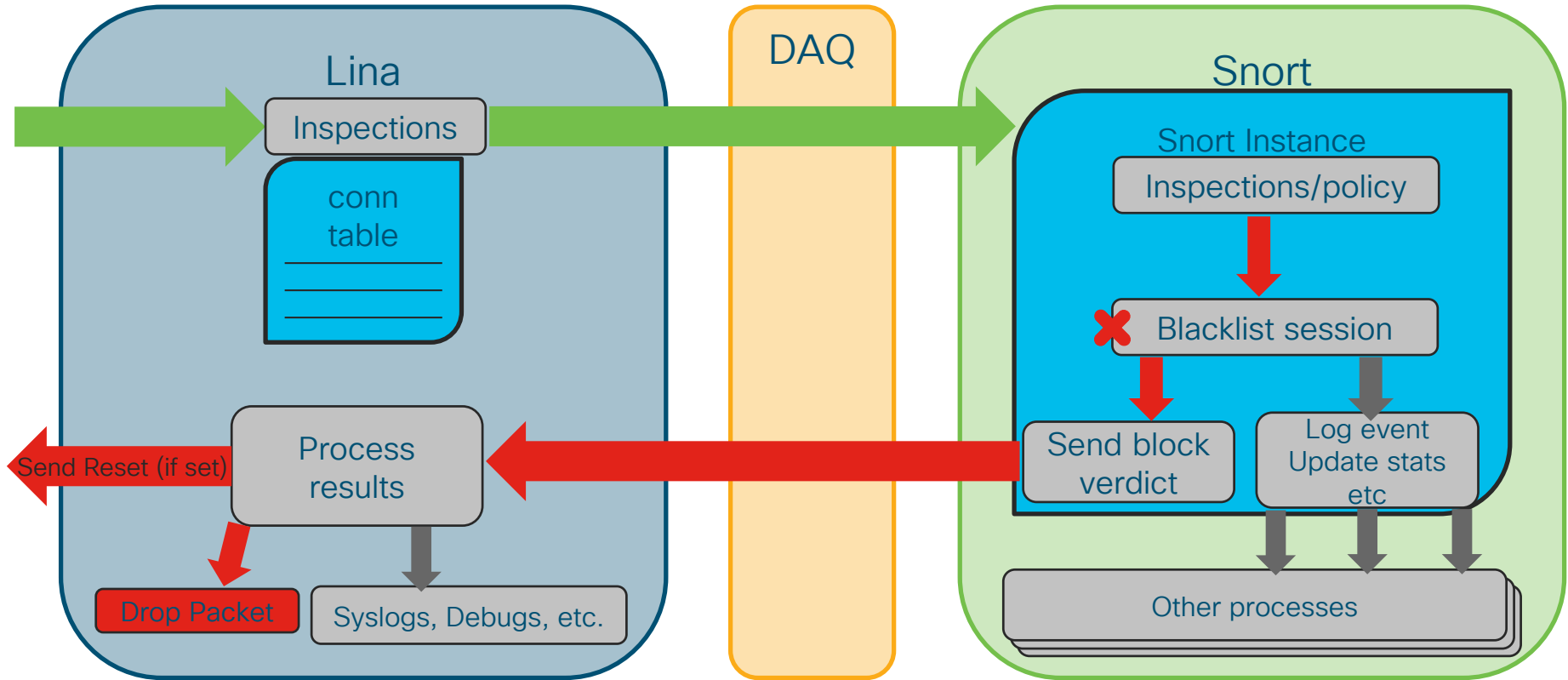


Snort and Lina Interactions

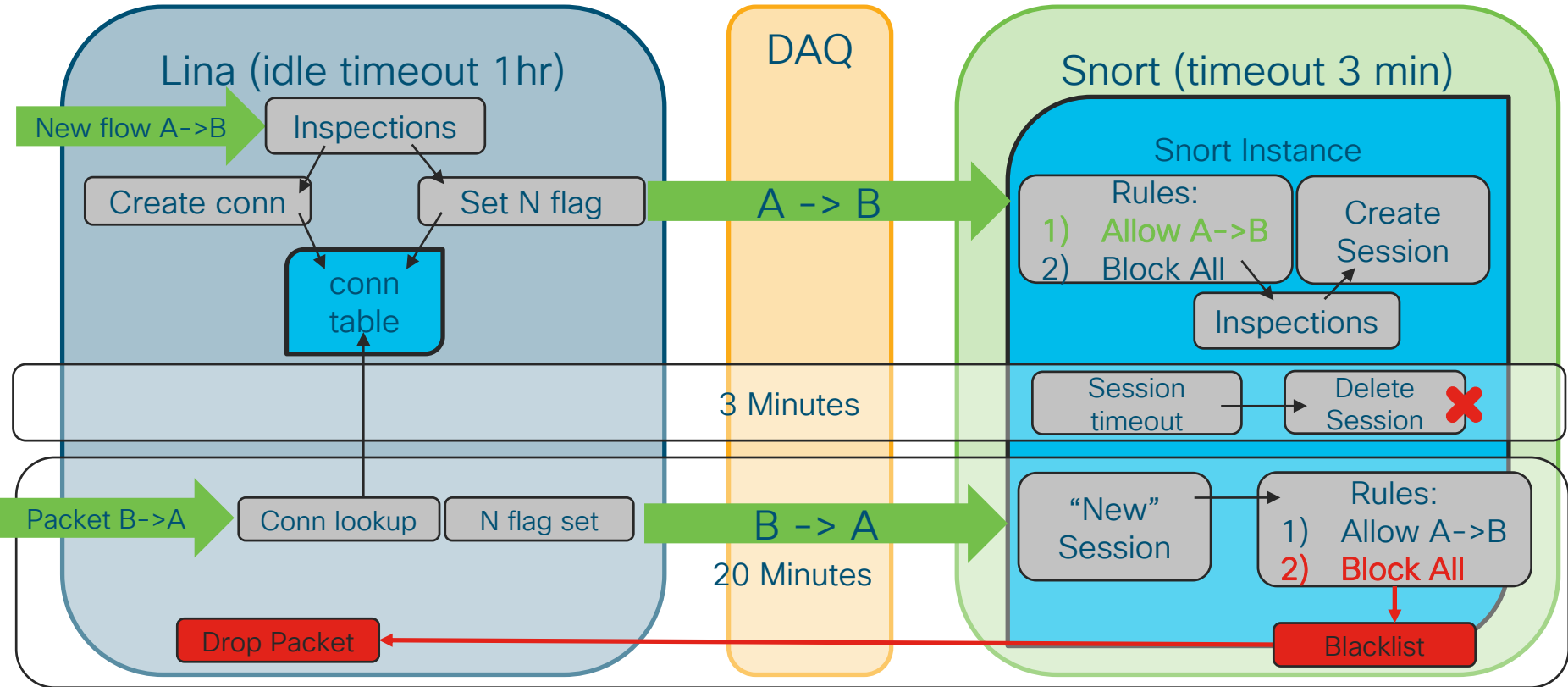
Session Tracking



Example flow – packet blocked by snort



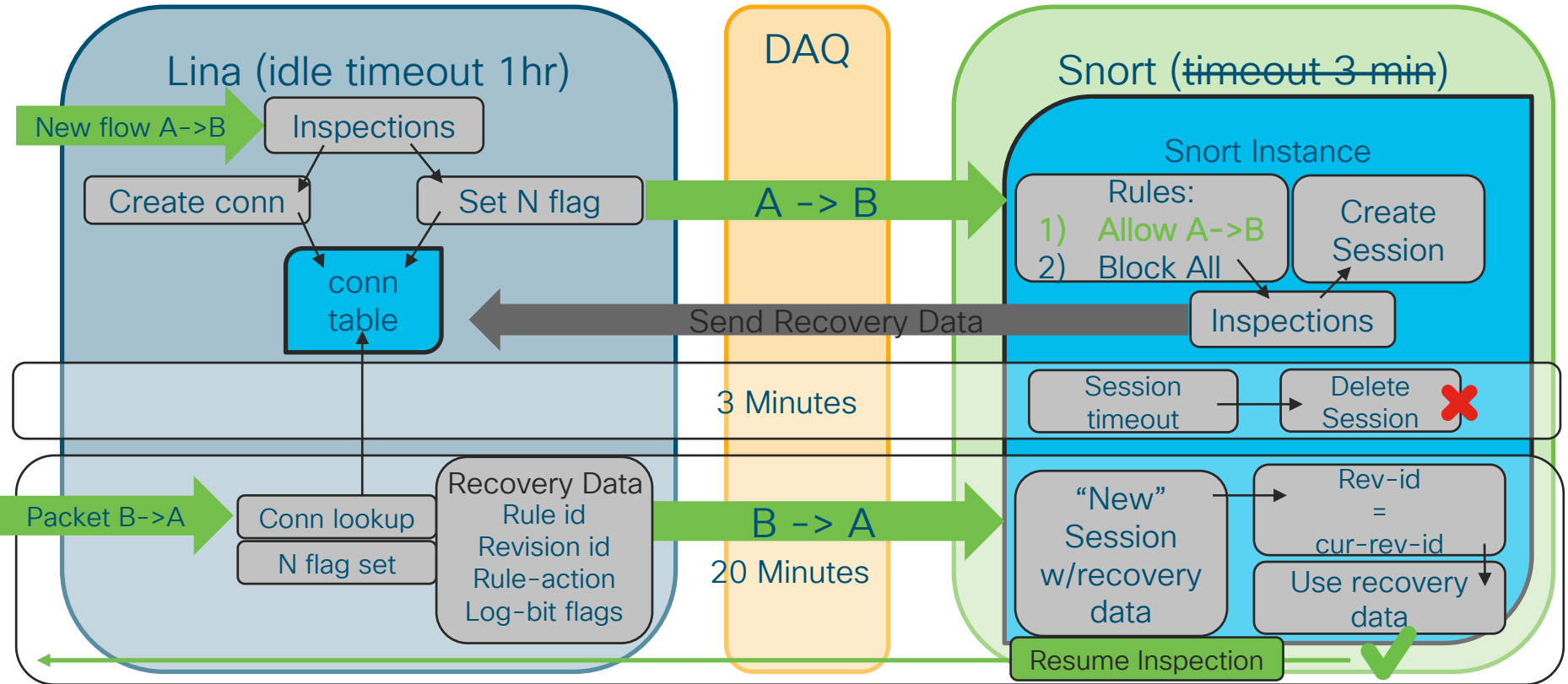
Example conn timeout (TCP) on version < 6.3



Changes in 6.3+ for session tracking lina/snort (TCP Only)

- Lina sets timeouts and syncs them to snort
- Snort sends lina recovery data (RD) for each session
- Lina stores RD in conn-meta
- Snort queries lina for RD if it doesn't know about a session
- Uses recovery data to match AC rule if revision hasn't changed
- When a conn times out in lina, it sends snort End of Flow (EOF) message

Example conn timeout (TCP) on version 6.3+



Configure timeouts in 6.3+

AC Policy > Advanced

The screenshot displays the Cisco ASA configuration interface for the Threat Defense Service Policy. The left sidebar shows a tree view of configuration sections, with 'Threat Defense Service Policy' selected. The main panel shows the 'Advanced' tab for this policy, with the 'Connection Setting' sub-tab active. The configuration includes various timeout settings for connections, connections per client, and connections timeout, as well as options for randomizing TCP sequence numbers and detecting dead connections.

Threat Defense Service Policy

1 Interface Object **2 Traffic Flow** **3 Connection Setting**

☐ Enable TCP State Bypass ☒ Randomize TCP Sequence Number ☐ Enable Decrement TTL

Connections:	Maximum TCP & UDP	Maximum Embryonic
	0	0

Connections Per Client:	Maximum TCP & UDP	Maximum Embryonic
	0	0

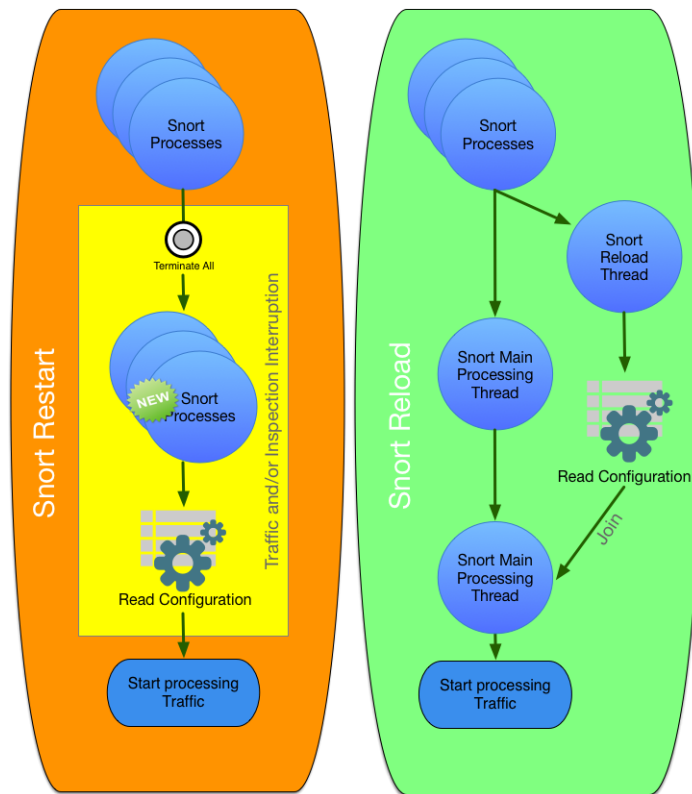
Connections Timeout:	Embryonic	Half Closed	Idle
	00:00:30	00:10:00	01:00:00

☐ Reset Connection Upon Timeout

Detect Dead Connections	Detection Timeout	Detection Retries
	00:00:15	5

<< Previous Finish Cancel

Snort Restart & Reload Architecture



Why does Snort have to restart?

- New version of Snort in policy deploy
- Reallocate memory for pre-processors/Security Intelligence
- Reload shared objects
- Pre-processor configuration changes
- Configured to restart instead of reload

Overview	Analysis	Policies	Devices	Objects	AMP	Intelligence
Access Control	Access Control	Network Discovery	Application Detectors	Correlation	Actions	
Snort Rule Test Policy						
Prefilter Policy: Default Prefilter Policy			SSL Policy: None		Identity Policy	
Rules	Security Intelligence	HTTP Responses	Advanced			
General Settings						
Maximum URL characters to store in connection events						1024
Allow an Interactive Block to bypass blocking for (seconds)						600
Retry URL cache miss lookup						Yes
Inspect traffic during policy apply						Yes
Identity Policy Settings						
Identity Policy						None
SSL Policy Settings						
SSL Policy to use for inspecting encrypted connections						None
Prefilter Policy Settings						
Prefilter Policy used before access control						Default Prefilter Policy
Network Analysis and Intrusion Policies						
Intrusion Policy used before Access Control rule is determined						Balanced Security and Connectivity
Intrusion Policy Variable Set						Default-Set
Default Network Analysis Policy						test
Files and Malware Settings						
Limit the number of bytes inspected when doing file type detection						1460
Allow file if cloud lookup for Block Malware takes longer than (seconds)						2
Do not calculate SHA256 hash values for files larger than (in bytes)						10485760
Minimum file size to store (bytes)						6144
Maximum file size to store (bytes)						1048576
Minimum file size for dynamic analysis testing (bytes)						0
Maximum file size for dynamic analysis testing (bytes)						104857600
Intelligent Application Bypass Settings						
Intelligent Application Bypass Settings						Off
Total Apps and Filters Configured						0

Full listing of restart reasons

https://www.cisco.com/c/en/us/td/docs/security/firepower/622/configuration/guide/fpmc-config-guide-v622/policy_management.html#concept_33516C5D6B574B6888B1A05F956ABDF9

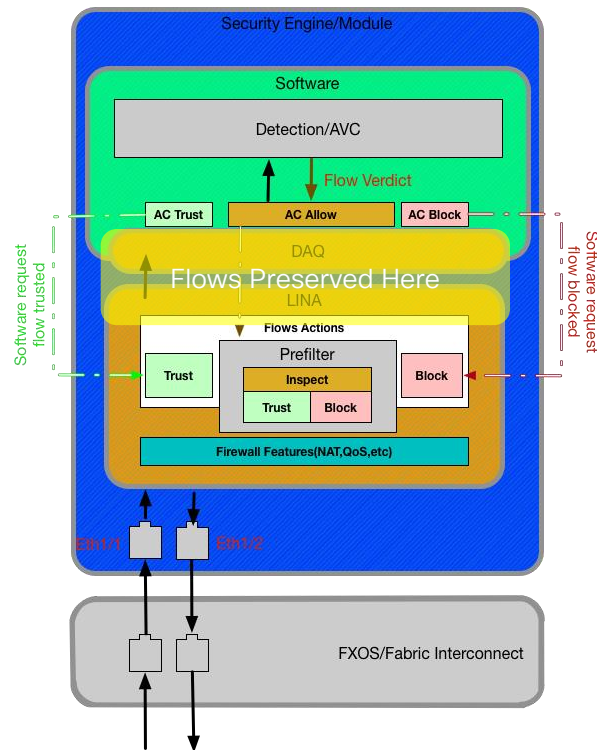
Mitigations

1 Snort Preserve-Connection

2 Software Bridge

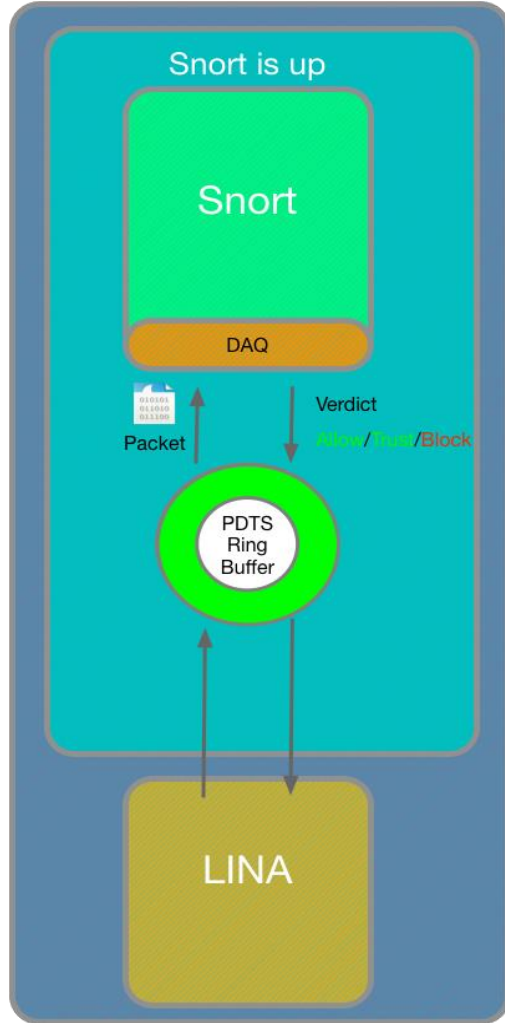
Snort Preserve-Connection

- When Snort goes down connections with Allow verdict are preserved in LINA
- Snort does **NOT** do a mid-session pickup on preserved flows on coming up
- Does **NOT** protect against new flows while Snort is down
- 6.2.0.2/6.2.3 Feature Introduction
- Can be enabled/disabled from CLISH:
configure snort preserve-connection
enable/disable



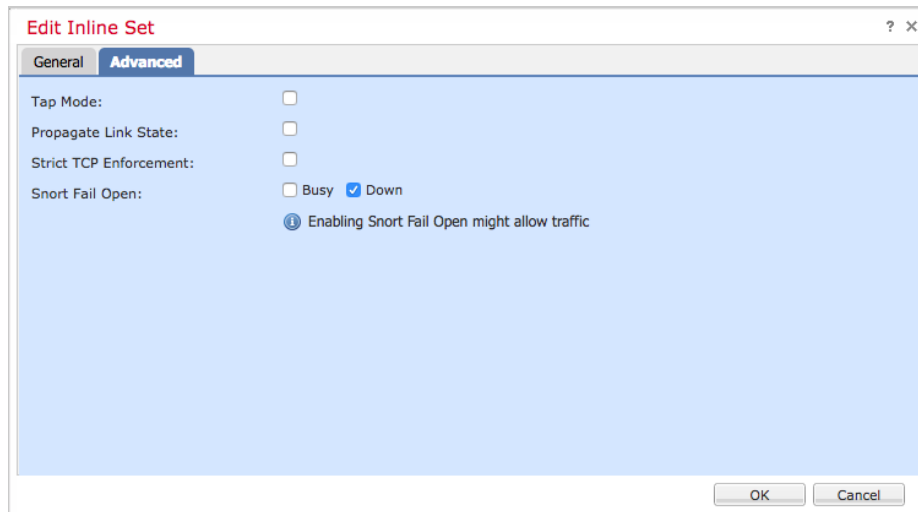
Software Bypass

- With inline Fail-Open deployments traffic is passed uninspected on the Software bridge when Snort is down.
- When Snort comes up, Snort does a mid-session pickup on traffic
- A.K.A Software Bypass
- CLISH Command: > pmtool disablebytype de



Snort Fail-Open when Busy / Down

- Snort fail-open when down means that all traffic will pass over software bridge when snort is down
- Snort fail-open when busy means traffic will be bypassed around Snort when the incoming buffer for snort reaches 85% full



Packet Processing: Decode Preprocessor (GID:116)

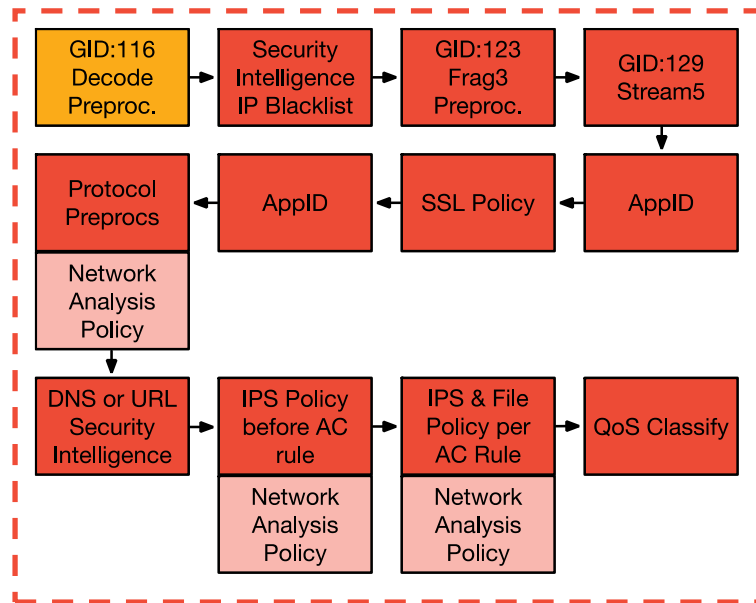
Decode performs basic checks on packets like:

- Confirm Ethernet protocol matches IPv4 or IPv6 value
- Verify IPv4 header is at least 20 bytes

Very rare for Decode to produce unexpected packet drops

Set GID:116 rules to “generate events” for visibility

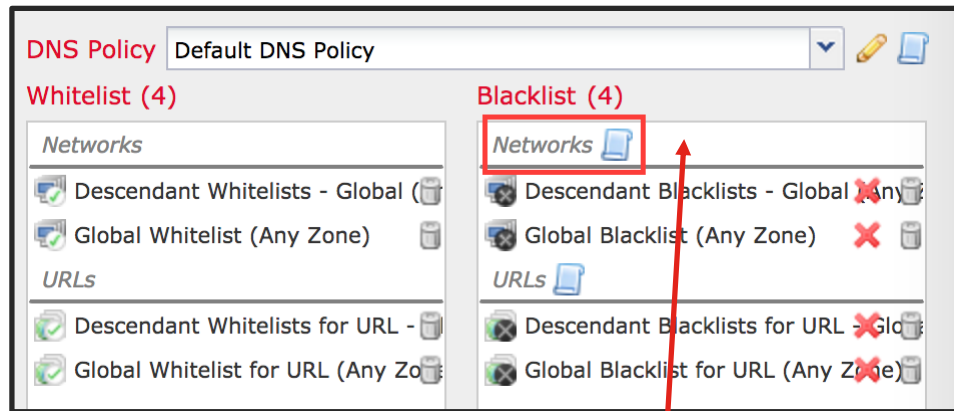
Filter: gid:116		
Filter returned 152 results		
→	🔍	🕒
Rule State	Event Filtering	Dynamic State
🚫	🔊	🚨
Alerting	💬	Comments
☐	☑	☑
GID	SID	Message
☐	116	1
		DECODE_NOT_IPV4_DGRAM
☐	116	2
		DECODE_IPV4_INVALID_HEADER_LEN
☐	116	3
		DECODE_IPV4_DGRAM_LT_IPHDR
☐	116	4
		DECODE_IPV4OPT_BADLEN



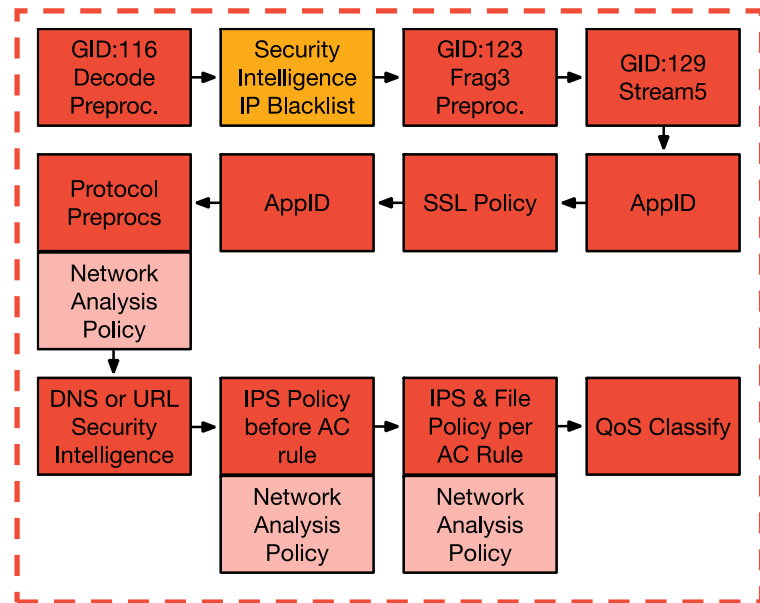
Snort Process Substeps

Packet Processing: IP Security Intelligence

- IP SI drops packets based on lists of malicious IP addresses
- SI drops packets at the IP-level without higher layer inspects
- Whitelist overrides Blacklist



Best Practice: Log SI blacklist events



Snort Process Substeps

Verify an IP is on a blacklist: `grep -r [IP_ADDRESS] /var/sf/iprep_download`

Packet Processing: Frag Preprocessor (GID:123)

Frag3 reassembles IP fragments before higher-level preprocs

Rare, but possible causes for drops:

- Zero-byte fragments
- Overlapping fragments

Set GID:123 rules to “generate events” for visibility

Filter:

gid:123

Filter returned 11 results

Rule State

Event Filtering

Dynamic State

Alerting

Comments

GID

SID

Message

123

13

FRAG3_TINY_FRAGMENT

123

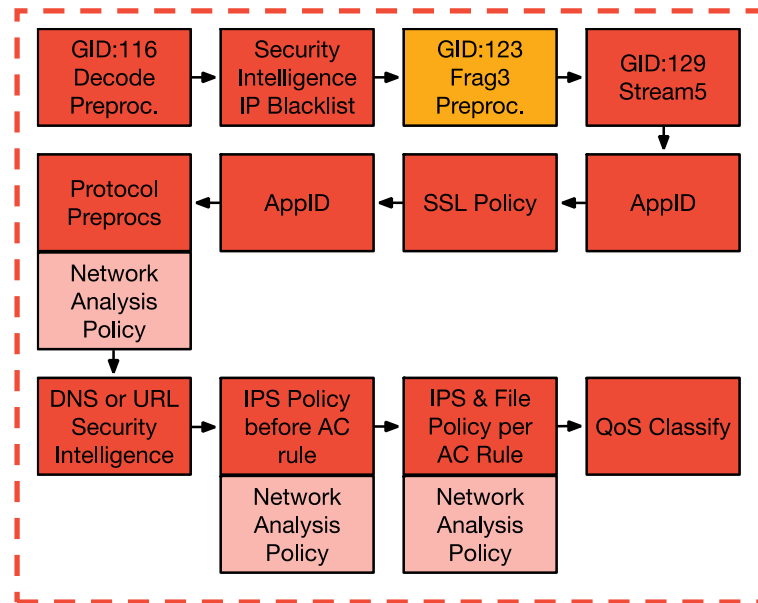
12

FRAG3_EXCESSIVE_OVERLAP

123

11

FRAG3_MIN_TTL

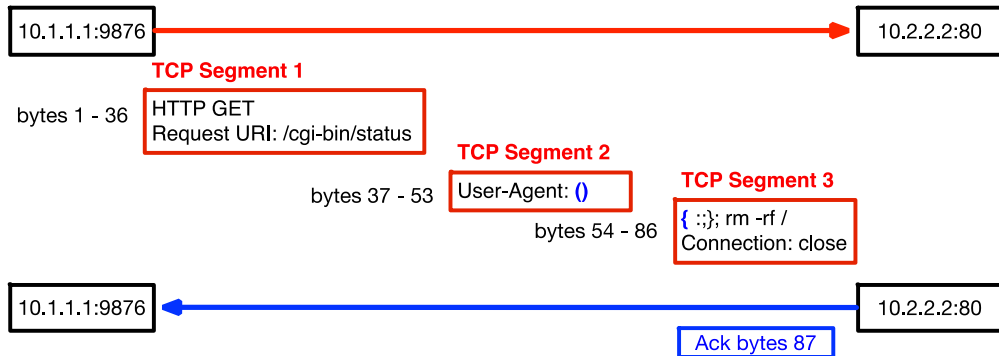


Snort Process Substeps

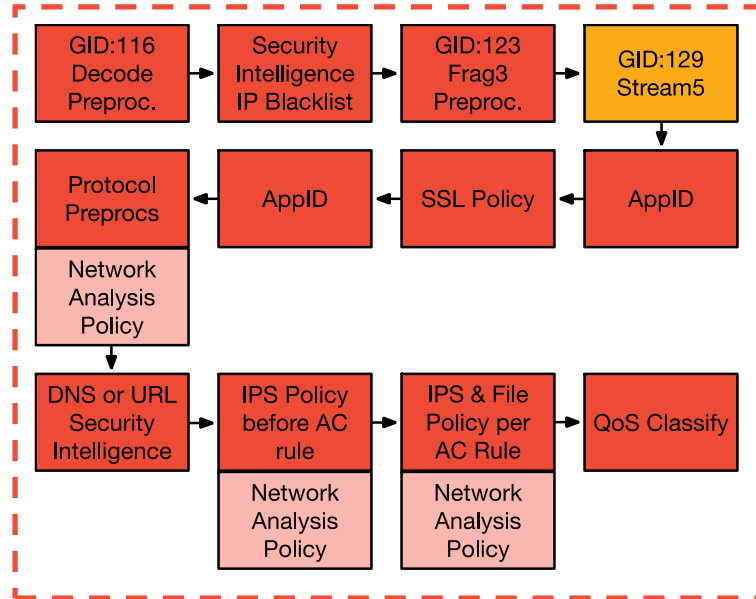
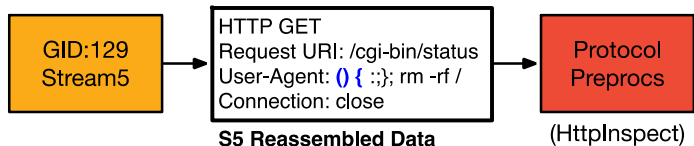
Packet Processing: Stream Preproc (GID: 129)

- S5 Reassembles TCP segments for Protocol preprocs
- TCP segments must be contiguous and acknowledged

Stream 5 Inputs: TCP Segments



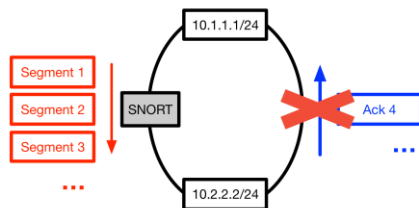
Stream Output: Data for Protocol Preprocs



Snort Process Substeps

Stream5 Asymmetric Traffic Reference Slides

Packet Processing: Stream5 Asymmetry Problem



- Snort sees half of the traffic for a given TCP session
- Snort receives TCP segments from 10.1.1.1 to 10.2.2.2, but not the other way around
- Segments stay in memory waiting for an ACK for reassembly, causing memory issues
- Common causes: Portchannel interfaces which map to interface asymmetric routing where the sensor only sees one direction of traffic

CiscoLive!



Packet Processing: Stream5 Asymmetry Problem

S5 syslogs observed in /var/log/messages:

S5: Session exceeded configured max bytes to queue xxxxx using xxxxx bytes

S5: Session exceeded configured max segs to queue xxxxx using xxxxx bytes

S5: Pruned session from cache that was using xxxxx bytes

S5: Pruned 5 sessions from cache for memcap. xxxxx ssnns remain

These syslogs may also be symptomatic of large TCP flows (such as backups), or snort instance oversubscription

CiscoLive!



Reference Slide: Check Stream5 Asymmetry

Check for asymmetry by displaying TCP SYN to SYN-ACK ratio for all snort instances:

1. > expert
2. cd /var/sf/detection_engines/[UUID]
3. for i in \$(ls -lv | grep instance); do echo \$i; perfstats -q < \$i/now | grep -i "syns/sec" -A 1; done

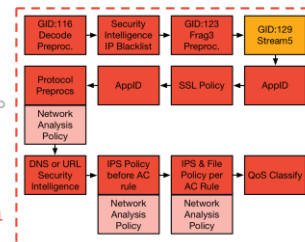
Asymmetric output (BAD):

```
instance-1
Syns/Sec: 179.1      # ratio is far from 1:1
SynAcks/Sec: 2.3
```

Symmetric output (GOOD):

```
instance-1
Syns/Sec: 77.8       # ratio is almost 1:1
SynAcks/Sec: 79.1
```

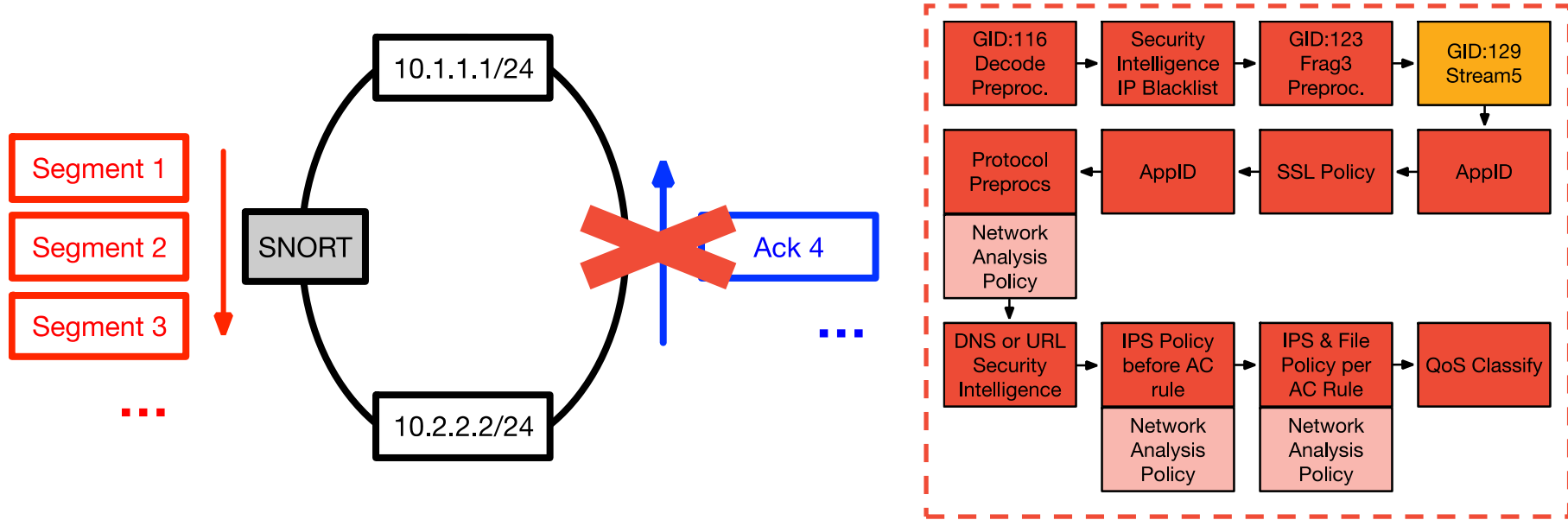
CiscoLive!



Snort Process Substeps

CiscoLive!

Packet Processing: Stream Asymmetry Problem



- Snort sees half of the traffic for a given TCP session
- Snort receives TCP segments from 10.1.1.1 to 10.2.2.2, but none of the reply traffic (TCP ACKs)
- Segments stay in memory waiting for an ACK for reassembly, consuming memory until an S5 threshold is hit
- Common causes: Portchannel interfaces which map to interface pairs are not in the same inline set, Asymmetric routing where the sensor only sees one direction of the traffic

Packet Processing: Stream Asymmetry Problem

S5 syslogs observed in /var/log/messages:

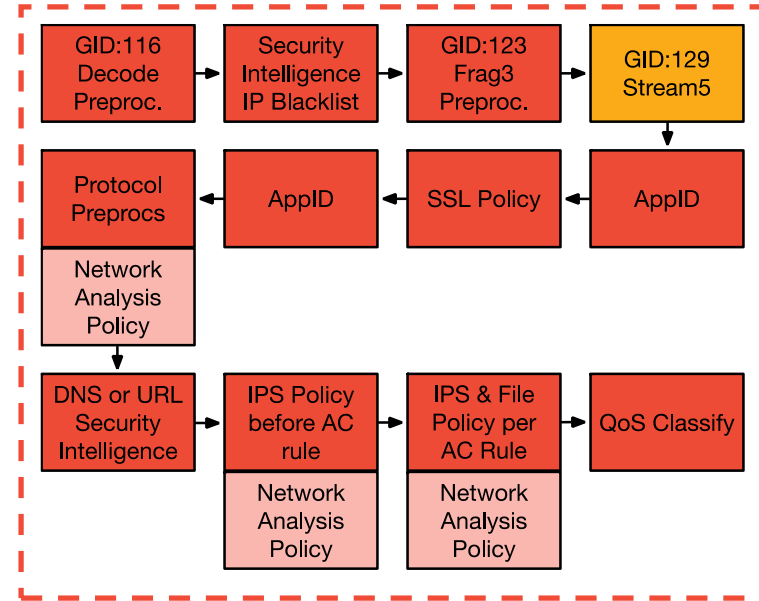
```
S5: Session exceeded configured max bytes  
to queue xxxxx using xxxxx bytes
```

```
S5: Session exceeded configured max segs  
to queue xxxxx using xxxxx bytes
```

```
S5: Pruned session from cache that was  
using xxxxx bytes
```

```
S5: Pruned 5 sessions from cache for  
memcap. xxxxx ssns remain
```

These syslogs may also be symptomatic of large TCP flows (such as backups), or snort instance oversubscription



Snort Process Substeps

Reference Slide: Check Stream Asymmetry

Check for asymmetry by displaying TCP SYN to SYN-ACK ratio for all snort instances:

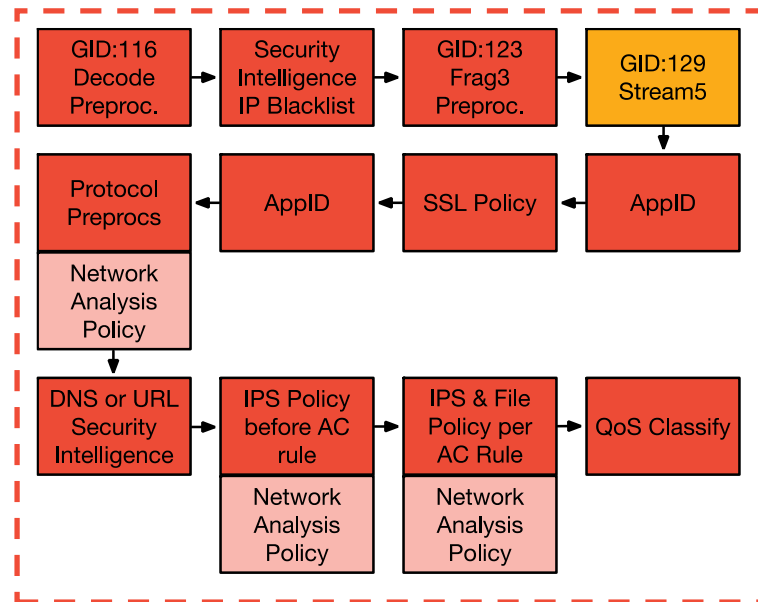
```
1. > expert
2. cd /var/sf/detection_engines/[UUID]
3. for i in $(ls -lv | grep instance); do echo
   $i; perfstats -q < $i/now | grep -i
   "syns/sec" -A 1; done
```

Asymmetric output (**BAD**):

```
instance-1
  Syns/Sec:    179.1    # ratio is far from 1:1
  SynAcks/Sec:   2.3
```

Symmetric output (**GOOD**):

```
instance-1
  Syns/Sec:    77.8    # ratio is almost 1:1
  SynAcks/Sec:  79.1
```



Snort Process Substeps

Asymmetric Traffic – TAC Script

Snort
performance



getS5HostInfo

- Script developed by TAC to get information about asymmetric traffic
- Available currently at: <https://github.com/johnjg12/snort-scripts>
- Generates CSV files and report files using syslog files (/var/log/messages)
- Hidden slides with details available in presentation PDF

Asymmetric Traffic – TAC Script

Snort
performance



Getting state and flag information from a session:

getS5HostInfo --LWstate 0x1 LWFlags 0x2001

LWstate 0x1

```
+-----+ Stream5 State Map +-----+

hex: 0x1
binary: 00000000 00000001

#) 00000000 00000001
  |||||  |||||
01) |||||  |||||+--- STREAMS_STATE_SYN
02) |||||  |||||+--- STREAMS_STATE_SYN_ACK
03) |||||  |||||+--- STREAMS_STATE_ACK
04) |||||  |||||+--- STREAMS_STATE_ESTABLISHED
05) |||||  |||||+--- STREAMS_STATE_DROP_CLIENT
06) |||||  |||||+--- STREAMS_STATE_DROP_SERVER
07) |||||  |||||+--- STREAMS_STATE_MIDSTREAM
08) |||||  |||||+--- STREAMS_STATE_TIMEDOUT
  |||||
09) |||||+----- STREAMS_STATE_UNREACH
  |||||+
  |||||+
10) ||||+----- STREAMS_STATE_CLOSED
11) 00000000 00000000-- STREAMS_STATE_NONE
```

LWFlags 0x2001

```
+-----+ Session Flag Map +-----+

hex: 0x2001
binary: 00000000 00000000 00100000 00000001

#) 00000000 00000000 00100000 00000001
  |||||  |||||  |||||  |||||
11) |||||  |||||  |||||+--- SSNFLAG_SEEN_CLIENT
12) |||||  |||||  |||||+--- SSNFLAG_SEEN_SERVER
13) |||||  |||||  |||||+--- SSNFLAG_ESTABLISHED
14) |||||  |||||  |||||+--- SSNFLAG_NMAP
15) |||||  |||||  |||||+--- SSNFLAG_ECN_CLIENT_QUERY
16) |||||  |||||  |||||+--- SSNFLAG_ECN_SERVER_REPLY
17) |||||  |||||  |||||+--- SSNFLAG_HTTP_1_1
18) |||||  |||||  |||||+--- SSNFLAG_SEEN_PMATCH
  |||||  |||||
19) |||||  |||||  |||||+--- SSNFLAG_MIDSTREAM
  |||||  |||||  |||||+--- SSNFLAG_CLIENT_FIN
  |||||  |||||  |||||+--- SSNFLAG_SERVER_FIN
12) |||||  |||||  |||||+--- SSNFLAG_CLIENT_PKT
13) |||||  |||||  |||||+--- SSNFLAG_SERVER_PKT
14) |||||  |||||  |||||+--- SSNFLAG_COUNTED_INITIALIZE
15) |||||  |||||  |||||+--- SSNFLAG_COUNTED_ESTABLISH
16) |||||  |||||  |||||+--- SSNFLAG_COUNTED_CLOSING
  |||||  |||||
17) |||||  |||||  |||||+--- SSNFLAG_TIMEDOUT
18) |||||  |||||  |||||+--- SSNFLAG_PRUNED
19) |||||  |||||  |||||+--- SSNFLAG_RESET
20) |||||  |||||  |||||+--- SSNFLAG_DROP_CLIENT
21) |||||  |||||  |||||+--- SSNFLAG_DROP_SERVER
22) |||||  |||||  |||||+--- SSNFLAG_LOGGED_QUEUE_FULL
23) |||||  |||||  |||||+--- SSNFLAG_STREAM_ORDER_BAD
22) |||||  |||||  |||||+--- SSNFLAG_FORCE_BLOCK
  |||||
23) |||||+----- SSNFLAG_CLIENT_SWAP
22) |||||+----- SSNFLAG_CLIENT_SWAPPED
27) 11111111 11111111 11111111 11111111-- SSNFLAG_ALL
28) 00000000 00000000 00000000 00000000-- SSNFLAG_NONE
```

Asymmetric Traffic – TAC Script

Snort
performance



Generate CSV file

Single File

```
getS5HostInfo --csv messages
```

Aggregating data from all messages files

```
egrep -h "S5:" messages* >> s5Mes.out
```

```
getS5HostInfo --csv s5Mes.out
```

Generate summary file

```
getS5HostInfo --summary <output_csv_file>
```

Asymmetric Traffic

getS5HostInfo --summary myfile.csv

Top 5 sessions for syn_no_syn_ack:

```
1 ) 10.0.0.154 -> 172.16.235.229 : 4101
2 ) 10.0.0.154 -> 172.16.234.48 : 4041
3 ) 10.0.1.14 -> 172.16.235.67 : 4031
4 ) 10.0.8.19 -> 172.16.235.67 : 3882
5 ) 10.0.0.15 -> 172.16.235.67 : 3881
```

Top 5 sessions for syn_ack_no_syn:

```
1 ) 192.168.1.50 -> 172.16.235.229 : 3267
2 ) 192.168.3.5 -> 172.16.234.48 : 2653
3 ) 192.168.2.105 -> 172.16.235.67 : 2452
4 ) 192.168.12.107 -> 172.16.235.67 : 2445
5 ) 192.168.12.106 -> 172.16.235.67 : 2221
```

Top 5 sessions for client_no_server_count:

```
1 ) 10.0.0.154 -> 172.16.235.229 : 4116
2 ) 10.0.0.154 -> 172.16.234.48 : 4051
3 ) 10.0.1.14 -> 172.16.235.67 : 4047
4 ) 10.0.8.19 -> 172.16.235.67 : 3894
5 ) 10.0.0.15 -> 172.16.235.67 : 3892
```

Top 50 sessions for server_no_client_count:

```
1 ) 192.168.1.50 -> 172.16.235.229 : 4443
2 ) 192.168.3.5 -> 172.16.234.48 : 3875
3 ) 192.168.2.105 -> 172.16.235.67 : 2532
4 ) 192.168.12.107 -> 172.16.235.67 : 430
5 ) 192.168.12.106 -> 172.16.235.67 : 417
```

```
Top Source ports seen:
Port : Times Seen
1 ) 20 : 8351
2 ) 60020 : 202
3 ) 38887 : 59
4 ) 39792 : 27
5 ) 33376 : 25
6 ) 33920 : 24
7 ) 34034 : 23
8 ) 41337 : 23
9 ) 42414 : 22
10 ) 57264 : 22
11 ) 46752 : 22
12 ) 46778 : 22
13 ) 47648 : 22
14 ) 33956 : 22
15 ) 42369 : 22
```

```
Top Dest ports seen:
Port : Times Seen
1 ) 25 : 87349
2 ) 60020 : 41244
3 ) 10051 : 7422
4 ) 8443 : 3855
5 ) 2058 : 3573
6 ) 2003 : 2942
7 ) 80 : 2269
8 ) 4242 : 1980
9 ) 1044 : 1472
10 ) 22 : 1386
11 ) 8200 : 1126
12 ) 1935 : 1057
13 ) 9997 : 934
14 ) 1031 : 876
15 ) 445 : 722
```

```
Top Application Protocols Seen:
AppID : Times Seen
1 ) 8 : 76845
2 ) 25 : 42301
3 ) 5 : 13566
4 ) 169 : 7529
5 ) 9 : 1443
6 ) 34 : 1232
7 ) 28 : 1126
8 ) 174 : 771
9 ) 13 : 716
10 ) 115 : 462
11 ) 101 : 138
12 ) 184 : 7
13 ) 114 : 3
14 ) 170 : 3
```

```
| +-+ |
| o" )~ Stream5 State Summary ~( "o |
| +-+ |
```

```
Time: 2015-05-31 04:02:03 - 2015-06-11 16:15:03
Total Sessions : 258866
Saw Client but not Server: 229927 (88%)
Saw Server but not Client: 18544 (7%)
Saw Client and Server : 10395 (4%)
STREAM5_STATE_ESTABLISHED: 27691 (10.70%)
STREAM5_STATE_DROP_CLIENT: 0 (0.00%)
STREAM5_STATE_DROP_SERVER: 0 (0.00%)
STREAM5_STATE_MIDSTREAM : 2466 (0.95%)
STREAM5_STATE_TIMEOUT : 729 (0.28%)
STREAM5_STATE_UNREACH : 0 (0.00%)
STREAM5_STATE_CLOSED : 0 (0.00%)
```

```
| +-+ |
| o" )~ Session Flags Summary ~( "o |
| +-+ |
```

```
Time: 2015-05-31 04:02:03 - 2015-06-11 16:15:03
Total Sessions : 258866
Saw SYN but not SYN_ACK : 228813 (88%)
Saw SYN_ACK but not SYN : 19524 (7%)
Saw SYN and SYN_ACK : 8126 (3%)
Saw 3-Way Handshake : 8126 (3%)
SSNFLAG_ESTABLISHED : 44 (0.02%)
SSNFLAG_NMAP : 0 (0.00%)
SSNFLAG_ECN_CLIENT_QUERY : 1 (0.00%)
SSNFLAG_ECN_SERVER_REPLY : 0 (0.00%)
SSNFLAG_HTTP_1_1 : 0 (0.00%)
SSNFLAG_SEEN_PMATCH : 0 (0.00%)
SSNFLAG_MIDSTREAM : 2466 (0.95%)
SSNFLAG_CLIENT_FIN : 0 (0.00%)
SSNFLAG_SERVER_FIN : 0 (0.00%)
SSNFLAG_CLIENT_PKT : 0 (0.00%)
SSNFLAG_SERVER_PKT : 0 (0.00%)
SSNFLAG_COUNTED_INITIALIZE: 258776 (99.97%)
SSNFLAG_COUNTED_ESTABLISH : 27690 (10.70%)
SSNFLAG_COUNTED_CLOSING : 88557 (34.21%)
SSNFLAG_TIMEOUT : 256338 (99.02%)
SSNFLAG_PRUNED : 2483 (0.96%)
SSNFLAG_RESET : 63762 (24.63%)
SSNFLAG_DROP_CLIENT : 0 (0.00%)
SSNFLAG_DROP_SERVER : 0 (0.00%)
SSNFLAG_LOGGED_QUEUE_FULL : 249859 (96.52%)
SSNFLAG_STREAM_ORDER_BAD : 81368 (31.43%)
SSNFLAG_FORCE_BLOCK : 0 (0.00%)
SSNFLAG_CLIENT_SWAP : 68 (0.03%)
SSNFLAG_CLIENT_SWAPPED : 68 (0.03%)
```

cisco *Live!*

Story Time!

<input type="checkbox"/>	▼ <u>First Packet</u> ✕	<u>Last Packet</u> ✕	<u>Action</u> ✕	<u>Initiator IP</u> ✕	<u>Responder IP</u> ✕	<u>Ingress Security Zone</u> ✕	<u>Source Port / ICMP Type</u> ✕	<u>Destination Port / ICMP Code</u> ✕
↓ <input type="checkbox"/>	2018-06-05 19:33:32	2018-06-05 19:35:33	Allow	 192.168.0.4	 8.8.8.8	Passive	12755 / udp	53 (domain) / udp
↓ <input type="checkbox"/>	2018-06-05 19:33:32	2018-06-05 19:35:33	Allow	 8.8.8.8	 192.168.0.4	Passive	53 (domain) / udp	12755 / udp
↓ <input type="checkbox"/>	2018-06-05 19:33:32	2018-06-05 19:35:33	Allow	 8.8.8.8	 192.168.0.4	Passive	53 (domain) / udp	12434 / udp
↓ <input type="checkbox"/>	2018-06-05 19:33:32	2018-06-05 19:35:33	Allow	 192.168.0.4	 8.8.8.8	Passive	12434 / udp	53 (domain) / udp
<< Page <input type="text" value="1"/> of 1 >> Displaying rows 1-4 of 4 rows								

```
Justin — ssh admin@10.0.0.10 — 135x36
> show version
-----[ Cartographer ]-----
Model      : Cisco ASA5506-X Threat Defense (75) Version 6.2.3.1 (Build 43)
UUID       : 8bd92a22-b2c1-11e7-a279-d47df0c19fbd
Rules update version : 2018-05-30-001-vrt
VDB version : 297
-----
> █
```

Asymmetric Traffic – Common Problems

Configuration
options



Problem:

Different VLANs on each side of session

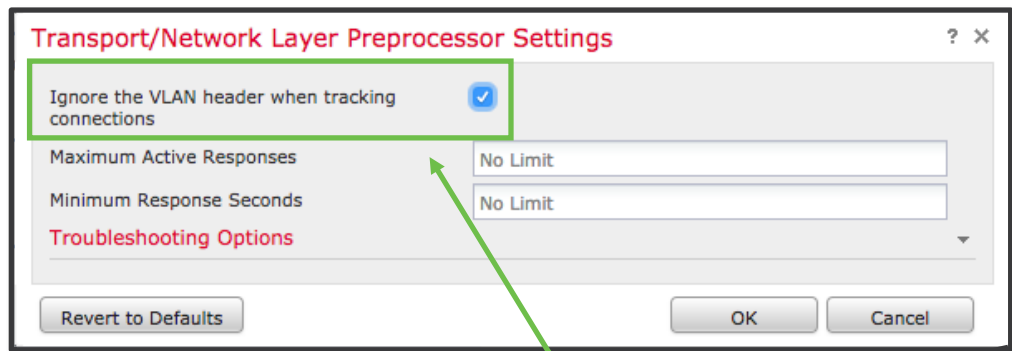
Example:

(VLAN50) 192.168.1.2 -> 10.8.0.2

(VLAN51) 10.8.0.2 -> 192.168.1.2

Fix:

Enable VLAN agnostic mode



Check this box to ignore VLANs when
identifying unique sessions

Access Control Policy Advanced tab

Transport/Network Layer Preprocessor Settings

Ignore the VLAN header when tracking connections

No

Asymmetric Traffic – Common Problems

Configuration
options



Problem:

Traffic from same session traversing multiple Inline sets

Example:

Inline set A 192.168.1.2 -> 10.8.0.2

Inline set B 10.8.0.2 -> 192.168.1.2

Fix:

Combine pairs into single inline set

Devices > Device Management [Edit device]

Separate inline sets

Device		Interfaces	Inline Sets
Name		Interface Pairs	
Inline Set A		s1p1 ↔ s1p2	
Inline Set B		s1p3 ↔ s1p4	



Single inline set

Device		Interfaces	Inline Sets
Name		Interface Pairs	
Single Inline Set		s1p1 ↔ s1p2, s1p3 ↔ s1p4	

Asymmetric Traffic – Common Problems

Configuration
options



Problem:

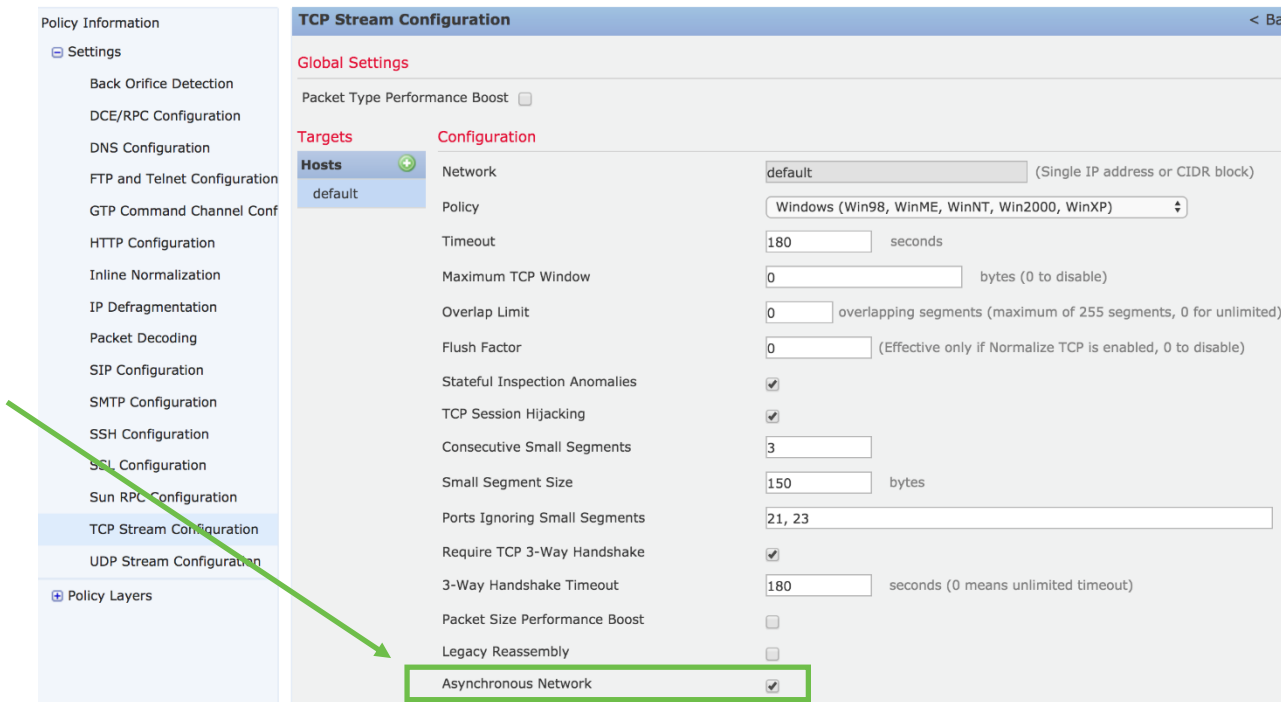
Traffic is actually asymmetric

Fix:

Configure network or
move device so that
there is no asymmetric
traffic

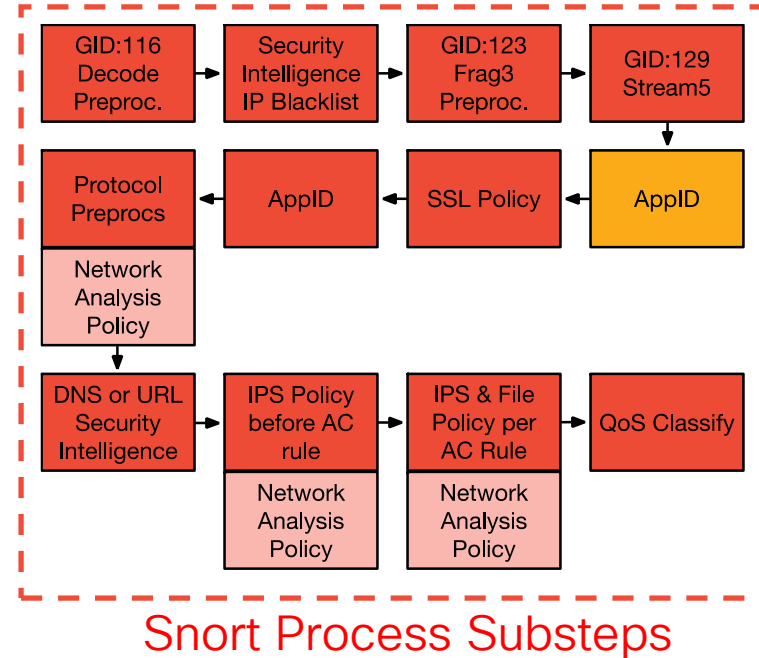
Mitigation:

Enable Asynchronous
Network option in NAP
> TCP Stream
Configuration



Packet Processing: AppID

- AppID identifies over 3,000 layer 7 network applications:
 - Facebook, Facebook chat, Facebook games, etc
- AppID runs both before and after SSL decryption
- AppID does not drop traffic
- An incorrect AppID disposition can cause traffic to match the wrong access control rule



Packet Processing: AppID Debugging

- Specify flow 5-tuple of a flow to see application matching:
> **system support application-identification-debug**

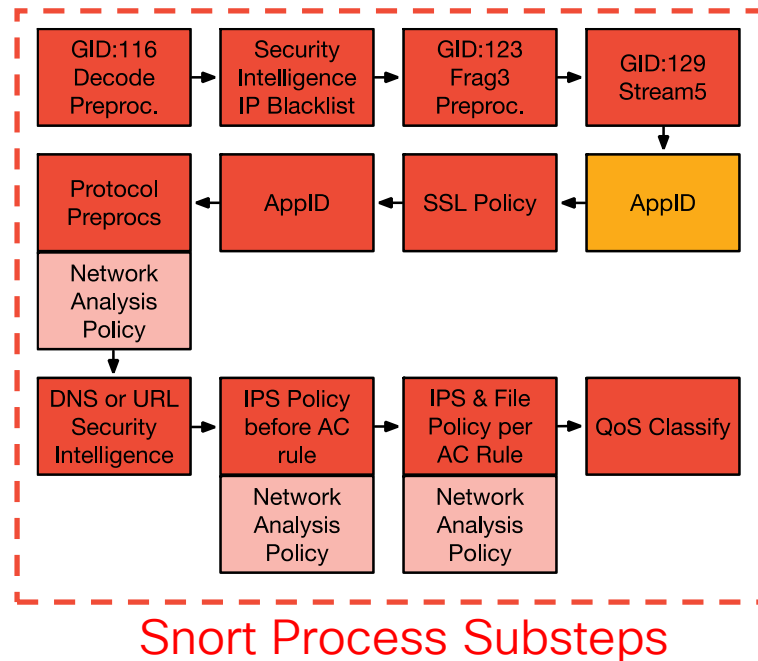
Output:

AS address space

I snort instance number

R 1st packet reversed (server to client)

- Specify flow 5-tuple to show access control rule matching:
> **system support firewall-engine-debug**



Packet Processing: SSL Policy

An authorized man-in-the-middle of TLS/SSL traffic

For servers you own:

Decrypt: Known Key - Requires private key and certificate

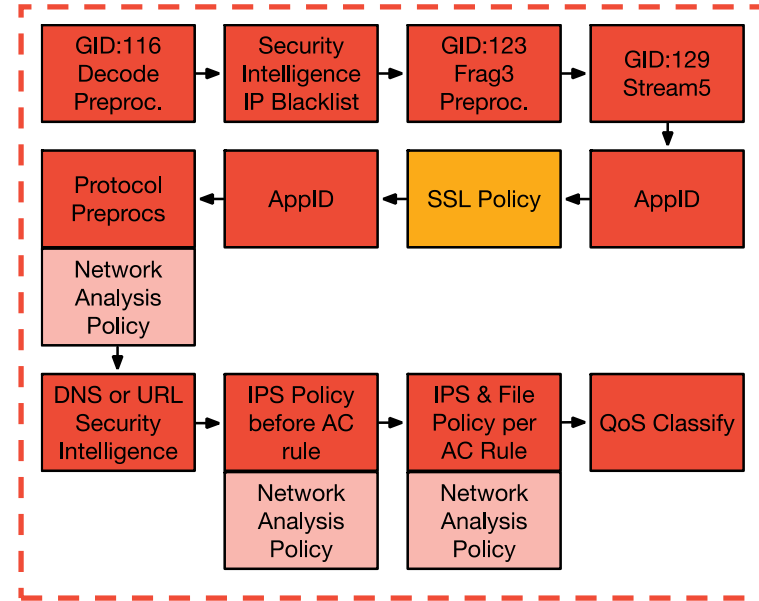
For clients navigating to 3rd party sites:

Decrypt: Resign - Resign certificate with an intermediate CA

Two options for new certificates to be trusted:

1. The client must trust the FMC as a Certificate Authority
2. The client must trust a CA which signs the FMC's CSR (Certificate Signing Request)

Traffic is TCP and SSL proxied in a DAQ extension which sends cleartext traffic to snort for IPS inspection

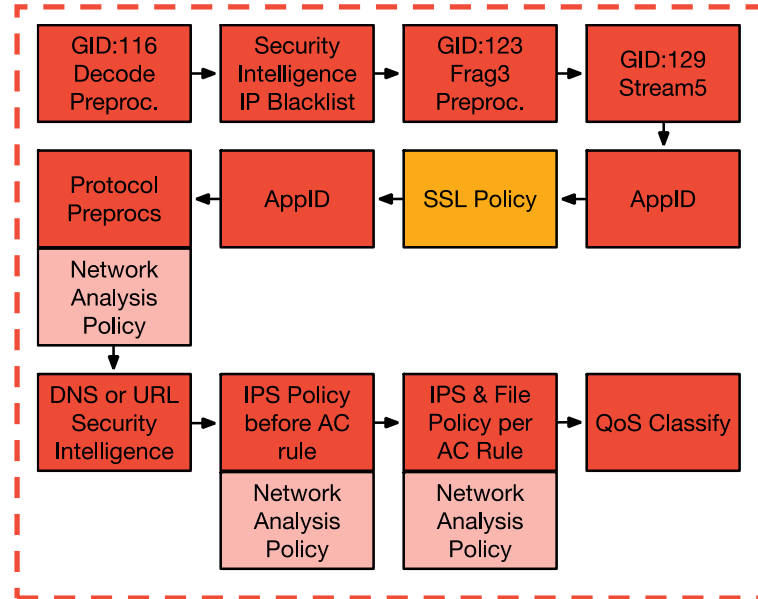


Snort Process Substeps

Packet Processing: SSL Policy Debugging

Be careful with “Undecryptable Actions,” especially if your default action in the SSL Policy rules is “Block”

Rules	Trusted CA Certificates	Undecryptable Actions
Compressed Session		Inherit Default Action ▼
SSLv2 Session		Inherit Default Action ▼
Unknown Cipher Suite		Inherit Default Action ▼
Unsupported Cipher Suite		Inherit Default Action ▼
Session not cached		Inherit Default Action ▼
Handshake Errors		Inherit Default Action ▼
Decryption Errors		Block ▼



Snort Process Substeps

Packet Processing: SSL Policy Debugging

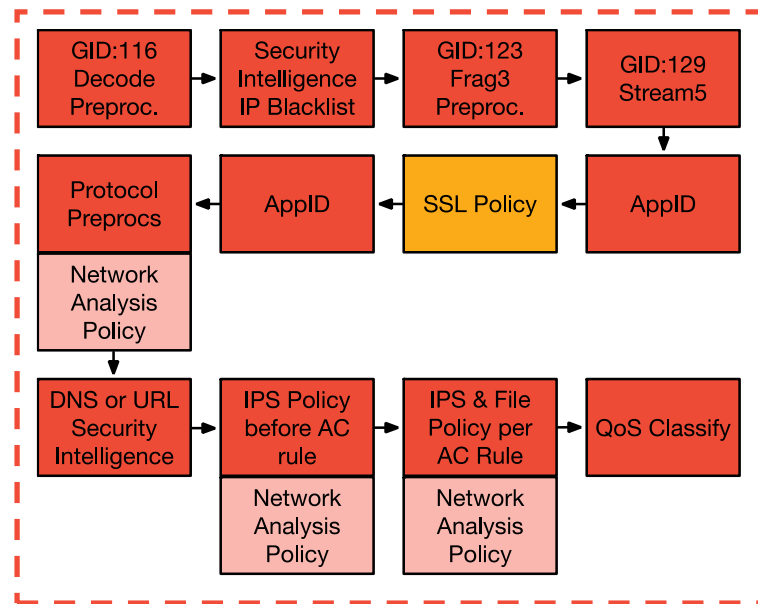
Troubleshooting Best Practices:

1) Take note of browser side errors!

2) View SSL decryption event columns in Connection Events:

- Navigate to “Analysis > Connections > Events”
- Click “Table View of Connection Events”
- Click “X” next to any column and select 13 SSL columns

3) Columns in connection events explain decryption errors



Snort Process Substeps

Connection Events (switch workflow)

Connections with Application Details > **Table View of Connection Events**

► Search Constraints ([Edit Search](#) [Save Search](#))

Jump to... ▼

	First Packet ×	Last Packet ×	Action ×	Reason ×	Initiator IP ×	Initiator Country ×	Responder IP ×	Responder Country ×
⬇	2017-05-30 13:09:23	2017-05-30 13:09:24	Block	SSL Block	192.168.1.200		216.58.217.138	USA
⬇	2017-05-30 13:08:53	2017-05-30 13:08:54	Block	SSL Block	192.168.1.200		216.58.217.138	USA
⬇	2017-05-30 13:08:23	2017-05-30 13:08:24	Block	SSL Block	192.168.1.200		216.58.217.138	USA
⬇	2017-05-30 13:08:19	2017-05-30 13:08:20	Block	SSL Block	192.168.1.200		216.58.217.138	USA
⬇	2017-05-30 13:07:53	2017-05-30 13:07:54	Block	SSL Block	192.168.1.200		216.58.217.138	USA
⬇	2017-05-30 13:07:23	2017-05-30 13:07:24	Block	SSL Block	192.168.1.200		216.58.217.138	USA

SSL Blocking
flow

Connection Event Review



Cause of the
SSL failure

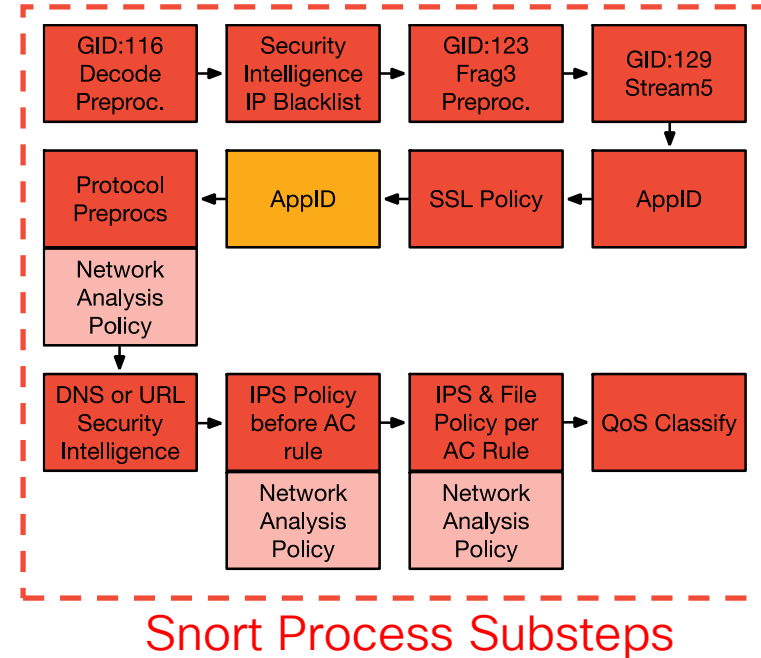
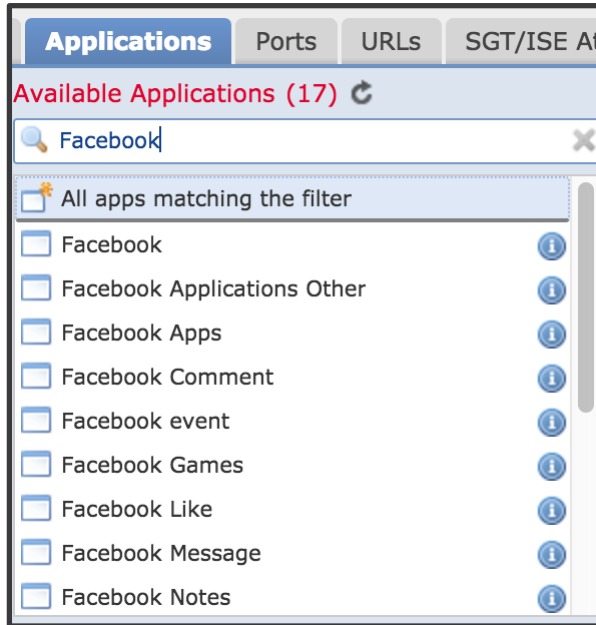
SSL flow flags
for what
happened with
flow

SSL Rule ×	SSL Session ID ×	SSL Ticket ID ×	SSL Flow Flags ×	SSL Flow Messages ×
MITM	0x0	0x0	VALID, INITIALIZED, SSL_DETECTED, CERTIFICATE_DECODED, FULL_HANDSHAKE, CLIENT_HELLO_SESSTKT, SERVER_HELLO_SESSTKT, CH_PROCESSED, SH_PROCESSED, CH_CIPHERS_MODIFIED, ...	CLIENT_HELLO, SERVER_HELLO, SERVER_CERTIFICATE
MITM	0x0	0x0	VALID, INITIALIZED, SSL_DETECTED, CERTIFICATE_DECODED, FULL_HANDSHAKE, CLIENT_HELLO_SESSTKT, SERVER_HELLO_SESSTKT, CH_PROCESSED, SH_PROCESSED, CH_CIPHERS_MODIFIED, ...	CLIENT_HELLO, SERVER_HELLO, SERVER_CERTIFICATE
MITM	0x0	0x0	VALID, INITIALIZED, SSL_DETECTED, CERTIFICATE_DECODED, FULL_HANDSHAKE, CLIENT_HELLO_SESSTKT, SERVER_HELLO_SESSTKT, CH_PROCESSED, SH_PROCESSED, CH_CIPHERS_MODIFIED, ...	CLIENT_HELLO, SERVER_HELLO, SERVER_CERTIFICATE
MITM	0x0	0x0	VALID, INITIALIZED, SSL_DETECTED, CERTIFICATE_DECODED, FULL_HANDSHAKE, CLIENT_HELLO_SESSTKT, SERVER_HELLO_SESSTKT, CH_PROCESSED, SH_PROCESSED, CH_CIPHERS_MODIFIED, ...	CLIENT_HELLO, SERVER_HELLO, SERVER_CERTIFICATE
MITM	0x0	0x0	VALID, INITIALIZED, SSL_DETECTED, CERTIFICATE_DECODED, FULL_HANDSHAKE, CLIENT_HELLO_SESSTKT, SERVER_HELLO_SESSTKT, CH_PROCESSED, SH_PROCESSED, CH_CIPHERS_MODIFIED, ...	CLIENT_HELLO, SERVER_HELLO, SERVER_CERTIFICATE
MITM	0x0	0x0	VALID, INITIALIZED, SSL_DETECTED, CERTIFICATE_DECODED, FULL_HANDSHAKE, CLIENT_HELLO_SESSTKT, SERVER_HELLO_SESSTKT, CH_PROCESSED, SH_PROCESSED, CH_CIPHERS_MODIFIED, ...	CLIENT_HELLO, SERVER_HELLO, SERVER_CERTIFICATE

cisco *Live!*

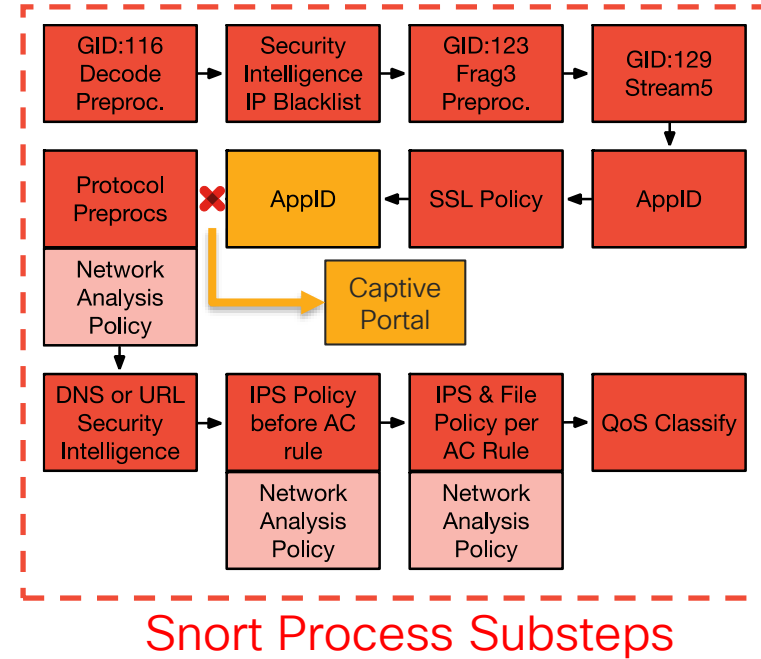
Packet Processing: AppID (Post SSL Decryption)

- Some apps require SSL decryption for further differentiation

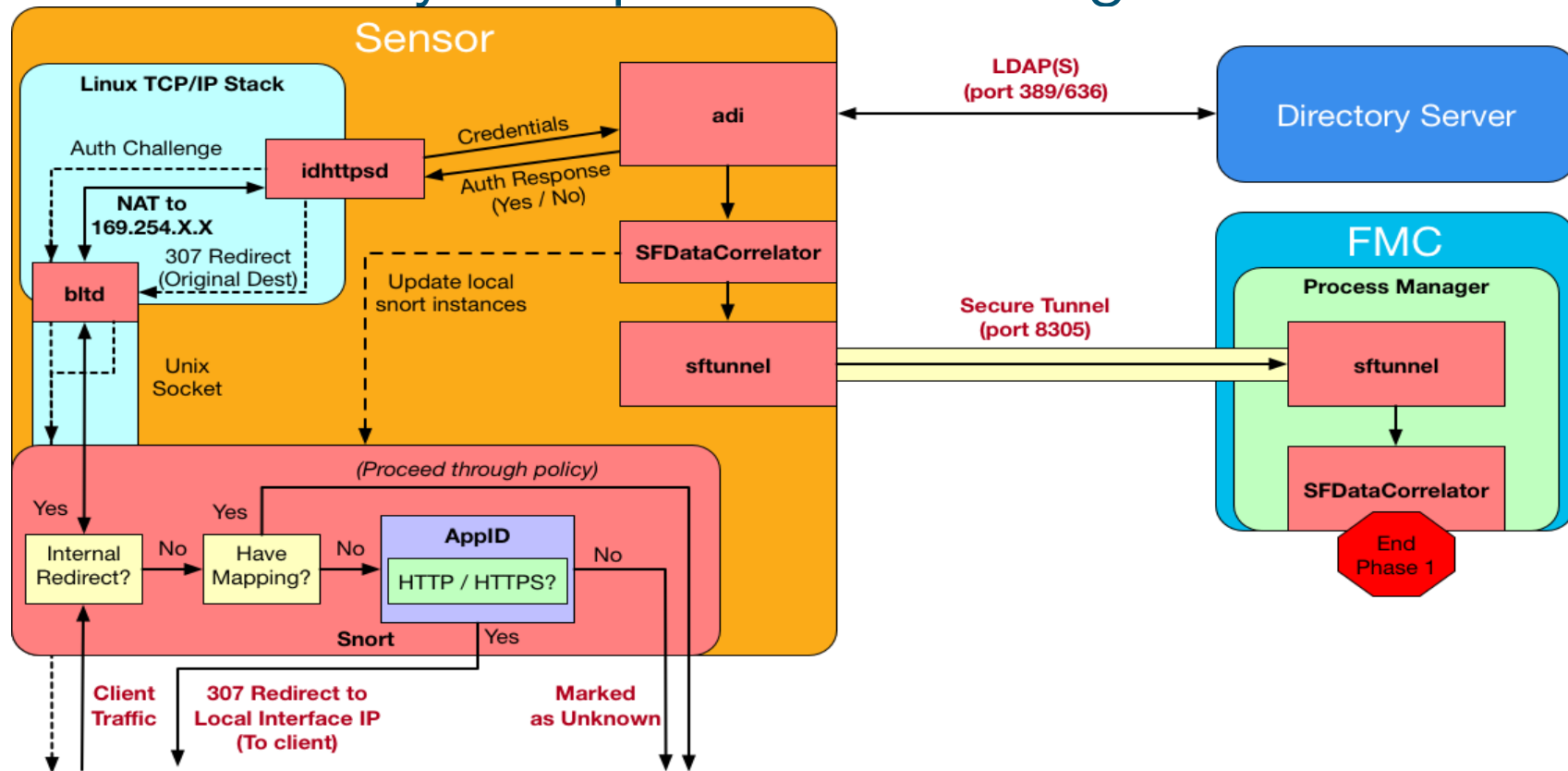


Packet Processing: Captive Portal

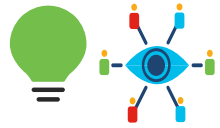
- Will only act if traffic is identified as HTTP or HTTPS
- Evaluation point to see if a user mapping currently exists for this IP address
- Intercepts client traffic and forces them to authenticate if there is no active mapping



User Identity - Captive Portal Diagram



Captive Portal new session walkthrough

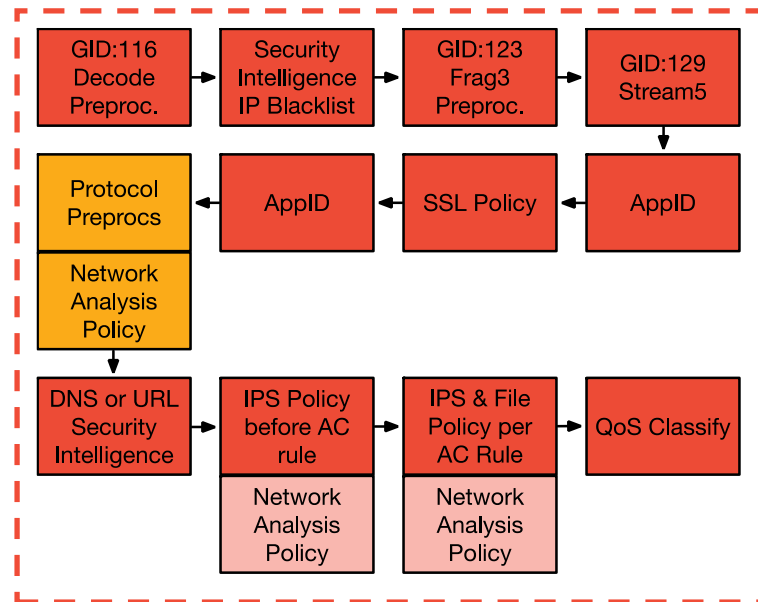


1. Client traffic (after coming from the data plane) makes its way to Snort
2. Check for current mappings for the requesting IP address
3. If no mapping, traffic eventually makes it into ApplD portion of Snort
4. Traffic is identified as HTTP/HTTPS snort injects a 307 response to client, redirecting them to the sensors interface IP
5. Traffic destined to the sensors local IP forces a flag to be set on the packet that instructs Snort to send this over to bltd
6. The response from the client is sent over to the bltd process via a Unix socket
7. bltd NATs the traffic to a 169.254.X.X IP address to be able to talk to the idhttpsd process
8. idhttpsd receives the GET request from the client (post bltd NAT)
9. idhttpsd challenges the clients authentication (method varies depending on configured authentication mechanism)
10. The challenge response from idhttpsd gets un-natted (by bltd) and sent back to the client (through snort)
11. Client responds to the authentication challenge
12. Response from client comes back through snort, gets re-natted by the bltd process and sent over to idhttpsd
13. idhttpsd passes the credentials it received (from clients response) to the adi process
14. adi tests authentication directly against the configured directory server
 1. adi gets a YES or NO
 2. Regardless of response, adi tells idhttpsd the verdict
 3. Assuming YES, adi will also tell SFDataCorrelator to create a mapping
15. SFDataCorrelator creates the mapping and updates snort with the mappings
16. SFDataCorrelator also sends this information to the FMC to propagate the mappings to other sensors
17. At the same time, idhttpsd will send the client another 307 redirect, redirecting the client to their original destination

Packet Processing: Protocol Preprocessors

Default Application Layer (L7) Preprocessors in a “Balanced Security and Connectivity” Network Analysis Policy (NAP):

Enabled	GID	Disabled	GID
DCE/RPC	133	SIP	140
DNS	131	POP	142
FTP & Telnet	125, 126	IMAP	141
HTTP	119		
Sun RPC	106		
GTP Command Channel	143		
SMTP	124		
SSH	128		
SSL	137		



Snort Process Substeps

Not shown:

Transport and Network Layer, SCADA, Specific Threat preprocessors

Packet Processing: Build a Network Analysis Policy

1 **Access Control**

2 **Create a Network Analysis Policy**

3 **Create Policy**

4 **Create and Edit Policy**

Create Network Analysis Policy

Policy Information

Name *

Description

Inline Mode ☒

Base Policy

* Required

Create Policy Create and Edit Policy

Settings


Application Layer Preprocessors

5

DCE/RPC Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
DNS Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
FTP and Telnet Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
HTTP Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
Sun RPC Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
SIP Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
GTP Command Channel Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
IMAP Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
POP Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
SMTP Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
SSH Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
SSL Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit

Packet Processing: Apply a Network Analysis Policy

Rules Security Intelligence HTTP Responses **Advanced** 1

Network Analysis and Intrusion Policies 2 

Intrusion Policy used before Access Control rule is determined Balanced Security and Connectivity

Intrusion Policy Variable Set Default Set

Default Network Analysis Policy Balanced Security and Connectivity

The NAP provides preprocessor settings

Network Analysis and Intrusion Policies ? x

Intrusion Policy used before Access Control rule is determined **Balanced Security and Connectivity** v


Intrusion Policy Variable Set **Default-Set** v 

Network Analysis Rules 3 **No Custom Rules**


Default Network Analysis Policy **Balanced Security and Connectivity** v



Network Analysis and Intrusion Policies ? x

Intrusion Policy used before Access Control rule is determined **Balanced Security and Connectivity** v

Intrusion Policy Variable Set **Default-Set** v 

Network Analysis Rules **1 Custom Rule** [Network Analysis Policy List](#)

4 

#	Source Zo...	Dest Zones	Source Network...	Dest Networks	VLAN T...	Network Analysis ...
1	Any	Any	IPv4-Private-19; IPv4-Private-17; IPv4-Private-10.	Any	Any	Connectivity Over Secur  

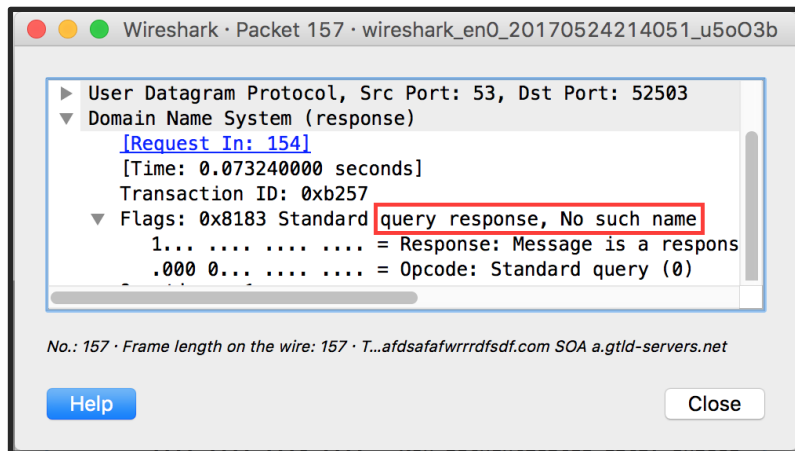
Default Network Analysis Policy **Balanced Security and Connectivity** v

Packet Processing: DNS Security Intelligence

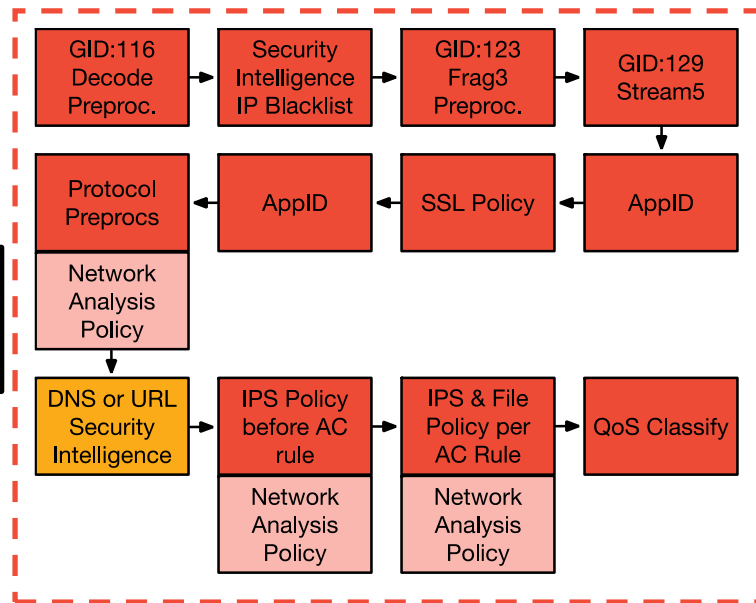
DNS SI performs a “man in the middle” of DNS queries

Option 1:

Alter DNS response to NXDOMAIN (domain not found)



NXDOMAIN
Response



Snort Process Substeps

Packet Processing: DNS Security Intelligence

DNS Security Intelligence NXDomain - Firewall Engine Debug

```
> system support firewall-engine-debug
```

```
[lines removed]
```

```
10.1.1.2-54821 and 172.18.108.34-53 17 AS 1 I 1 no session DNS SI shared mem lookup  
returned 1 for example.com
```

```
[lines removed]
```

```
10.1.1.2-54821 and 172.18.108.34-53 17 AS 1 I 1 no session Got DNS list match. si list  
1048587  
10.1.1.2-54821 and 172.18.108.34-53 17 AS 1 I 1 no session Firing DNS action DNS NXDomain  
10.1.1.2-54821 and 172.18.108.34-53 17 AS 1 I 1 no session DNS SI: Matched rule order 3,  
Id 5, si list id 1048587, action 22, reason 2048, SI Categories 1048587,0
```

Packet Processing: DNS Security Intelligence

DNS SI performs a “man in the middle” of DNS queries

Option 2:

Alter DNS response to inject a Sinkhole server IP address



Sinkhole ? X

Name: CNC-Sinkhole

IPv4 Policy: 10.99.99.99

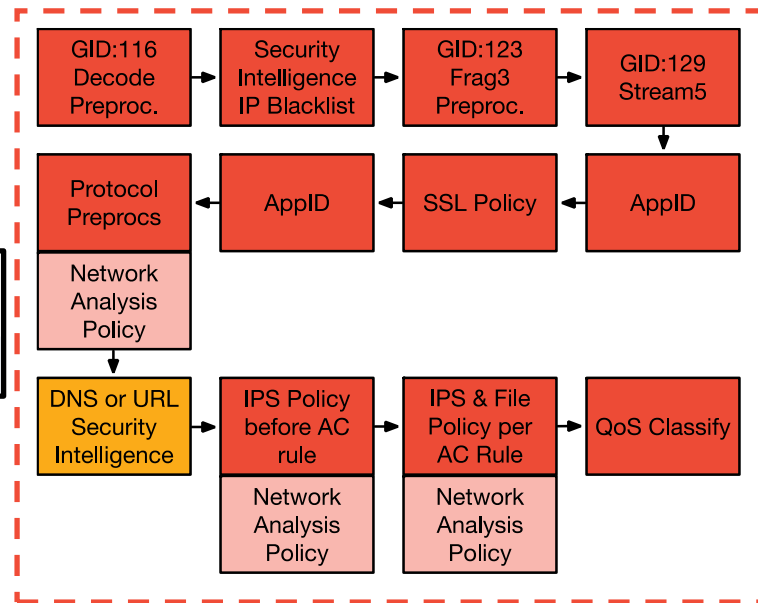
IPv6 Policy: 2001:DB8:1::dead:beef

Log Connections to Sinkhole: ☒

Block and Log Connections to Sinkhole: ☐

Type: Command and Control

Save Cancel



Snort Process Substeps

Packet Processing: DNS Security Intelligence

DNS Security Intelligence Sinkhole - Firewall Engine Debug

```
> system support firewall-engine-debug
```

```
[lines removed]
```

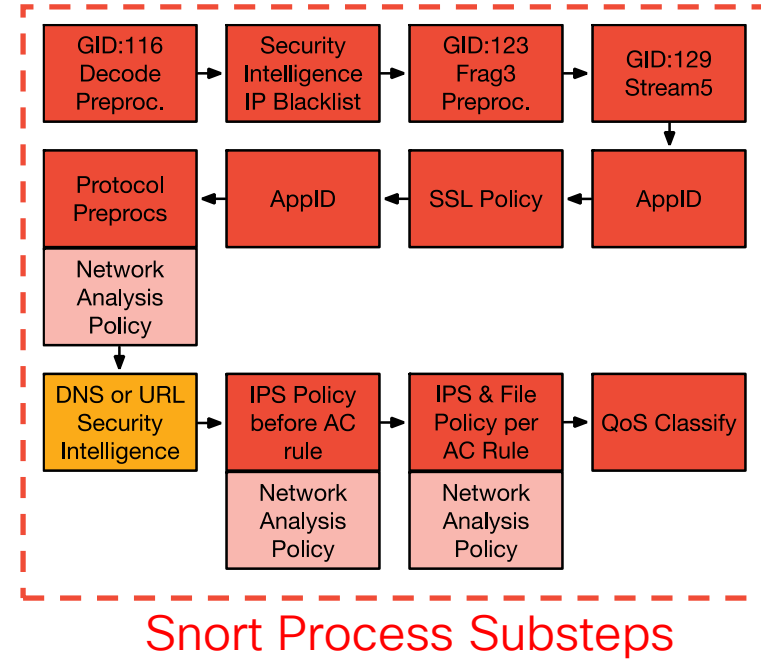
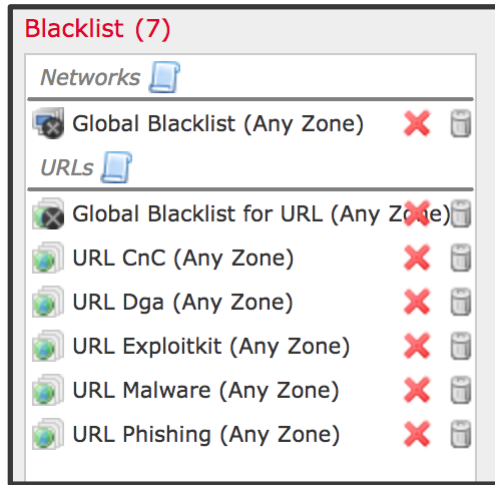
```
10.1.1.2-42818 and 172.18.108.34-53 17 AS 1 I 2 no session DNS SI shared mem lookup  
returned 1 for example.com
```

```
[lines removed]
```

```
10.1.1.2-42818 and 172.18.108.34-53 17 AS 1 I 2 no session Got DNS list match. si list  
1048587  
10.1.1.2-42818 and 172.18.108.34-53 17 AS 1 I 2 no session Firing DNS action DNS Sinkhole  
10.1.1.2-42818 and 172.18.108.34-53 17 AS 1 I 2 no session DNS SI: Matched rule order 3,  
Id 5, si list id 1048587, action 23, reason 2048, SI Categories 1048587,0
```

Packet Processing: URL Security Intelligence

- URL SI is independent from Access Control URL rules
- Blocks lists of malicious domains
- Matches the HTTP GET or TLS Client Hello



Packet Processing: URL Security Intelligence

URL Security Intelligence Block (Deny) - Firewall Engine Debug

```
> system support firewall-engine-debug
```

```
[lines removed]
```

```
10.1.1.2-35316 > 10.9.9.9-80 6 AS 1 I 21 URL SI:
```

```
ShmDBLookupURL("http://example.com/") returned 1
```

```
10.1.1.2-35316 > 10.9.9.9-80 6 AS 1 I 21 matched non-allow rule order 33, id 33
```

```
10.1.1.2-35316 > 10.9.9.9-80 6 AS 1 I 21 URL SI: Matched rule order 33, Id 33,  
si list id 1048584, action 4
```

```
10.1.1.2-35316 > 10.9.9.9-80 6 AS 1 I 21 deny action
```


Packet Processing: URL Security Intelligence

The screenshot displays the Cisco Talos Reputation Center web interface. At the top, the Cisco Talos logo is visible alongside navigation links for Software, Vulnerability Information, Reputation Center, Library, Support, Careers, Blog, and About. A search bar contains 'google.com'. Below the search bar, a navigation menu includes 'IP & Domain Reputation Overview', 'File Reputation Lookup', 'Email & Spam Data', 'Malware Data', and 'Reputation Support'. The main content area is divided into two columns. The left column, titled 'LOCATION DATA', shows 'Top Cities' with a list including Krakow, Poland; Mountain View, United States; Nagai, Iraq; Odessa, Ukraine; and Velestsko Mezric, Czech Republic. Below this is 'OWNER DETAILS' showing the domain 'google.com' and 'MAIL SERVERS' listing various aspmx.google.com addresses. The right column, titled 'REPUTATION DETAILS', shows 'WEB REPUTATION' with a 'VOLUME CHANGE' of 59% and a 'STATUS' of 'EXPIRED'. A red arrow points to a 'Submit a dispute here' link. Below this is a 'BLACKLISTS' section showing 'TALOS SECURITY INTELLIGENCE BLACKLIST' with a status of 'EXPIRED'.

Dispute
Reputations
6.5









New!
MGMI

This screenshot shows a different view of the Cisco Talos Reputation Center interface. It features a navigation bar with tabs for Overview, Analysis, Policies, Devices, Objects, AMP, and Intelligence. Below the navigation bar, a search bar is present. The main content area displays a table with columns for 'URL', 'Category', and 'Reputation'. The first row shows 'google.com' with a category of 'Search Engines and Portals' and a reputation of 'Favorable'. A red arrow points to a 'Dispute' link in the bottom right corner of the table.

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Packet Processing: URL Security Intelligence

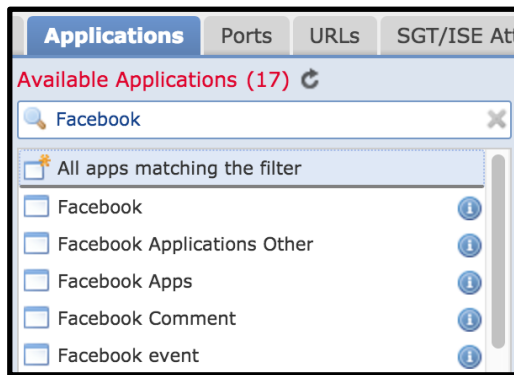
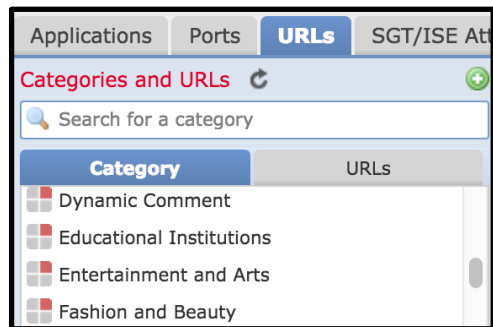
Analysis > Connections > Security Intelligence Events

▼ First Packet ×	Last Packet ×	Action ×	Reason ×	Initiator IP ×	Responder IP ×	Security Intelligence × Category
2017-05-16 17:00:16		Domain Not Found	DNS Block	 192.168.1.95	 	DNS Response
2017-05-16 16:57:50	2017-05-16 16:57:50	Block	URL Block	 192.168.1.95	 10.83.48.40	my_custom_url
2017-05-16 16:50:05		Block	IP Block	 192.168.1.95	 	Malware

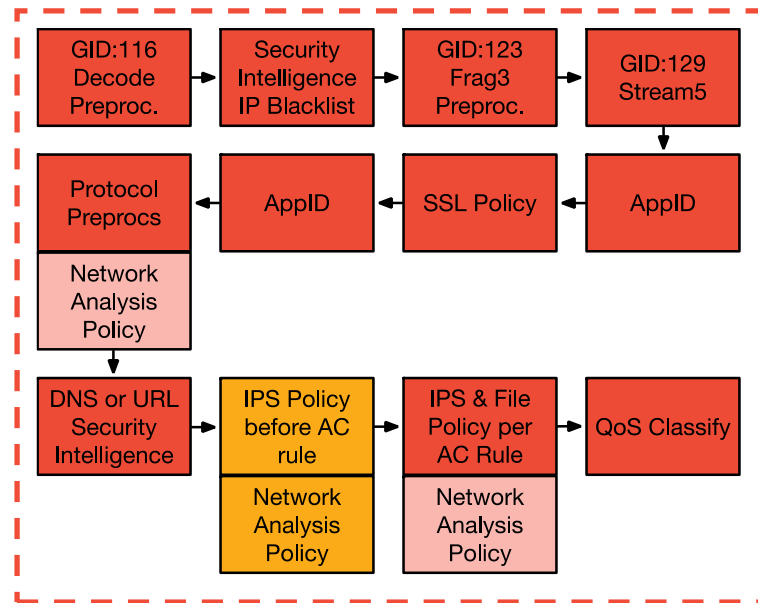
With logging enabled for all SI types you should be able to easily see what is being blocked by SI.

Packet Processing: IPS Policy before Access Rules

- Access Control rules can match URLs or Applications

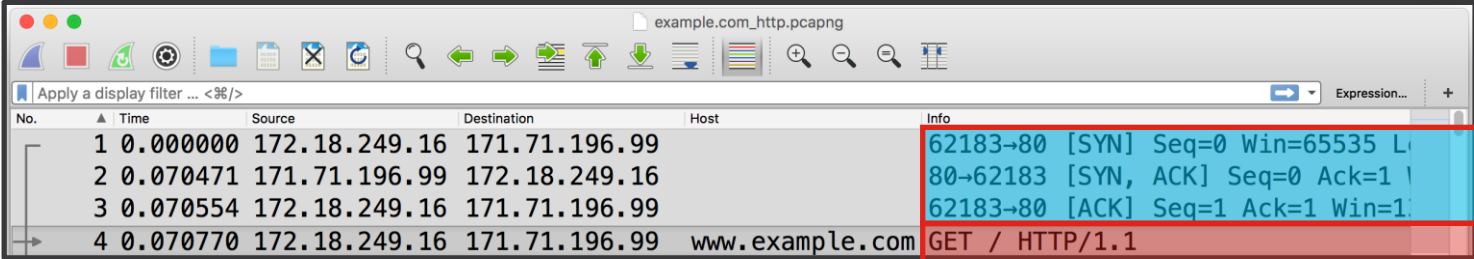


- To match a URL or App rule, Snort often needs the TLS Client Hello or HTTP GET
- Packets sent in a flow before matching an AC rule hit the “Intrusion Policy used before Access Control rule is determined”



Snort Process Substeps

Packet Processing: IPS Policy before Access Rules



example.com_http.pcapng

Apply a display filter ... <⌘>/

No.	Time	Source	Destination	Host	Info
1	0.000000	172.18.249.16	171.71.196.99		62183→80 [SYN] Seq=0 Win=65535 Len=0
2	0.070471	171.71.196.99	172.18.249.16		80→62183 [SYN, ACK] Seq=0 Ack=1 Win=0 Len=0
3	0.070554	172.18.249.16	171.71.196.99		62183→80 [ACK] Seq=1 Ack=1 Win=0 Len=0
4	0.070770	172.18.249.16	171.71.196.99	www.example.com	GET / HTTP/1.1

TCP 3-way Handshake

HTTP GET



Rules Security Intelligence HTTP Responses **Advanced**

Network Analysis and Intrusion Policies

Intrusion Policy used before Access Control rule is determined

Balanced Security and Connectivity

Intrusion Policy Variable Set Default Set

Packets before
HTTP GET

Packets after
HTTP GET

#	Name	Source Networks	Dest Networks	Applications	URLs	Action
▼ Mandatory						
1	Trust Backup Servers	10.12.12.12	10.34.34.34		Any	Trust
2	Block Example.com	Any	Any	Any	example.com	Block

Packet Processing: Access Control Policy Rules

Access Control Policy rules are evaluated from top to bottom

Allow - Permit unless prohibited by an IPS or File Policy

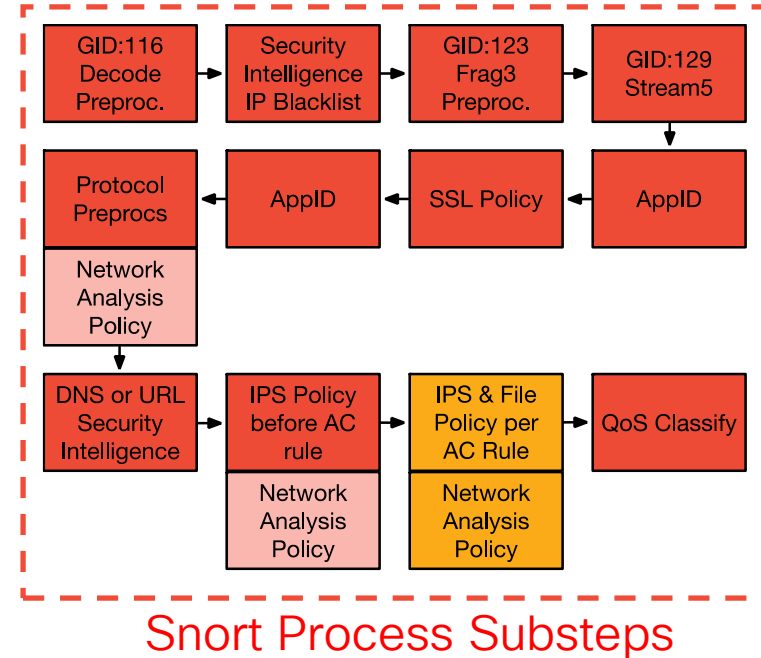
Trust - Pass the traffic without IPS or File inspection

Block - Silently drop the flow

Block with Reset - Send a TCP Reset or ICMP Unreachable

Interactive Block with Reset - Inject an HTTP 403 Forbidden

Monitor - Log the traffic and continue rule evaluation



Packet Processing: Access Control Policy Rules

Rules							
Security Intelligence HTTP Responses Advanced							
Filter by Device							
#	Name	Source Networks	Dest Networks	Applications	URLs	Action	
Mandatory							
1	Trust Backup Servers	10.12.12.12	10.34.34.34		Any	Trust	0
2	Block Example.com	Any	Any	Any	example.com	Block	0
3	Block Gambling Sites	Any	Any	Any	Gambling	Block	0
4	File Inspection	Any	Any	<input type="checkbox"/> FTP Data <input type="checkbox"/> FTP <input type="checkbox"/> HTTP <input type="checkbox"/> NetBIOS-ssn (SMB) <input type="checkbox"/> SMTP	Any	Allow	0
Default							
There are no rules in this section. Add Rule or Add Category							
Default Action							
Intrusion Prevention: Balanced Security and Connectivity							

(IPS) Protection Policy

Malware File Policy

SafeSearch

YouTube EDU

Logging

cisco Live!

Packet Processing: Access Control Policy Rules

FMC

Hit Count

Select a device: Flipkey-vFTD-6.4.0 | 6:49 (17 second(s) ago) | Refresh

Prefilter (Default Prefilter Policy) → AC Policy (flipkey_ACP_inline)
Total Rules 2

Filter Rules/Policy | Filter by: None | In Last: None | Last Deployed: 2019-06-03 16:41:10 (1 day(s) ago)

⚠ Policies have been modified and the hit count information displayed is not the latest.

#	Rule Name	Policy Name	Hit Count	Last Hit Time
1	Inline_IPS	flipkey_ACP_inline	0	
2	Default Action	flipkey_ACP_inline	0	

Deploy System Help admin

Analyze Hit Counts Save Cancel

New!
MGMI

Hit Counters
6.4

Security Policies

FDM

→ SSL Decryption → Identity → Security Intelligence → NAT → Access Control → Intrusion

1 rule

Search

Updated: less than 1 min ago

#	NAME	HIT COUNT	ACTION	SOURCE			DESTINATION			APPLICATIONS	URLS	USERS		ACTIONS
		LAST HIT		ZONES	NETWORKS	PORTS	ZONES	NETWORKS	PORTS/PRO...					
> 1	Inside_Outside_Rule	3,476 2019-05-03 01:18:38	 Allow		ANY	ANY	outside_zone	ANY	ANY	ANY	ANY	ANY	 	

Default Action 0
Not hit yet

Access Control Block

Generate PDF

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Packet Processing: Access Control Rule Evaluation

#	Name	Source Zones	Dest Zones	Source Networks	Dest Networks	VLAN ...	Users	Applic...	Sourc...	Dest P...	URLs	ISE/S... Attrib...	Acti...	
▼ Mandatory - JG AC (all) (1-6)														
1	Trust ssh for host	Any	Any	192.168.0.7	Any	Any	Any	Any	Any	SSH	Any	Any	→ Trust	
2	inspect	Any	Any	10.0.0.0/8	Any	Any	Any	Any	Any	Any	Any	Any	✓ Allow	
3	trust server backup	Any	Any	192.168.62.3	10.123.175.22	Any	Any	Any	Any	Any	Any	Any	→ Trust	

SSH Connection from 192.168.62.3 to 10.123.175.22

1. SYN 192.168.62.3 → 10.123.175.22
2. SYN,ACK 10.123.175.22 → 192.168.62.3
3. ACK 192.168.62.3 → 10.123.175.22
4. SSH 192.168.62.3 → 10.123.175.22

Starts evaluation at 'inspect' rule



Service identified as SSH

No match 'inspect' rule (non-http)

Match 'trust server backup' rule and Trust flow

Packet Processing: Rule Evaluation

firewall-engine-
debug



Example: SSH Connection from 192.168.62.3 to 10.123.175.22

SYN ➡ SYN,ACK ➡ ACK ➡ First SSH Packet (client to server)

```
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 New session
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first
with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0, client
0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 pending rule order 4, 'inspect', XFF wait for AppId
```

```
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first
with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0, client
0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 pending rule order 4, 'inspect', XFF wait for AppId
```

```
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first
with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0, client
0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 pending rule order 4, 'inspect', XFF wait for AppId
```

```
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first
with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 846, payload -1,
client 2000000846, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 no match rule order 4, 'inspect', XFF non-http
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 match rule order 5, 'trust server backup', action Trust
```

Packet Processing: Rule Evaluation

firewall-engine-
debug



SSH Connection from 192.168.62.3 to 10.123.175.22 (truncated)

```
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 New session
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first
with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0, client
0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 pending rule order 4, 'inspect', XFF wait for AppId
```

[...omitted for brevity]

```
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first
with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 846, payload -1,
client 200000846, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 no match rule order 4, 'inspect', XFF non-http
192.168.62.3-46594 > 10.123.175.22-22 6 AS 1 I 0 match rule order 5, 'trust server backup', action Trust
```

[! How to map service/application ID to name]

```
> expert
$ grep "^846[^0-9]" /var/sf/appid/odp/appMapping.data
846 SSH 32 0 0 ssh
```

Packet Processing: Rule Evaluation

SSH Connection from 192.168.62.3 to 10.123.175.22

(Blocked/Ended before matching an AC rule)

firewall-engine-
debug



```
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 New session
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 4, 'inspect', and IPProto first with
zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0, client 0, misc
0, user 9999997, icmpType 0, icmpCode 0
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 pending rule order 4, 'inspect', XFF wait for AppId
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 Deleting session
```

[!Session was deleted because we hit a drop IPS rule and blacklisted the flow.
This happened before AC rule was matched (Intrusion policy before AC rule match dropped).
Firewall engine will re-evaluate from top of AC policy to find a rule for logging decision]

```
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 Starting with minimum 0, id 0 and IPProto first with zones
1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: 0, ISE sgt id: 0, svc -1, payload -1, client -1, misc -1, user
9999997, icmpType 102, icmpCode 22
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 no match rule order 3, 'Trust ssh for host', src network
and GEO
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 no match rule order 4, 'inspect', XFF non-http
192.168.62.3-54650 > 10.123.175.22-22 6 AS 1 I 0 match rule order 5, 'trust server backup', action Trust
```

Action ×	Reason ×	Initiator IP ×	Responder IP	Source Port / ICMP Type	Destination Port / ICMP Code	Application Protocol	Client ×	Intrusion Events	Access Control Policy	Access Control Rule
Block	Intrusion Block	192.168.62.3	10.123.175.22	55654 / tcp	22 (ssh) / tcp				JG AC (all)	trust server backup

AC Rule has “Trust” action but connection event action shows “Block”

Packet Processing: Access Control with IPS

Edit Policy: Example IPS Policy

Policy Information

- Rules
- Firepower Recommendations
- Advanced Settings
- Policy Layers**
- My Changes
 - Rules
 - Balanced Security and Connectivity
 - Rules
 - Global Rule Thresholding

Rules - Layer: My Changes < Back

Rule Configuration

Rule Content

Category

Classifications

Microsoft Vulnerabilities

Microsoft Worms

Platform Specific

Preprocessors

Priority

Rule Update

Filter: gid:1 sid:31977

Filter returned 1 result

Layer: My Changes

Rule State	Event Filtering	Dynamic State	Alerting	Comments
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
GID	SID	Message		
<input type="checkbox"/> 1	31977	OS-OTHER Bash CGI environment variable injection attempt		

Hide details Above Below 1 of 1

Documentation

rule alert tcp \$EXTERNAL_NET any -> \$HOME_NET \$HTTP_PORTS (msg:"OS-OTHER Bash CGI environment variable injection attempt"; flow:to_server,established; content:"() {"; fast_pattern:only; http_uri; metadata:policy balanced-ips drop, policy max-detect-ips drop, policy security-ips drop, ruleset community, service http; reference:cve,2014-6271; reference:cve,2014-6277; reference:cve,2014-6278; reference:cve,2014-7169; classtype:attempted-admin; sid:31977; rev:5; gid:1;)

Intrusion Policies are built on layers

Prebuilt base layers from Cisco TALOS:

- Connectivity over Security (~500 rules)
- Balanced Security & Connectivity (~9,000 rules)
- Security over Connectivity (~13,000 rules)

Packet Processing: Access Control with File

The screenshot displays the configuration page for a file policy in a network device. It is divided into several sections:

- Application Protocol:** A dropdown menu set to "Any".
- Direction of Transfer:** A dropdown menu set to "Any".
- Action:** A dropdown menu set to "Block Malware" with a red gear icon.
- File Type Categories:** A list with checkboxes and counts: "Office Documents" (16), "Archive" (17), and "Multimedia" (2).
- File Types:** A search bar "Search name and description" and a list of file types: "7Z (7-Zip compressed file)" and "ACCDB (Microsoft Access 2007 file)".
- Store Files:** A section with checkboxes for "Malware", "Unknown", "Clean", and "Custom".
- Selected File Categories and Types:** A list of selected categories: "Category: PDF files", "Category: Executables", and "Category: Office Documents".
- Other Options:** Checkboxes for "Spero Analysis for MSEXE", "Dynamic Analysis", "Capacity Handling" (with an info icon), "Local Malware Analysis", and "Reset Connection" (which is checked).

- Like Intrusion Policies, a File Policy is tied to an Access Control Rule
- Checks multiple file types by looking up a SHA256 checksum for known malware
- Can submit unknown files to the AMP cloud or AMP ThreatGrid appliance

```
> system support firewall-engine-debug
10.1.1.2-16969 > 10.9.9.9-80 6 AS 0 I 1 File malware event for
275a021bbfb6489e54d471899f7db9d1663fc695ec2fe2a2c4538aabf651fd0f named eicar.com with
disposition Malware and action Block Malware
```

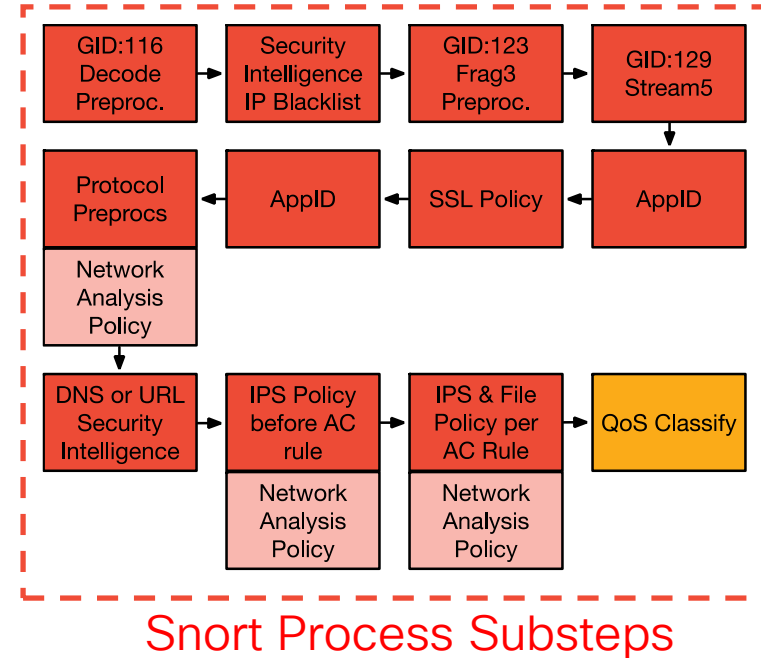
Packet Processing: QoS Classification in Snort

Eligible traffic for rate-limiting:

- **Allowed** or **Trusted**

Ineligible traffic for rate-limiting:

- **Blocked** or **Prefilter Fastpath** (Snort exempt)
- Snort classifies traffic by matching it to a QoS rule
- Snort tells Lina the Flow-rule QoS id for each flow
- On the Lina interface, the Rule ID matches a traffic class



Packet Processing: QoS Classification in Snort

Rules Policy Assignments (1)

Filter by Device Add Rule Search Rules

#	Name	Source Interface O...	Source Networks	Dest Ports	Download	Upload	Applied On
1	Police Port 80	inside	10.0.0.0/8	TCP (6):8	1 Mbits/sec	Unlimited	Source interface 0

Rate Limit per Interface

```
> expert
```

```
$ cat /ngfw/var/sf/detection_engines/[UUID]/qos.rules
```

```
[lines removed]
```

```
268435467 ratelimit 2 10.0.0.0 8 any any any 80 any 6
```

← QoS Rule ID

```
> system support firewall-engine-debug
```

```
[lines removed]
```

```
10.1.1.2-59831 > 10.9.9.9-80 6 AS 1 I 19 match rule order 1, id 268435467 action Rate Limit
```

```
10.1.1.2-59831 > 10.9.9.9-80 6 AS 1 I 19 QoS policy match status ((null)), match action
```

```
(Rate Limit), QoS rule id (268435467)
```

Packet Processing: QoS Interface Policing in LINA

```
> system support diagnostic-cli
```

```
firepower# show run service-policy
service-policy global_policy global
service-policy policy_map_inside interface inside
```

```
firepower# show service-policy interface inside
```

```
Interface inside:
```

```
Service-policy: policy_map_inside
```

```
Flow-rule QoS id: 268435467
```

← QoS Rule ID

```
Output police Interface inside:
```

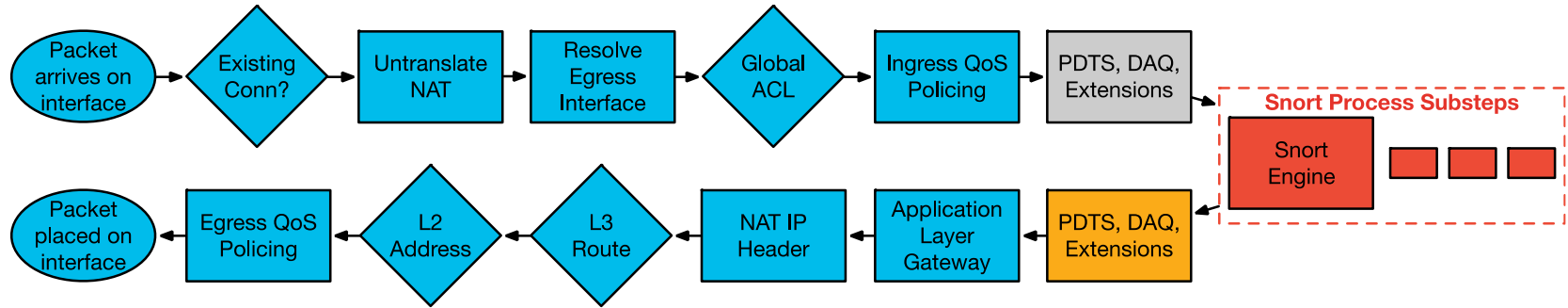
```
  cir 1000000 bps, bc 31250 bytes
```

```
firepower# show conn detail
```

```
TCP outside: 10.9.9.9/80 inside: 10.1.1.2/59831,
```

```
  flags UxIO N, qos-rule-id 268435467, idle 0s, uptime 4m5s, timeout 1h0m, bytes  
15542738, xlate id 0x7f05a30260c0
```

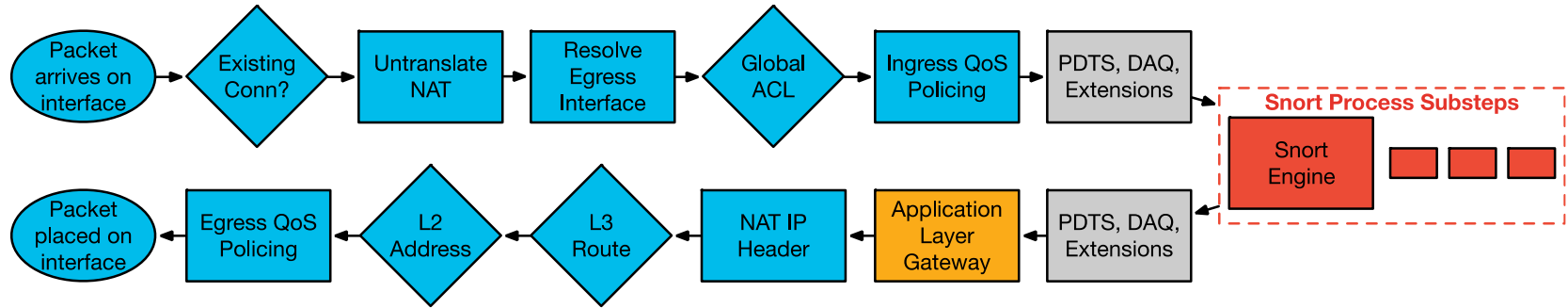

Packet Processing: Packet Data Transport System



The Packet Data Transport System sends packets back to Lina after Snort processing.

Note: It is extremely rare for any packets to be dropped at this stage.

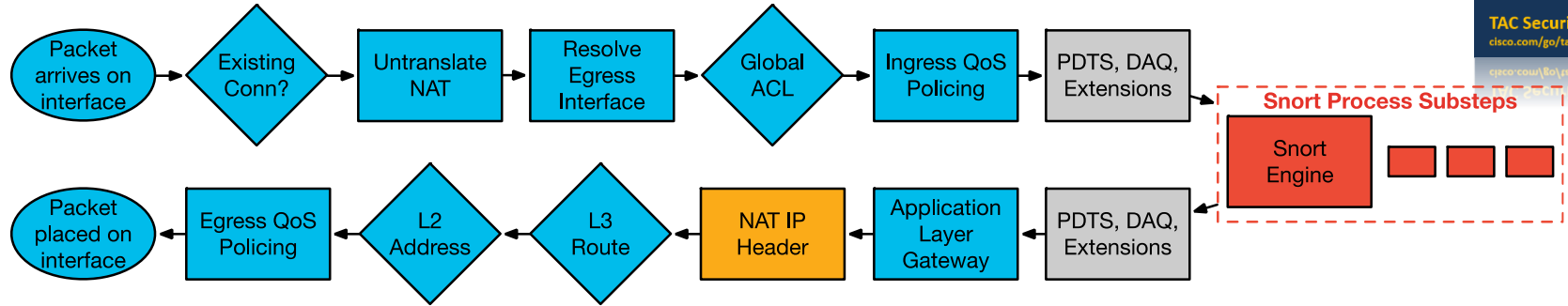
Packet Processing: Application Layer Gateway



- Stateful inspection ensures protocol compliance at TCP/UDP/ICMP level
- (Optional) Customizable application inspection up to Layer 7 (FTP, SIP, and so on)
 - Rewrite embedded IP addresses, open up ACL pinholes for secondary connections
 - Additional security checks are applied to the application payload

```
ASA-4-406002: FTP port command different address: 10.2.252.21(192.168.1.21) to  
209.165.202.130 on interface inside  
ASA-4-405104: H225 message received from outside_address/outside_port to  
inside_address/inside_port before SETUP
```

Packet Processing: NAT IP Header



- Translate the source and destination IP addresses in the IP header
- Translate the port if performing PAT
- Update header checksums

Auto NAT (Object NAT)

- Auto NAT is the simplest form of NAT, and is defined *within an object*

Static Host NAT

```
object network obj-WebServer
  host 10.1.2.100
  nat (inside,outside) static 198.51.100.10
```

Dynamic PAT (interface overload)

```
object network InternalUsers
  subnet 192.168.2.0 255.255.255.0
  nat (inside,outside) dynamic interface
```

Rules									
Filter by Device									
Original Packet					Translated Packet				
#	Dire...	Type	Source Interfa...	Destina... Interfa...	Original Sources	Ori De	Ori Se	Translated Sources	Tr T De S
▶ NAT Rules Before									
▼ Auto NAT Rules									
#	↔	Static	inside	outside	10.1.2.100			198.51.100.10	
#	➡	Dynamic	inside	outside	InternalUsers			Interface	

Manual NAT (Twice NAT)

- Manual NAT can specify the source and the destination translations

Network Objects

```
object network 10.10.10.0-net
  subnet 10.10.10.0 255.255.255.0
!
object network 192.168.1.0-net
  subnet 192.168.1.0 255.255.255.0
```

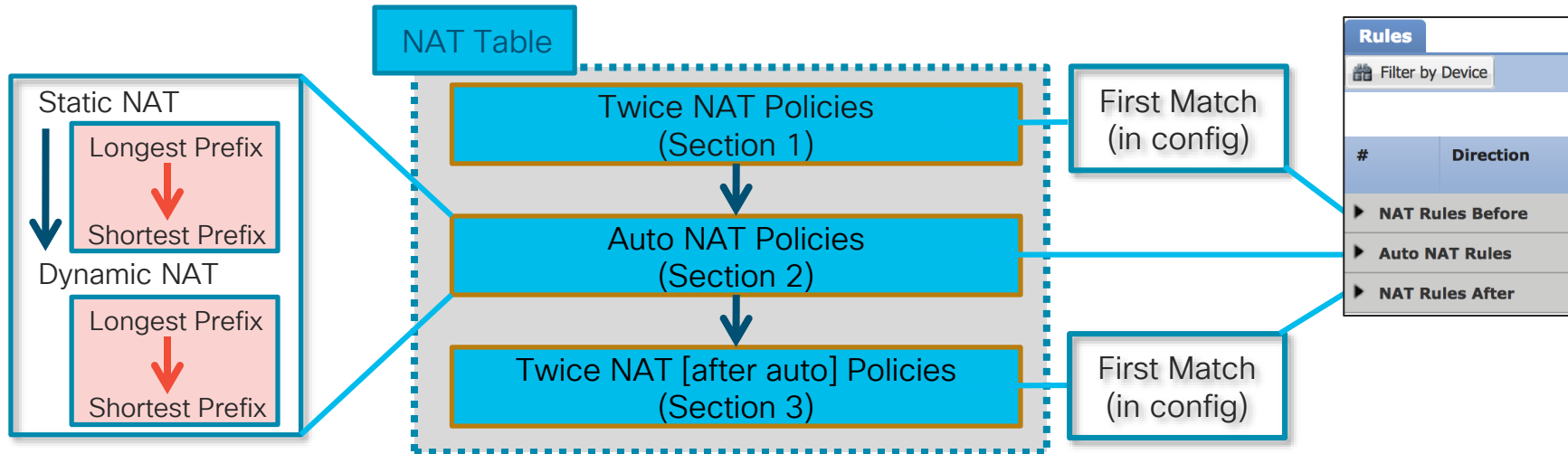
Twice NAT Config

```
nat (inside,outside) source static 10.10.10.0-net 10.10.10.0-net
destination static 192.168.1.0-net 192.168.1.0-net
```

NAT Order of Operation



- FTD configuration is built into the **NAT table**
- The NAT Table is based on **First Match** (top to bottom)
- The **show nat** command will display the NAT table in order



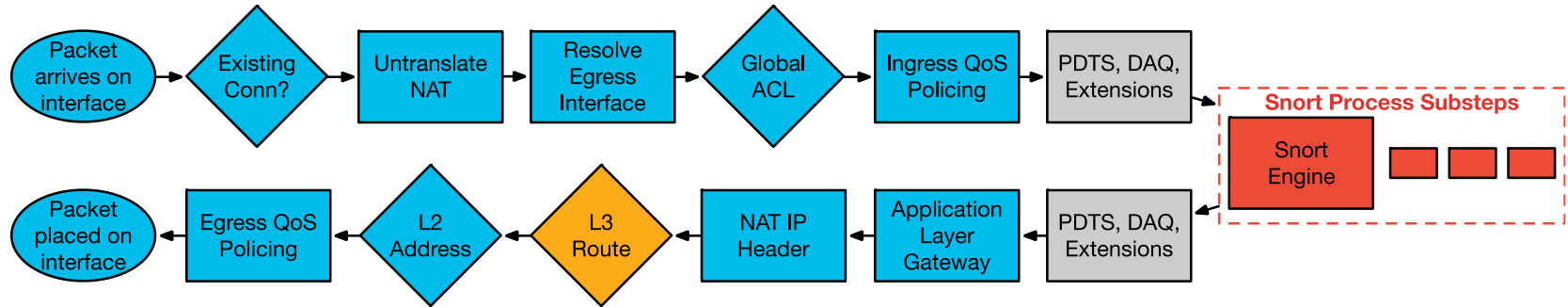
Carrier Grade NAT (CGNAT)

New!

- In 2019, version 6.5 added CGNAT functionality to FTD
- CGNAT allocates xlates to source IPs in blocks instead of individually
- Goal is to improve performance and reduce logging overhead
- Troubleshooting methodology remains the same

```
> show local-host 10.0.0.1
.....
Port Block Allocation:
    Block 1: IP 192.0.2.107, UDP port range 53248-54271, in use 934
Xlate:
    UDP PAT from inside:10.0.0.1/934 to outside:192.0.2.107/53736 flags ri idle 0:00:00
timeout 0:05:00
    UDP PAT from inside:10.0.0.1/933 to outside:192.0.2.107/53625 flags ri idle 0:00:00
timeout 0:05:00
```

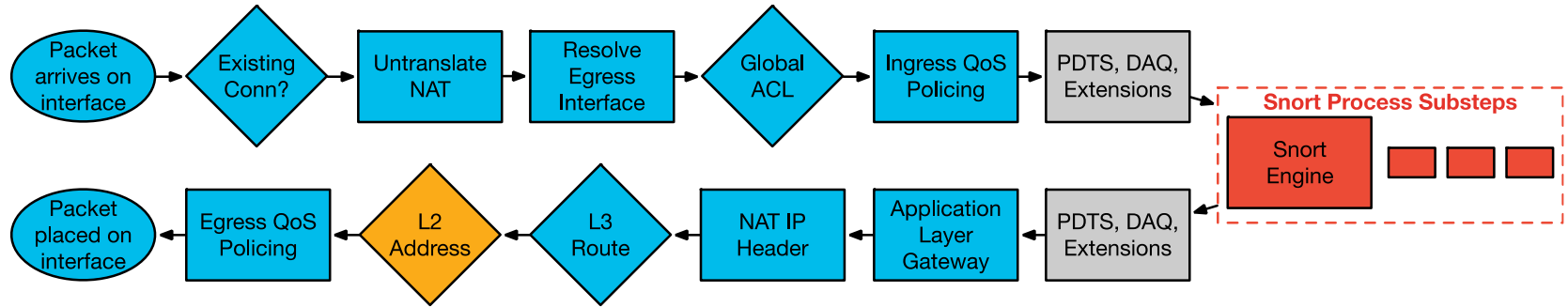
Packet Processing: L3 Route Lookup



- After the IP header translation an interface route lookup is performed
- Only routes pointing out the egress interface are eligible
- Remember: NAT rule can forward the packet to the egress interface, even though the routing table may point to a different interface
 - If the destination is not routable out of the identified egress interface, the packet is dropped

```
%ASA-6-110003: Routing failed to locate next hop for TCP from inside:192.168.103.220/59138  
to dmz:172.15.124.76/23
```

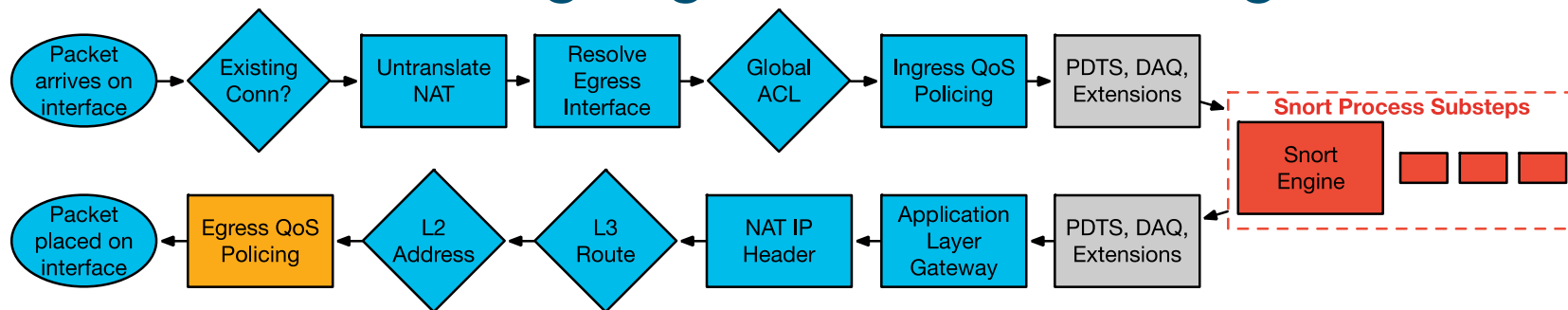

Packet Processing: L2 Address Lookup



- Once a Layer 3 route has been found, and next hop IP address identified, Layer 2 resolution is performed
 - Layer 2 rewrite of MAC header
- If Layer 2 resolution fails – **no** syslog
 - **show arp** will not display an entry for the L3 next hop
 - **debug arp** will indicate if we are not receiving an ARP reply

```
arp-req: generating request for 10.1.2.33 at interface outside
arp-req: request for 10.1.2.33 still pending
```

Packet Processing: Egress QoS Policing



```
> system support diagnostic-cli
```

```
firepower# show service-policy interface outside
```

```
Interface outside:
```

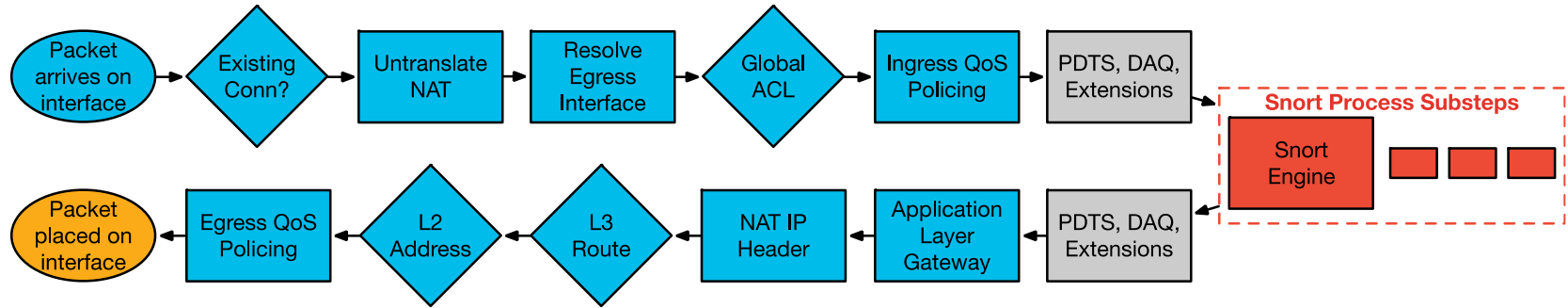
```
Service-policy: policy_map_outside
```

```
Flow-rule QoS id: 268435467
```

```
Output police Interface outside:
```

```
  cir 1000000 bps, bc 31250 bytes
```

Packet Processing: Transmit Packet



- Packet is transmitted on wire
- Interface counters will increment on interface
- **Underrun** counter indicates drops due to egress interface oversubscription
 - TX ring is full

```
> show interface outside
Interface GigabitEthernet0/1 "outside", is up, line protocol is up
...
273399 packets output, 115316725 bytes, 80 underruns
...
input queue (blocks free curr/low): hardware (485/441)
output queue (blocks free curr/low): hardware (463/0)
```

Packet Processing: Other FTD Modes

- **Transparent Mode**

- Functions as an L2 bridge, re-writes VLAN tags in trunk mode
- Traffic is processed by Lina and Snort

- **Inline Sets**

- Functions as an L1 “bump in the wire”, no L2/L3 packet re-writing
- Snort processing only (Lina sees the packet but only redirects to Snort)
- Can be used in conjunction with both transparent and routed mode

- **Flow Offload**

- Enabled by the Prefilter Fastpath option on 4100/9300 platforms*
- Bypasses Lina and Snort completely
- L2/L3 re-writing is handled by special network adapter in the security engine blade
- View offloaded flows via the ‘show flow-offload flow detail’ command in Lina CLI

Troubleshooting Tools

Tools – Syslogs

- Syslogs remain the primary mechanism for recording connections **to** and **through** the firewall
- Should be the **first** troubleshooting tool to use for most issues
- Most syslogs in FTD are still generated from Lina:
 - Health of Lina resources and processes
 - Lina CPU, memory, block depletion
 - Failover events
 - NAT translation builds/teardowns

Note: Lina syslog config is defined under 'Platform Settings' in FMC



Enable Logging

The screenshot shows the Cisco FMC interface for configuring platform settings. The 'Devices' tab is selected, and the 'Platform Settings' sub-tab is active. The page title is '4120_Platform_Settings'. The 'Logging Setup' tab is selected, and the 'Enable Logging' checkbox is checked. A yellow box highlights the 'Enable Logging' checkbox, and a blue arrow points from the 'Enable Logging' text above to it. The page shows various logging settings including Basic Logging Settings, VPN Logging Settings, and Specify FTP Server Information.

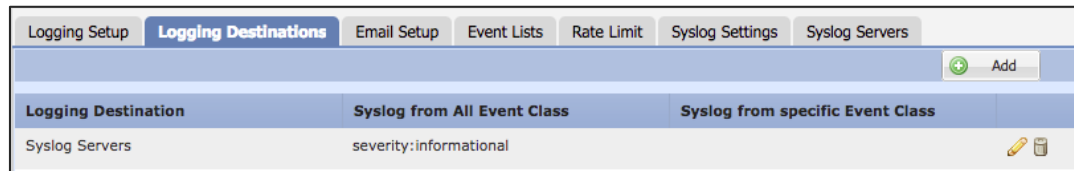
Tools – Syslogs – FMC vs. CLI configuration

- FMC screenshots and corresponding Lina CLI configuration:

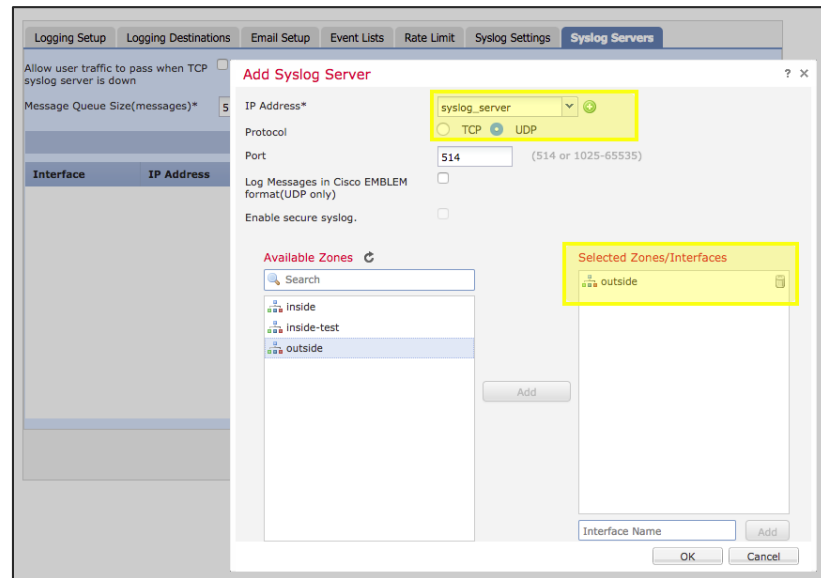
1



2



3



1

2

3

```
firepower# show run logging
logging enable
logging trap informational
logging host outside 10.1.0.1
```

Note: The syslog_server object is defined as 10.1.0.1

Tools – Syslogs – Connection Logging

- Lina connection logging and packet deny logs are **disabled** by default in FTD

CLI:

```
firepower# show run logging
```

```
...
```

```
no logging message 106015
```

```
no logging message 313001
```

```
no logging message 313008
```

```
no logging message 106023
```

```
no logging message 710003
```

```
no logging message 106100
```

```
no logging message 302015
```

```
no logging message 302014
```

```
no logging message 302013
```

```
no logging message 302019
```

```
no logging message 302017
```

```
no logging message 302016
```

```
no logging message 302021
```

```
no logging message 302020
```

Packet denials and
ACL logging

UDP, TCP, GRE, and
ICMP connections

FMC:

Syslog ID	Logging Level	Enabled
106015	(default)	✗
106023	(default)	✗
106100	(default)	✗
302013	(default)	✗
302014	(default)	✗

Tools – Syslogs – Connection Log Example



- Snort can also generate syslog messages for connection events when configured in the Access Policy.

Connection Events [\(switch workflow\)](#)
Connections with Application Details > Table View of Connection Events

No Search Constraints ([Edit Search](#))

Jump to... ▾

	First Packet	Last Packet	Action	Reason	Initiator IP	Initiator Country	Responder IP	Responder Country	Ingress Security Zone	Egress Security Zone	Source Port / ICMP Type	Destination Port / ICMP Code	Application Protocol	Client	Web Application	URL	URL Category	URL Reputation	Device
⬇	<input type="checkbox"/>	2017-05-21 17:07:02	Block		14.36.104.20	KOR	104.20.65.131	USA	inside	outside	33813 / tcp	80 (http) / tcp	HTTP	cURL	Web Browsing	http://www.gambling.com/			FPR4100-FTD

⏪ << Page 1 of 1 >> ⏩ Displaying row 1 of 1 rows

Add Rule

Name: Block_Hosts ☒ Enabled Insert: below rule 1

Action: ☒ Block

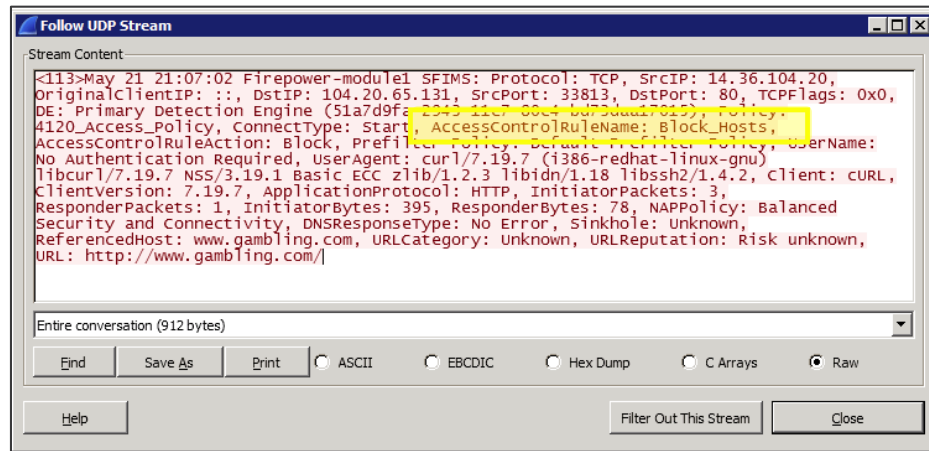
Zones Networks VLAN Tags Users Applications Ports URLs SGT/ISE Attributes Inspection **Logging** Comments

☒ Log at Beginning of Connection
☐ Log at End of Connection

File Events:
☐ Log Files

Send Connection Events to:
☒ Event Viewer
☒ Syslog Syslog
☐ SNMP Trap Select an SNMP Alert Configuration...

Add Cancel



Syslog generated (Wireshark view) →

cisco *Live!*

Tools – Syslogs – Snort vs. Lina

- Example: Logging at **beginning** AND **end** of connection AND **syslog** options for AC rule with Lina connection logging messages enabled in Syslog settings.

Date	Time	Priority	Hostname	Message
5/24/17	17:30:24	System4. Alert	10.1.1.79	May 24 21:30:22 FPR4100 SFIMS: Protocol: TCP, SrcIP: 10.1.1.20, OriginalClientIP: ::, DstIP: 172.18.124.145, SrcPort: 50072, DstPort: 21, TCPFlags: 0x0, DE: Primary Detection Engine (51a7d9fa-2943-11e7-80c4-bd73daa17015), Policy: 4120_Access_Policy, ConnectType: End , AccessControlRuleName: Allow_Hosts , AccessControlRuleAction: Allow , UserName: No Authentication Required, Client: FTP client, ApplicationProtocol: FTP, InitiatorPackets: 6, ResponderPackets: 6, InitiatorBytes: 434, ResponderBytes: 462, DNSResponseType: No Error, Sinkhole: Unknown, URLCategory: Unknown, URLReputation: Risk unknown
5/24/17	17:30:24	System4. Alert	10.1.1.79	May 24 21:30:17 FPR4100 SFIMS: Protocol: TCP, SrcIP: 10.1.1.20, OriginalClientIP: ::, DstIP: 172.18.124.145, SrcPort: 50072, DstPort: 21, TCPFlags: 0x0, DE: Primary Detection Engine (51a7d9fa-2943-11e7-80c4-bd73daa17015), Policy: 4120_Access_Policy, ConnectType: Start , AccessControlRuleName: Allow_Hosts , AccessControlRuleAction: Allow , UserName: No Authentication Required, InitiatorPackets: 2, ResponderPackets: 1, InitiatorBytes: 148, ResponderBytes: 78, DNSResponseType: No Error, Sinkhole: Unknown, URLCategory: Unknown, URLReputation: Risk unknown
5/24/17	17:30:24	Local4. Info	10.1.1.80	%ASA-6-302014: Teardown TCP connection 14704 for inside:10.1.1.20/50072 to outside:172.18.124.145/21 duration 0:00:05 bytes 40 Flow closed by inspection
5/24/17	17:30:18	Local4. Info	10.1.1.80	%ASA-6-302013: Built inbound TCP connection 14704 for inside:10.1.1.20/50072 (10.2.104.80/50072) to outside:172.18.124.145/21 (172.18.124.145/21)

Build

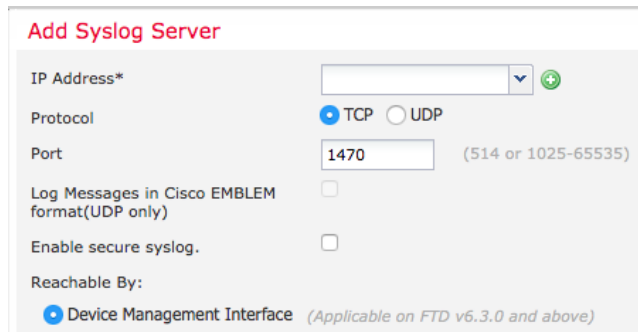
Snort Policy

Snort Action

Teardown

Tools – FTD Unified Syslogging

- In FTD 6.3 and later, syslogs can be generated from a single IP address (FTD management interface)



New!
MGMI

- %ASA- prefix changed to %FTD- and is also prepended to Snort logs
- Logging configuration in Platform Settings can be propagated to Access Control Policy



https://www.cisco.com/c/en/us/td/docs/security/firepower/630/relnotes/firepower-release-notes-630/new_features.html

Custom Syslog Levels

- Assign any syslog message to any available level
- Problem:

You want to record what exec commands are being executed on the firewall; syslog ID 111009 records this information, but by default it is at level 7 (debug)

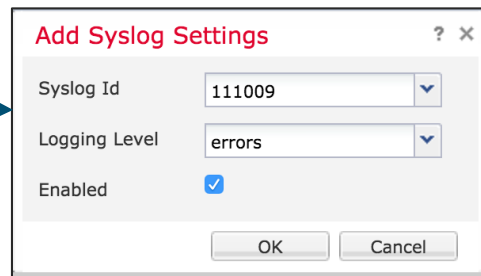
```
ASA-7-111009: User 'johndoe' executed cmd: show run
```

The problem is we don't want to log all 1775 other syslogs that are generated at debug level

```
ASA-3-111009: User 'johndoe' executed cmd: show run
```

Levels

0—Emergency	4—Warning
1—Alert	5—Notifications
2—Critical	6—Informational
3—Errors	7—Debugging



Add Syslog Settings ? x

Syslog Id: 111009

Logging Level: errors

Enabled: ☒

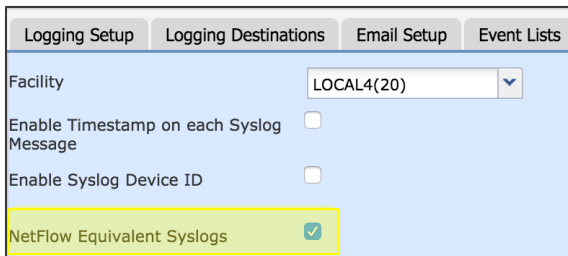
OK Cancel

Devices Settings → Platform Settings → Syslog

NetFlow Secure Event Logging (NSEL)

- NetFlow v9 support is available in **FTD 6.2+** via FlexConfig
 - Provides a method to deliver binary logs at high speeds
 - Reduce processing overhead in printing logs
 - Combine multiple events into one NetFlow record
- FlowSets Supported:
 - Flow Creation
 - Flow Teardown
 - Flow Denied
 - Flow Update
- Remove redundant syslog messages:

Enabled by default on FTD but destinations must be configured via FlexConfig



Logging Setup	Logging Destinations	Email Setup	Event Lists
Facility LOCAL4(20) ▼			
Enable Timestamp on each Syslog Message <input type="checkbox"/>			
Enable Syslog Device ID <input type="checkbox"/>			
NetFlow Equivalent Syslogs <input checked="" type="checkbox"/>			

NSEL – Netflow Destination Configuration Example

1) Define destination

Edit Text Object ? X

Name:

Description:

This variable defines a single NetFlow export destination.
1. interface
2. destination
3. port <1-65535> UDP port number

Variable Type: Multiple ▾ Count: 3 ▾

1	inside
2	10.1.0.1
3	2055

Allow Overrides: ☒

Override (0) ▾

Save Cancel

2) Add FlexConfig object to a FlexConfig policy

Left pane (Objects):

- ISIS_Configure
- ISIS_Interface_Configuration
- ISIS_Unconfigure
- ISIS_Unconfigure_All
- Netflow_Add_Destination
- Netflow_Clear_Parameters
- Netflow_Delete_Destination
- Netflow_Set_Parameters
- NGFW_TCP_NORMALIZATION

Right pane (Selected Append FlexConfigs):

#	Name
1	Backup_EEM_Script
2	Netflow_Add_Destination

3) Save and preview config before deployment

Preview FlexConfig

Select Device:

```
###Flex-config Prepended CLI ###  
  
###CLI generated from managed features ###  
timeout conn 1:00:00 half-closed 0:10:00 udp 0:02:00 icmp 0:00:02  
  
###Flex-config Appended CLI ###  
flow-export destination inside 10.1.0.1 2055  
policy-map global_policy  
  class class-default  
    flow-export event-type all destination 10.1.0.1  
    flow-export event-type flow-create destination 10.1.0.1  
    flow-export event-type flow-denied destination 10.1.0.1  
    flow-export event-type flow-teardown destination 10.1.0.1  
    flow-export event-type flow-update destination 10.1.0.1
```

Objects ➡ Object Management ➡ FlexConfig ➡ Text Object

Devices ➡ FlexConfig ➡ Edit (Pencil icon)


Logging – Common Issues

- **SNMP Trap as a logging destination** should only be used when you really have an SNMP server that you want to receive **all** syslogs
- **Logging to the console** should only be enabled **while actively troubleshooting** on the console
- **Logging on the standby unit** should only be used if you want to receive double the syslogs
- **Allow user traffic to pass when TCP syslog server is down** should nearly always be enabled with TCP syslogging

Debug Commands

- Debugs should not be the first choice to troubleshoot a problem
- Debugs can **negatively** impact the CPU complex and affect performance
- Most debugs are not conditional
- Know how much traffic of the matching type is passing through the firewall before enabling the respective debug

Show Output Filters



See
Appendix

- Filters limit the output of **show** commands to only what you want to see
- Applies only to the '**system support diagnostic-cli**' interface
- Use the pipe character "**|**" at the end of **show <command>** followed by
 - **begin** Start displaying the output beginning at the first match of the RegEx, and continue to display the remaining output
 - **include** Display any line that matches the RegEx
 - **exclude** Display any line that does not match the RegEx
 - **redirect** Send output to a file (flash, tftp, ftp...)
 - **append** Append output to an existing file (flash, tftp, ftp...)

```
show <cmd> | begin|include|exclude|grep|redirect|append [-v] <regular_exp>
```

Traffic Rates

```
firepower# show traffic
```

```
[...]
```

```
TenGigabitEthernet5/1:
```

```
received (in 2502.440 secs):
```

```
99047659 packets 130449274327 bytes
```

```
39580 pkts/sec 52128831 bytes/sec
```

```
transmitted (in 2502.440 secs):
```

```
51704620 packets 3581723093 bytes
```

```
20661 pkts/sec 1431292 bytes/sec
```

```
1 minute input rate 144028 pkts/sec, 25190735 bytes/sec
```

```
1 minute output rate 74753 pkts/sec, 5145896 bytes/sec
```

```
1 minute drop rate, 0 pkts/sec
```

```
5 minute input rate 131339 pkts/sec, 115953675 bytes/sec
```

```
5 minute output rate 68276 pkts/sec, 4748861 bytes/sec
```

```
5 minute drop rate, 0 pkts/sec
```

Uptime statistics is useful to determine historical average packet size and rates:

$52128831 \text{ B/sec} / 39580 \text{ pkts/sec} = \sim 1317 \text{ B/packet}$

One-minute average is useful to detect bursts and small packets:
 $25190735 \text{ B/sec} / 144028 \text{ pkts/sec} = \sim 174 \text{ B/packet}$

Xlate Table

- **show xlate** displays information about NAT translations through FTD
 - Second biggest memory consumer in Lina after conn table, no hardcoded size limit
- You can limit the output to just the **local** or **global** IP

```
firepower# show xlate local 10.2.1.2
5014 in use, 5772 most used
TCP PAT from inside:192.168.103.220/57762 to outside:10.2.1.2/43756 flags ri
idle 0:00:00 timeout 0:00:30
TCP PAT from inside:192.168.103.220/57761 to outside:10.2.1.2/54464 flags ri
idle 0:00:00 timeout 0:00:30
```

```
firepower# show nat pool
TCP PAT pool outside, address 10.2.1.2, range 1-511, allocated 1
TCP PAT pool outside, address 10.2.1.2, range 512-1023, allocated 0
TCP PAT pool outside, address 10.2.1.2, range 1024-65535, allocated 64102
```

Detailed NAT Information

TAC Tip

- **show nat** displays information about the NAT table
 - **detail** keyword will display object definitions
 - Watch the hit counts for policies that are not matching traffic

```
firepower# show nat detail
Manual NAT Policies (Section 1)
1 (inside) to (outside) source static science-obj science-obj destination static vpn-obj vpn-obj
  translate_hits = 0, untranslate_hits = 0
  Source - Origin: 192.168.0.0/16, Translated: 192.168.0.0/16
  Destination - Origin: 172.16.1.0/24, Translated: 172.16.1.0/24

Auto NAT Policies (Section 2)
1 (dmz) to (outside) source static webserver-obj 14.36.103.83
  translate_hits = 0, untranslate_hits = 3232
  Source - Origin: 192.168.22.32/32, Translated: 14.36.103.83/32
2 (inside) to (outside) source dynamic science-obj interface
  translate_hits = 37723, untranslate_hits = 0
  Source - Origin: 192.168.0.0/16, Translated: 14.36.103.96/16
```

Check specific
translation policies in
the applied order.

Translate hits indicate
connections from **real**
to **mapped** interfaces

Untranslate hits indicate
connections from **mapped**
to **real** interfaces

Connection Table

```
firepower# show conn detail
```

```
2 in use, 64511 most used
```

```
Flags: A - awaiting responder ACK to SYN, a - awaiting initiator ACK to SYN,
```

```
      b - TCP state-bypass or nailed,
```

```
      C - CTIQBE media, c - cluster centralized,
```

```
      D - DNS, d - dump, E - outside back connection, e - semi-distributed,
```

```
      F - initiator FIN, f - responder FIN,
```

```
      G - group, g - MGCP, H - H.323, h - H.225.0, I - initiator data,
```

```
      i - incomplete, J - GTP, j - GTP data, K - GTP t3-response
```

```
      k - Skinny media, M - SMTP data, m - SIP media, N - inspected by Snort, n - GUP
```

```
      O - responder data, P - inside back connection,
```

```
      q - SQL*Net data, R - initiator acknowledged FIN,
```

```
      R - UDP SUNRPC, r - responder acknowledged FIN,
```

```
      T - SIP, t - SIP transient, U - up,
```

```
      V - VPN orphan, v - M3UA W - WAAS,
```

```
      w - secondary domain backup,
```

```
      X - inspected by service module,
```

```
      x - per session, Y - director stub flow, y - backup stub flow,
```

```
      Z - SecureSafe redirection, z - forwarding stub flow
```

```
TCP outside:198.133.219.25/80 dmz:10.9.9.3/4101,
```

```
      flags UION, idle 8s, uptime 10s, timeout 1h,
```

```
      bytes 127
```

```
UDP outside:172.18.124.1/123 dmz:10.1.1.9/123,
```

```
      gs -, idle 15s, uptime 16s, timeout 2m, bytes 1431
```

Narrow down the output with
`show conn address <ip>`

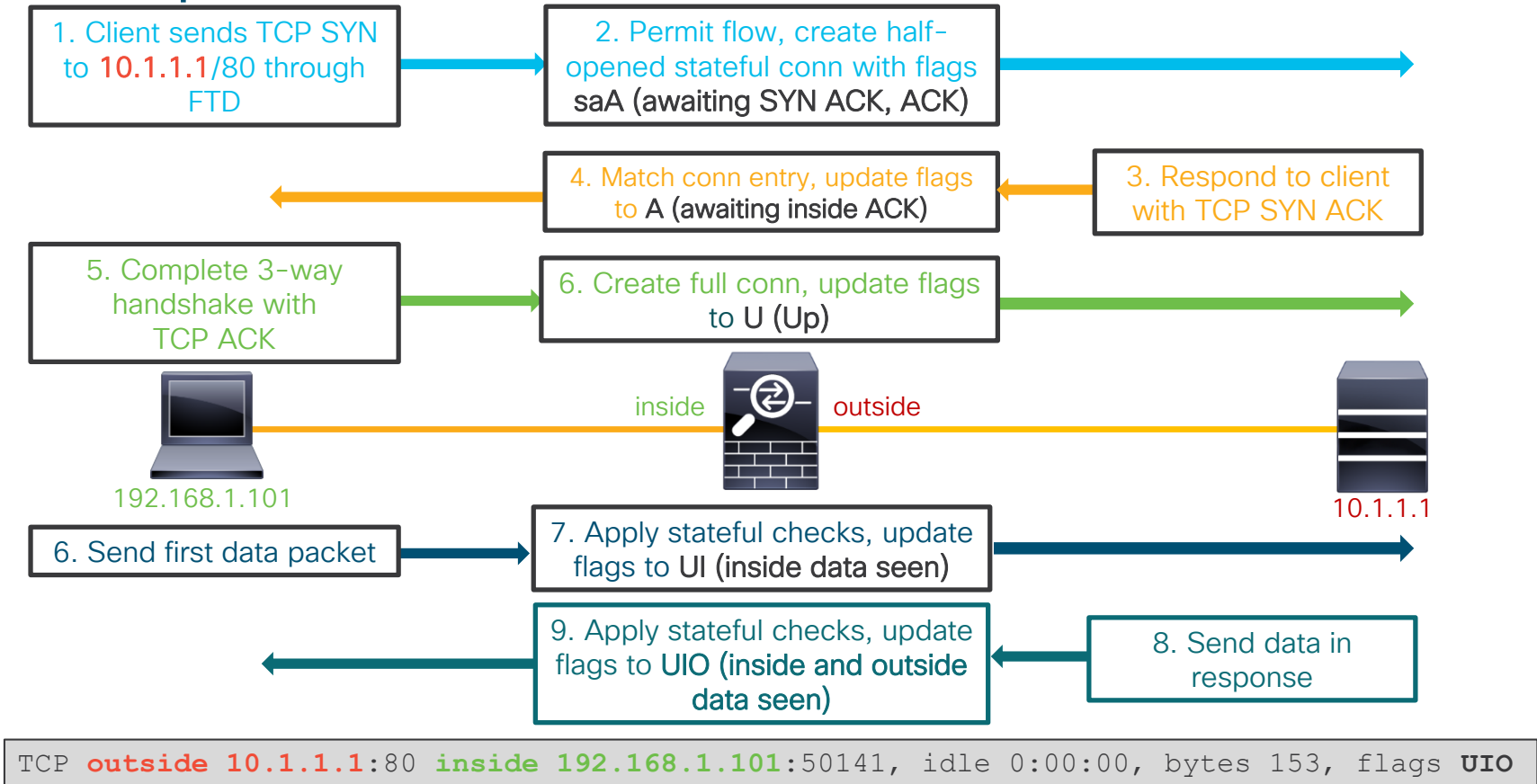
Conn flags indicate current
state

N flag shows if connection
is sent to snort

Bidirectional byte count;
use NSEL to report each
direction separately.

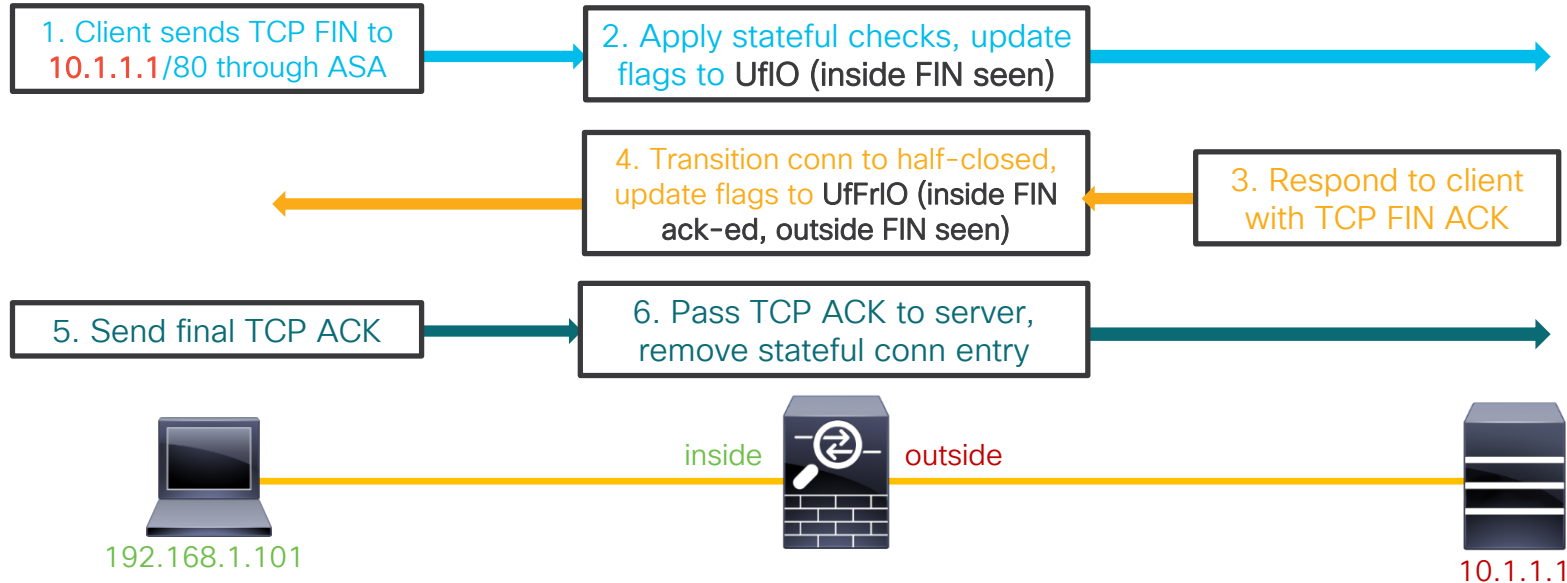
`detail` option adds uptime
and timeout information

Example: TCP Connection Establishment



Example: TCP Connection Termination

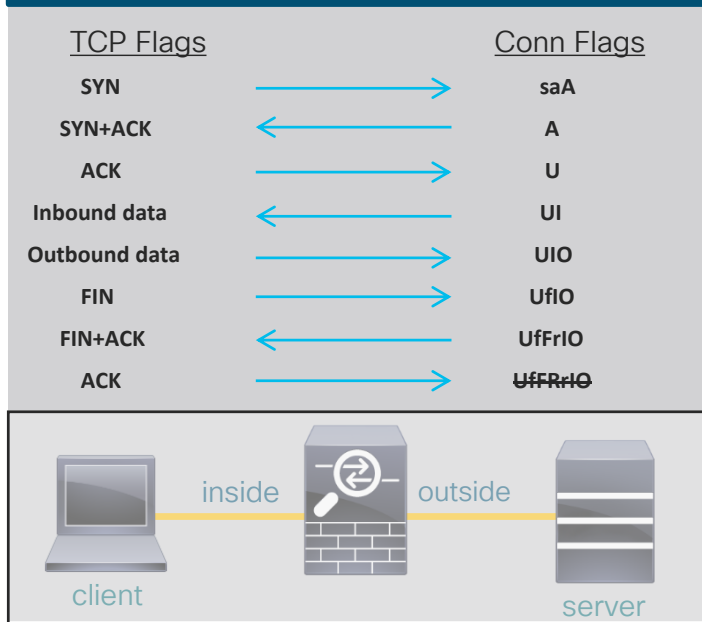
TCP **outside** 10.1.1.1:80 **inside** 192.168.1.101:50141, idle 0:00:00, bytes 153, flags **UfO**



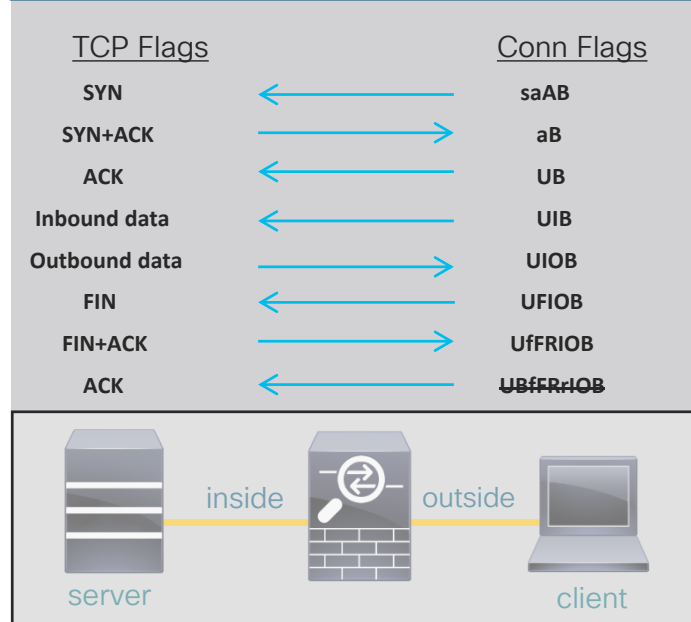
TCP Connection Flags



Outbound Connection



Inbound Connection



TCP Connection Termination Reasons

- If logging messages are enabled and a TCP flow was built through FTD, it will **always** log a teardown reason
- TCP teardown message is logged at level 6 (informational) by default
- For problems with abnormal connection termination, temporarily increase logging level and check the teardown reason

What do these termination reasons mean in the Teardown TCP connection syslog?

```
%ASA-6-302014: Teardown TCP connection 90 for outside:10.1.1.1/80 to  
inside:192.168.1.101/1107 duration 0:00:30 bytes 0 SYN Timeout
```

```
%ASA-6-302014: Teardown TCP connection 3681 for DMZ:172.16.171.125/21 to  
inside:192.168.1.110/24245 duration 0:01:03 bytes 12504 TCP Reset-O
```

TCP Connection Termination Reasons



Reason	Description
Conn-Timeout	Connection Ended Because It Was Idle Longer Than the Configured Idle Timeout
Deny Terminate	Flow Was Terminated by Application Inspection
Failover Primary Closed	The Standby Unit in a Failover Pair Deleted a Connection Because of a Message Received from the Active Unit
FIN Timeout	Force Termination After Ten Minutes Awaiting the Last ACK or After Half-Closed Timeout
Flow Closed by Inspection	Flow Was Terminated by Inspection Feature
Flow Terminated by IPS	Flow Was Terminated by IPS
Flow Reset by IPS	Flow Was Reset by IPS
Flow Terminated by TCP Intercept	Flow Was Terminated by TCP Intercept
Invalid SYN	SYN Packet Not Valid
Idle Timeout	Connection Timed Out Because It Was Idle Longer than the Timeout Value
IPS Fail-Close	Flow Was Terminated Due to IPS Card Down
SYN Control	Back Channel Initiation from Wrong Side

TCP Connection Termination Reasons



Reason	Description
SYN Timeout	Force Termination After Twenty Seconds Awaiting Three-Way Handshake Completion
TCP Bad Retransmission	Connection Terminated Because of Bad TCP Retransmission
TCP Fins	Normal Close Down Sequence
TCP Invalid SYN	Invalid TCP SYN Packet
TCP Reset-I	TCP Reset Was Sent From the Inside Host
TCP Reset-O	TCP Reset Was Sent From the Outside Host
TCP Segment Partial Overlap	Detected a Partially Overlapping Segment
TCP Unexpected Window Size Variation	Connection Terminated Due to a Variation in the TCP Window Size
Tunnel Has Been Torn Down	Flow Terminated Because Tunnel Is Down
Unauth Deny	Connection Denied by URL Filtering Server
Unknown	Catch-All Error
Xlate Clear	User Executed the 'Clear Xlate' Command

Local Host Table

- A local-host entry is created for every IP tracked by FTD
- It groups xlates, connections, and AAA information
- Useful for monitoring connections terminating on servers or offending clients

```
firepower# show local-host detail connection tcp 50 embryonic
Interface dmz: 0 active, 0 maximum active, 0 denied
Interface inside: 1 active, 1 maximum active, 0 denied
local host: <192.168.103.220>,
  TCP flow count/limit = 798/unlimited
  TCP embryonic count to host = 0
  TCP intercept watermark = unlimited
  UDP flow count/limit = 0/unlimited
Conn:
  TCP outside:172.18.124.76/80 inside:192.168.103.220/34078,
    flags UO, idle 0s, uptime 0s, timeout 30s, bytes 0
  TCP outside:172.18.124.76/80 inside:192.168.103.220/34077,
    flags UO, idle 0s, uptime 0s, timeout 30s, bytes 0
(output truncated)
```

Can be added to show only half-open connections

Only display hosts that have more than 50 active TCP connections.

Accelerated Security Path (ASP)

- Packets and flows dropped in the ASP will increment a counter
 - Frame drop counters are per packet
 - Flow drops are per flow
- See command reference under [show asp drop](#) for full list of counters

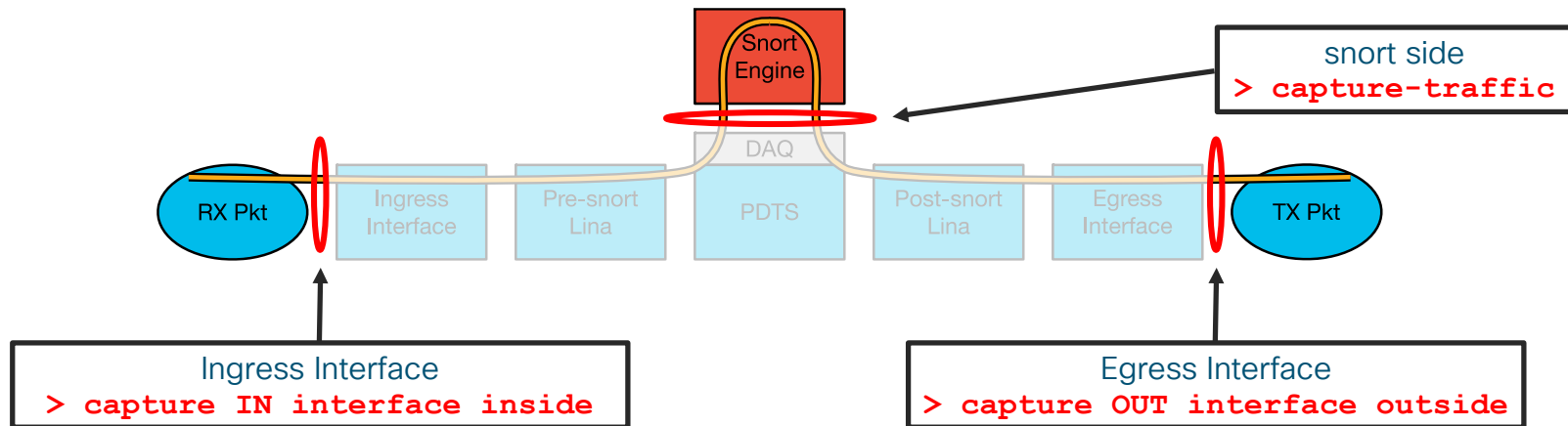
```
> show asp drop
```

```
Frame drop:
```

Invalid encapsulation (invalid-encap)	10897
Invalid tcp length (invalid-tcp-hdr-length)	9382
Invalid udp length (invalid-udp-length)	10
No valid adjacency (no-adjacency)	5594
No route to host (no-route)	1009
Reverse-path verify failed (rpf-violated)	15
Flow is denied by access rule (acl-drop)	25247101
First TCP packet not SYN (tcp-not-syn)	36888
Bad TCP Checksum (bad-tcp-cksum)	893

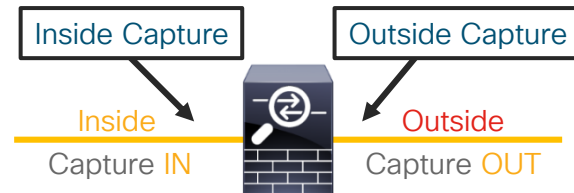
```
...
```

Where Packets Are Captured in Packet Flow



- Ingress packets are captured **before** most packet processing
- Egress packets are captured **after** all processing
- “>capture-traffic” is a capture in snort which shows packets read from the DAQ

Lina Packet Capture (CLI)



- Inline capability to record packets passing through FTD
- Apply capture under unique name to ingress and egress interfaces
 - Define the traffic that you want to capture, use pre-NAT “on the wire” information
 - Tcpcmdump-like format for displaying captured packets on the box

```
firepower# capture OUT interface outside match ip any host 172.18.124.1
firepower# capture IN interface inside match ip any host 172.18.124.1
firepower# show capture IN
```

Unlike ACL, match covers both directions of the flow

4 packets captured

1:	10:51:26.139046	802.1Q	vlan#10	P0	172.18.254.46 > 172.18.124.1:	icmp: echo request
2:	10:51:26.139503	802.1Q	vlan#10	P0	172.18.124.1 > 172.18.254.46:	icmp: echo reply
3:	10:51:27.140739	802.1Q	vlan#10	P0	172.18.254.46 > 172.18.124.1:	icmp: echo request
4:	10:51:27.141182	802.1Q	vlan#10	P0	172.18.124.1 > 172.18.254.46:	icmp: echo reply

4 packets shown

```
firepower# no capture IN interface inside
firepower# no capture IN
```

Removing the interface stops the capture but keeps contents in memory

Remember to remove the captures when done with troubleshooting

Lina Packet Capture (CLI)

- Capture buffer maintained in RAM (512KB by default, 33 MB max)
 - Stops capturing when full by default, **circular** option available
- Default recorded packet length is 1518 bytes
- May elevate CPU utilization when applied under very high packet rates
- Copy captures off via FTP, SCP, or TFTP (example below)

Much larger capture sizes coming soon!

```
firepower# capture OUT interface outside match ip any host 172.18.124.1
firepower# copy /pcap capture:OUT tftp://10.10.1.1/capout.pcap
```

Download binary PCAP to open in your favorite packet analyser (such as Wireshark)

Configured capture name

Save capture file under this name

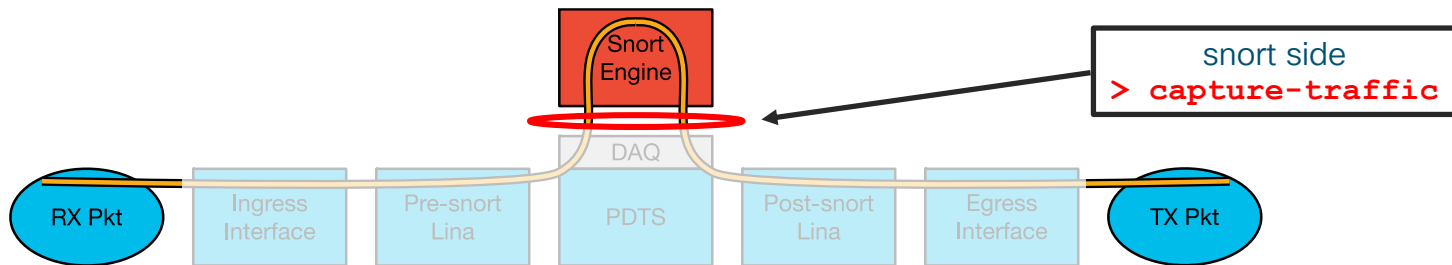
Packet Capture at time of Crash

Introduced in
FTD 6.2.2

- Before 6.2.2, Lina capture contents are lost if the device crashes
- New feature allows use of a circular buffer to capture all traffic just before a crash occurs
- Very useful for troubleshooting traffic-related crashes

```
firepower# capture capin interface inside circular-buffer buffer 33000000
<<after forcing crash>>
firepower# show flash:
--#--  --length--  -----date/time-----  path
  109  198          Dec 09 2017 00:59:00  lina_phase1.log
<<output truncated>>
  110  1761873      Jan 22 2019 10:36:34  capin.pcap
  111   502025      Jan 22 2019 10:36:42  crashinfo_20190122_103635.UTC
```

Snort-side captures with > capture-traffic



```
> capture-traffic
```

```
Please choose domain to capture traffic from:
```

```
0 - br1
1 - Router
```

```
Selection? 1
```

```
Please specify tcpdump options desired.
(or enter '?' for a list of supported options)
```

```
Options: -n -s 0 -w SNORTCAP.pcap -c 1000 host 192.168.1.2 and port 80
```

tcpdump -c 1000
Stop after 1000 packets

Standard BPF
(Berkeley Packet Filter) Options

tcpdump -n
Don't resolve hostnames

tcpdump -s 0
Capture the whole packet

tcpdump -w FILE.pcap
Write the capture to file

> capture-traffic
PCAPs are written to:
/ngfw/var/common/

Capturing ASP drops

- Capture all frames dropped in the ASP

```
firepower# capture drops type asp-drop all
```

- Capture all frames with a specific drop reason

```
firepower# capture drop type asp-drop ?  
  
acl-drop          Flow is denied by configured  
rule  
all               All packet drop reasons  
bad-crypto        Bad crypto return in packet  
bad-ipsec-natt    Bad IPSEC NATT packet  
bad-ipsec-prot    IPSEC not AH or ESP  
bad-ipsec-udp     Bad IPSEC UDP packet  
bad-tcp-cksum     Bad TCP checksum  
bad-tcp-flags     Bad TCP flags
```

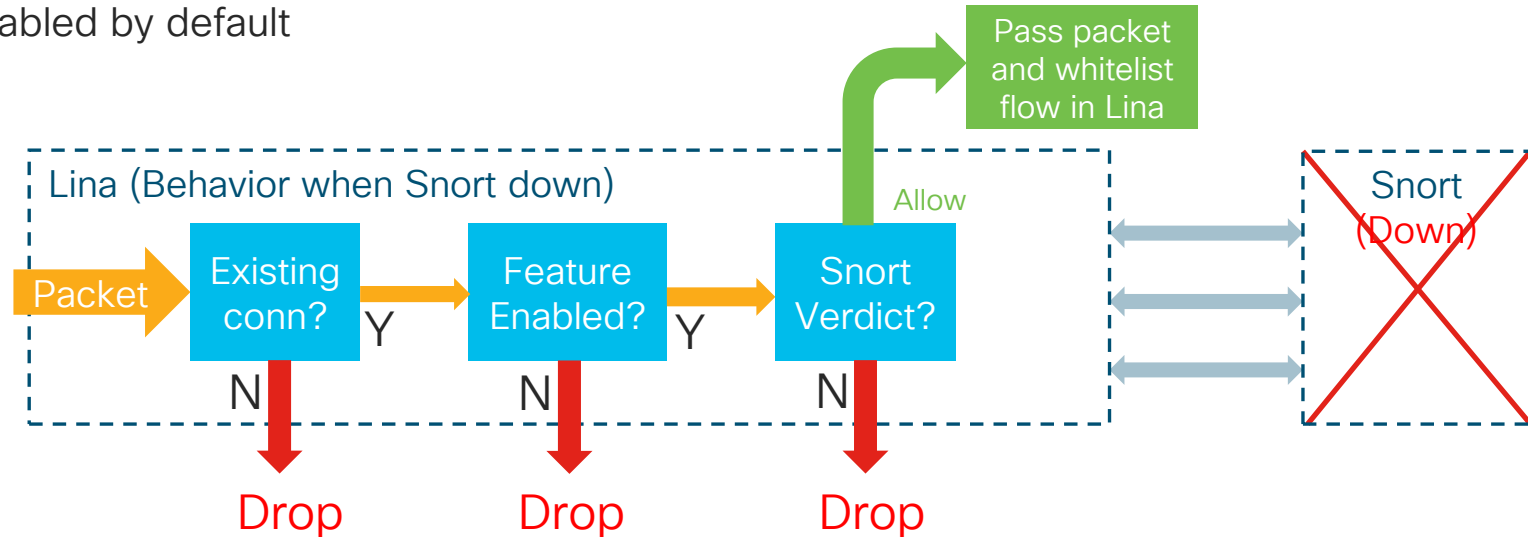
- ASP flow drops are non-atomic and cannot be captured

```
firepower# capture drops type asp-drop tcp-not-syn
```

In FTD you can filter ASP drops using an inline match statement like a normal packet capture

Snort Preserve-Connection

- Allows packets to pass while snort is down/restarting
- Flow must have reached an “Allow” verdict (AC policy)
- Added in 6.2.3
- Enabled by default



Snort Preserve-Connection: Enable/Disable

Show Current Setting

```
> show running-config snort  
snort preserve-connection
```

Change Setting

```
> configure snort preserve-connection disable  
Building configuration...  
Cryptochecksum: 4fd6de40 7bf66af6 b1836604 04f8496d  
  
5745 bytes copied in 0.690 secs  
[OK]  
> show running-config snort  
no snort preserve-connection
```

Snort Preserve-Connection: Troubleshooting

```
> show snort statistics
```

```
Packet Counters:
```

```
Passed Packets
```

```
Blocked Packets
```

```
Injected Packets
```

```
Packets bypassed (Snort Down)
```

```
Packets bypassed (Snort Busy)
```

```
62501
```

```
2339
```

```
5739
```

```
5678
```

```
0
```

Packets Preserved

```
[lines removed]
```

```
> show conn
```

```
0 in use, 231 most used
```

```
Inspect Snort:
```

```
preserve-connection: 14 enabled, 5 in effect, 215 most enabled, 40 most in effect
```

```
[lines removed]
```

Preserve-Connection Info

Snort Preserve-Connection: Troubleshooting

```
> system support diagnostic-cli  
firepower> en  
Password:  
firepower#  
firepower# debug snort generic
```

New flow created

```
snort-insp: flow created TCP: 10.1.1.1 (zone: 0) to 10.2.2.2 (tzone 0)
```

Feature Enable
and flow reached
allow verdict

```
snort-insp: Packet from outside:10.2.2.2/443 to inside:10.1.1.1/55569 is bypassed as SNORT is down.
```

```
snort-insp: Packet from outside:10.2.2.2/443 to inside:10.1.1.1/55569 is dropped as SNORT is down.
```

Feature Disabled

X 60 FTD

Password:

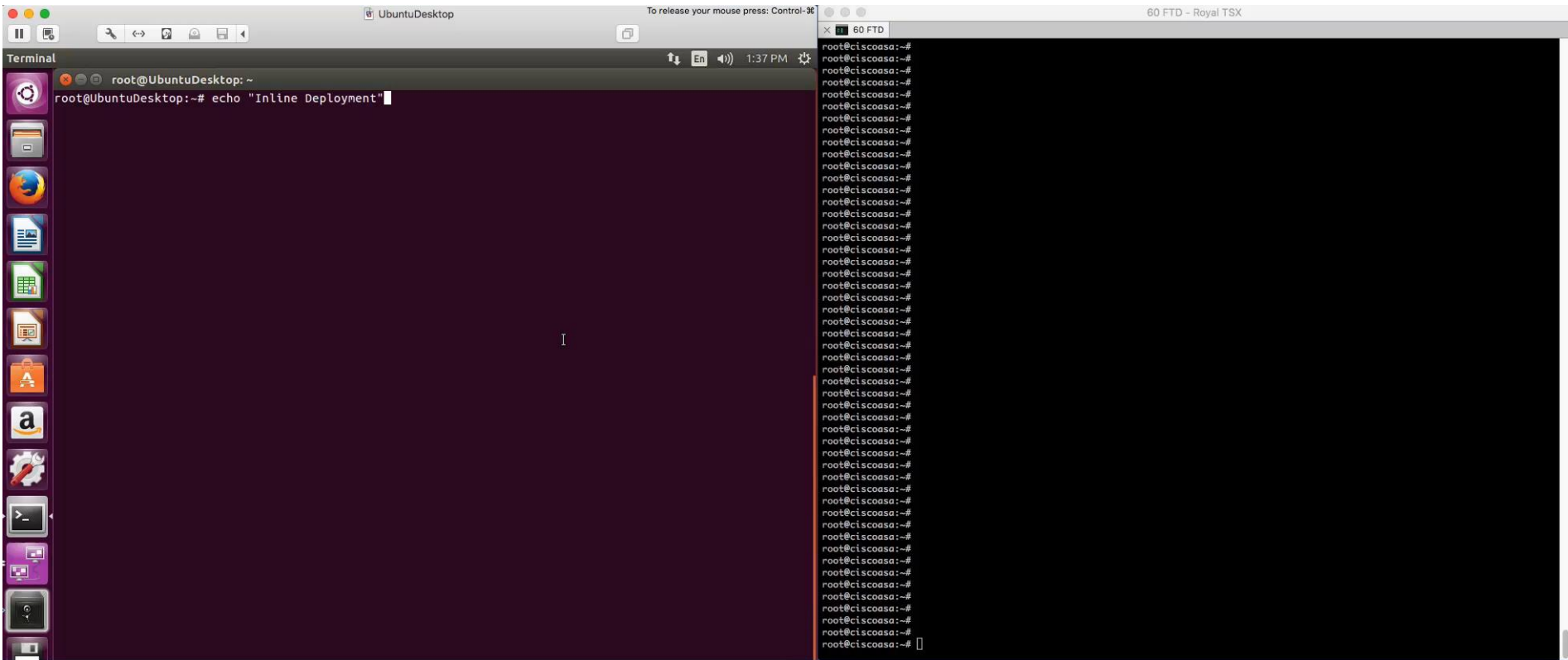
Last login: Sun Jan 28 13:07:34 2018 from 10.61.242.151

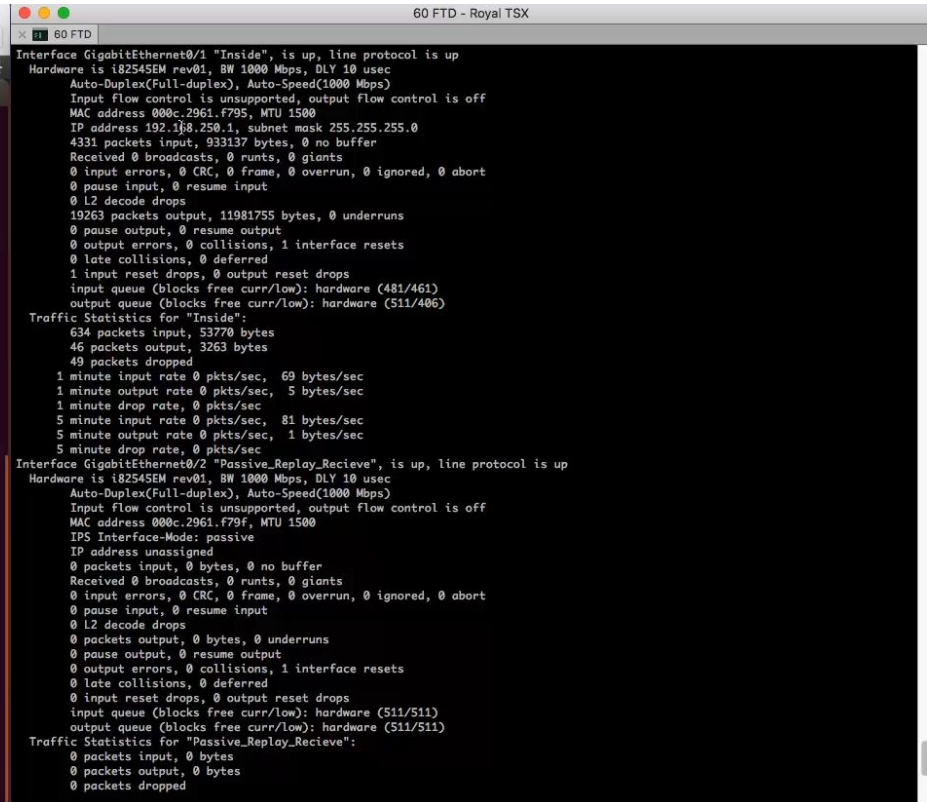
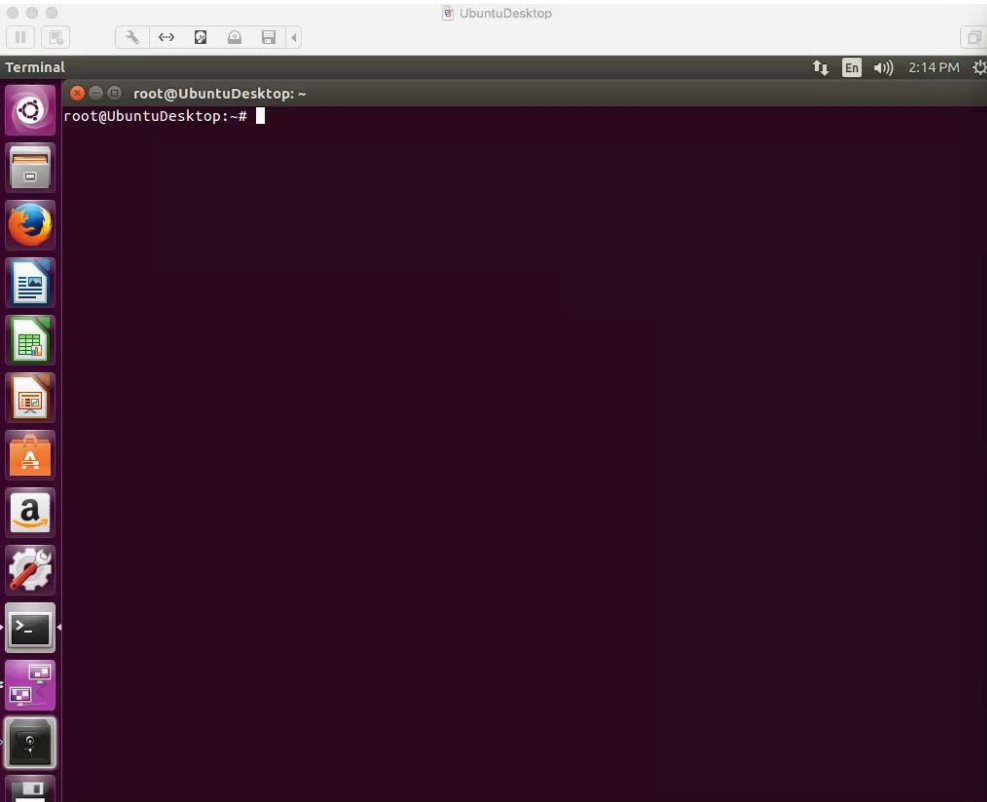
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All other trademarks are property of their respective owners.

Cisco Fire Linux OS v6.2.0 (build 42)
Cisco Firepower Threat Defense for VMWare v6.2.0.3 (build 108)

> █

}



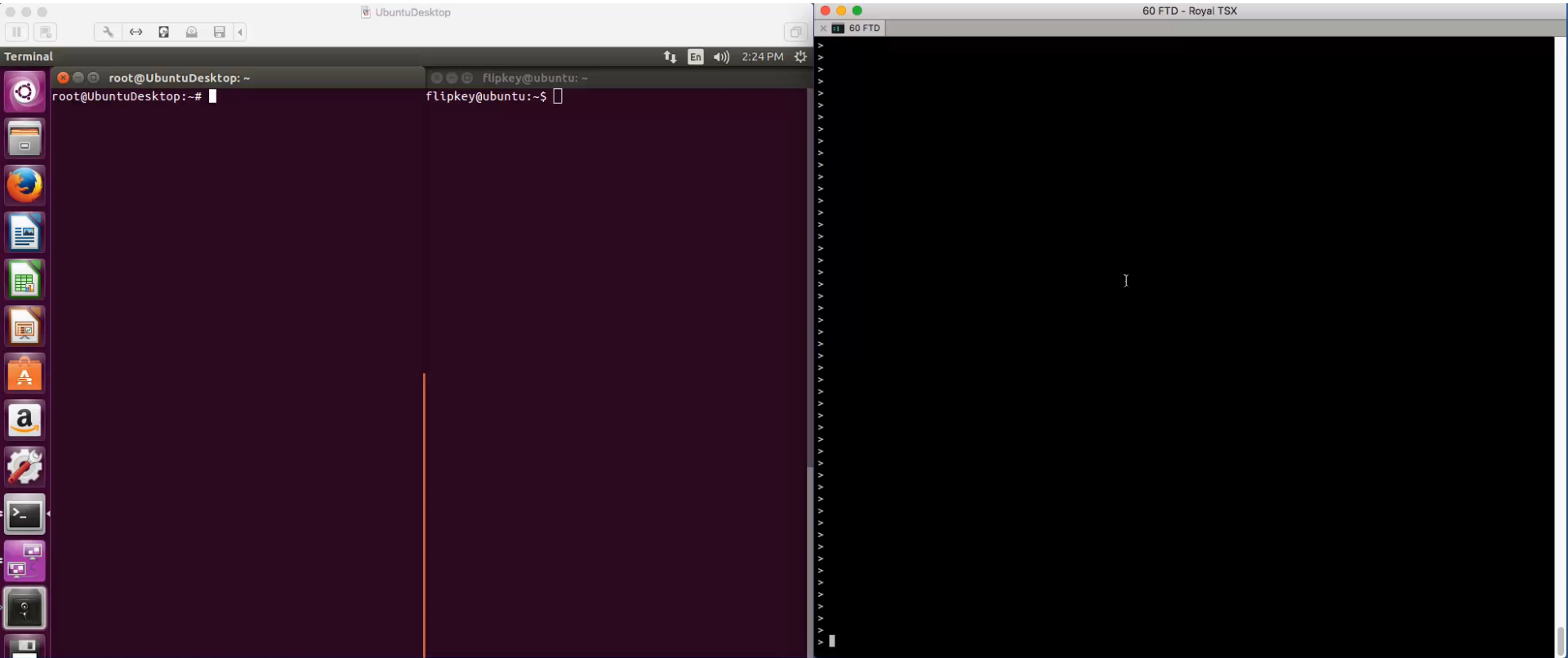


```
UbuntuDesktop
Terminal
root@UbuntuDesktop: ~
root@UbuntuDesktop:~# echo routed
routed
root@UbuntuDesktop:~# ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1) 56(84) bytes of data.
64 bytes from 192.168.1.1: icmp_seq=1 ttl=64 time=11.9 ms
64 bytes from 192.168.1.1: icmp_seq=2 ttl=64 time=12.5 ms
64 bytes from 192.168.1.1: icmp_seq=3 ttl=64 time=12.1 ms
64 bytes from 192.168.1.1: icmp_seq=4 ttl=64 time=11.9 ms
64 bytes from 192.168.1.1: icmp_seq=5 ttl=64 time=22.4 ms
64 bytes from 192.168.1.1: icmp_seq=6 ttl=64 time=22.5 ms
64 bytes from 192.168.1.1: icmp_seq=7 ttl=64 time=22.0 ms
64 bytes from 192.168.1.1: icmp_seq=8 ttl=64 time=11.7 ms
64 bytes from 192.168.1.1: icmp_seq=9 ttl=64 time=3.70 ms
64 bytes from 192.168.1.1: icmp_seq=10 ttl=64 time=12.3 ms
^C
--- 192.168.1.1 ping statistics ---
24 packets transmitted, 10 received, 58% packet loss, time 23116ms
rtt min/avg/max/mdev = 3.707/14.342/22.585/5.792 ms
root@UbuntuDesktop:~# ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1) 56(84) bytes of data.
64 bytes from 192.168.1.1: icmp_seq=13 ttl=64 time=22.0 ms
64 bytes from 192.168.1.1: icmp_seq=14 ttl=64 time=32.7 ms
64 bytes from 192.168.1.1: icmp_seq=15 ttl=64 time=11.9 ms
64 bytes from 192.168.1.1: icmp_seq=16 ttl=64 time=11.9 ms
64 bytes from 192.168.1.1: icmp_seq=17 ttl=64 time=11.3 ms
64 bytes from 192.168.1.1: icmp_seq=18 ttl=64 time=11.7 ms
64 bytes from 192.168.1.1: icmp_seq=19 ttl=64 time=11.3 ms
64 bytes from 192.168.1.1: icmp_seq=20 ttl=64 time=13.0 ms
64 bytes from 192.168.1.1: icmp_seq=21 ttl=64 time=23.0 ms
64 bytes from 192.168.1.1: icmp_seq=22 ttl=64 time=11.9 ms
64 bytes from 192.168.1.1: icmp_seq=23 ttl=64 time=11.9 ms
^C
--- 192.168.1.1 ping statistics ---
23 packets transmitted, 11 received, 52% packet loss, time 22014ms
rtt min/avg/max/mdev = 11.347/15.747/32.748/6.749 ms
root@UbuntuDesktop:~#
```

```
60 FTD
0 packets output, 0 bytes
0 packets dropped
1 minute input rate 0 pkts/sec, 0 bytes/sec
1 minute output rate 0 pkts/sec, 0 bytes/sec
1 minute drop rate, 0 pkts/sec
5 minute input rate 0 pkts/sec, 0 bytes/sec
5 minute output rate 0 pkts/sec, 0 bytes/sec
5 minute drop rate, 0 pkts/sec
Interface Management0/0 "diagnostic", is up, line protocol is up
Hardware is en_vtun rev00, BW 1000 Mbps, DLY 10 usec
Auto-Duplex(Full-duplex), Auto-Speed(1000 Mbps)
Input flow control is unsupported, output flow control is off
MAC address 000c-2961-f781, MTU 1500
IP address unassigned
360 packets input, 23530 bytes, 0 no buffer
Received 0 broadcasts, 0 runts, 0 giants
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
0 pause input, 0 resume input
0 L2 decode drops
0 packets output, 0 bytes, 0 underruns
0 pause output, 0 resume output
0 output errors, 0 collisions, 0 interface resets
0 late collisions, 0 deferred
0 input reset drops, 0 output reset drops
input queue (blocks free curr/low): hardware (0/0)
output queue (blocks free curr/low): hardware (0/0)
Traffic Statistics for "diagnostic":
360 packets input, 18364 bytes
0 packets output, 0 bytes
328 packets dropped
1 minute input rate 0 pkts/sec, 2 bytes/sec
1 minute output rate 0 pkts/sec, 0 bytes/sec
1 minute drop rate, 0 pkts/sec
5 minute input rate 0 pkts/sec, 0 bytes/sec
5 minute output rate 0 pkts/sec, 0 bytes/sec
5 minute drop rate, 0 pkts/sec
Management-only interface. Blocked 0 through-the-device packets

>
> configure snort preserve-connection disable
shell-init: error retrieving current directory: getcwd: cannot access parent directories: Permission denied
shell-init: error retrieving current directory: getcwd: cannot access parent directories: Permission denied
Building configuration...
Cryptochecksums: 86926298 3c18c63f f64246a7 7d06fe7d

8351 bytes copied in 0.120 secs
[OK]
> exit
root@ciscoasa:~# pmtool disablebytype snort
root@ciscoasa:~# pmtool enablebytype snort
root@ciscoasa:~# su adm!
```



Packet Tracer

Packet Tracer

- Unique capability to record the path of a specially tagged packet through FTD
 - Best way to understand the packet path in the specific software version
- Inject a simulated packet to analyse the behaviour and validate configuration

The diagram illustrates the Packet Tracer command-line interface (CLI) with two examples. The first example shows the command `packet-tracer input inside tcp 192.168.1.101 23121 172.16.171.125 23 detailed`. Annotations point to various parts of the command: 'Feature order and name' points to the command itself; 'Ingress interface' points to 'inside'; 'Packet information as it enters the ingress interface' points to the IP and port numbers; and 'Include detailed internal flow and policy structure information' points to the 'detailed' keyword. The second example shows the command `packet-tracer input inside tcp 2002:DB8:1:1::20 10000 2002:DB8:1:2::100 80 detailed`. An annotation 'IPv6 Example' points to this command. Both examples show the output of the command, including 'Phase: 1', 'Type: CAPTURE', 'Subtype:', 'Result: ALLOW', 'Config:', and 'Additional Information: [...]'. The output for the second example also includes 'found next-hop 2002:db8:1:2::100 using egress ifc outside'.

```
firepower# packet-tracer input inside tcp 192.168.1.101 23121 172.16.171.125 23 detailed

Phase: 1
Type: CAPTURE
Subtype:
Result: ALLOW
Config:
Additional Information:
[...]
```

firepower# packet-tracer input inside tcp 2002:DB8:1:1::20 10000 2002:DB8:1:2::100 80 detailed

...

Result: ALLOW

Config:

Additional Information:

found next-hop 2002:db8:1:2::100 using egress ifc outside

Sample Packet Tracer Output

```
firepower# packet-tracer input outside tcp 172.18.124.66 1234 172.18.254.139 3389
```

```
Phase: 1  
Type: CAPTURE  
Subtype:  
Result: ALLOW  
Config:  
Additional Information:  
MAC Access list
```

```
Phase: 2  
Type: ACCESS-LIST  
Subtype:  
Result: ALLOW  
Config:  
Implicit Rule  
Additional Information:  
MAC Access list
```

```
Phase: 3  
Type: UN-NAT  
Subtype: static  
Result: ALLOW  
Config:  
nat (outside,dmz) source dynamic any interface destination static interface Win7-vm service rdp-outside rdp-outside  
Additional Information:  
NAT divert to egress interface dmz  
Untranslate 172.18.254.139/3389 to 192.168.103.221/3389
```

Sample Packet Tracer Output (Cont'd)

```
Phase: 4
Type: ACCESS-LIST
Subtype: log
Result: ALLOW
Config:
access-group outside_in in interface outside
access-list outside_in extended permit tcp any any eq 3389
Additional Information:
.....
Phase: 8
Type: NAT
Subtype:
Result: ALLOW
Config:
nat (outside,dmz) source dynamic any interface destination static interface Win7-vm service rdp-outside rdp-outside
Additional Information:
Dynamic translate 172.18.124.66/1234 to 192.168.103.221/1234
.....
Phase: 12
Type: FLOW-CREATION
Subtype:
Result: ALLOW
Config:
Additional Information:
New flow created with id 16538274, packet dispatched to next module
```


Packet Tracer in FMC

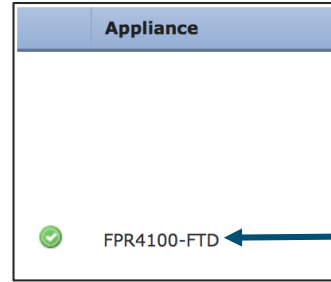
1

Launch from System
Health > Monitor



2

Click on appliance hostname



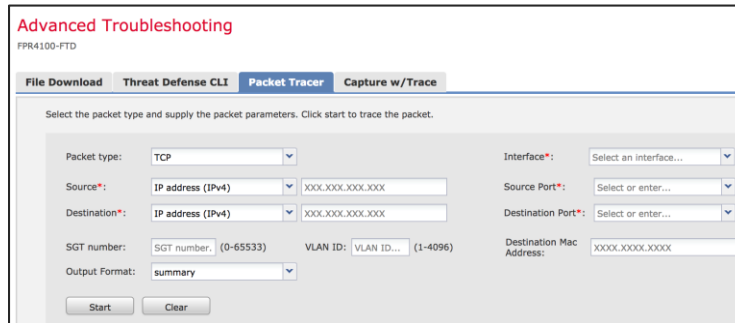
3

Advanced
Troubleshooting



4

Input packet parameters



Packet Tracer in FMC – Example Output

The screenshot shows the Cisco FMC Packet Tracer interface. The top navigation bar includes tabs for Overview, Analysis, Policies, Devices, Objects, AMP, and Intelligence. Below this is a sub-navigation bar with Configuration, Users, Domains, Integration, Updates, Licenses, Health & Monitor (selected), Monitoring, and Tools. The main heading is "Advanced Troubleshooting" for FPR4100-FTD. The "Packet Tracer" tab is active, showing a form to define a simulated packet. The form includes fields for Packet type (TCP), Source (IP address 172.18.124.45), Destination (IP address 8.8.8.8), Interface (inside), Source Port (10000), Destination Port (80), SGT number, VLAN ID, and Output Format (detailed). A "Start" button is present. Below the form is an "Output" section with a "Raw" view selected, displaying the results of the packet trace. The output shows Phase 1 (CAPTURE) with a result of ALLOW, and Phase 2 (ACCESS-LIST) with a result of ALLOW. A callout box points to the "Define simulated packet" form, and another callout box points to the "Feature type and resulting action" section of the output.

Overview Analysis Policies Devices Objects AMP Intelligence Deploy System Help kklous

Configuration Users Domains Integration Updates Licenses Health & Monitor Monitoring Tools

Advanced Troubleshooting

FPR4100-FTD

File Download Threat Defense CLI **Packet Tracer** Capture w/Trace

Select the packet type and supply the packet parameters. Click start to trace the packet.

Packet type: TCP Interface*: inside

Source*: IP address (IPv4) 172.18.124.45 Source Port*: 10000

Destination*: IP address (IPv4) 8.8.8.8 Destination Port*: 80

SGT number: SGT number. (0-65533) VLAN ID: VLAN ID... (1-4096) Destination Mac Address: XXXX.XXXX.XXXX

Output Format: detailed

Start Clear

Output Raw

Phase: 1
Type: CAPTURE
Subtype:
Result: ALLOW
Config:
Additional Information:
Forward Flow based lookup yields rule:
in id=0x7f030878fe10, priority=13, domain=capture, deny=false
hits=5251993, user_data=0x7f063805f1a0, cs_id=0x0, l3_type=0x0
src mac=0000.0000.0000, mask=0000.0000.0000
dst mac=0000.0000.0000, mask=0000.0000.0000
input_ifc=inside, output_ifc=any

Phase: 2
Type: ACCESS-LIST
Subtype:
Result: ALLOW

Define simulated packet

Feature type and
resulting action

cisco *Live!*

Packet Capture w/ Trace

- Enable packet tracer within an internal packet capture

```
firepower# capture IN interface inside trace trace-count 200 match tcp any any eq
```

Trace inbound
packets only

Traced packet count per
capture (1-1000, 50 by
default)

- Find the packet that you want to trace in the capture

```
firepower# show capture inside
68 packets captured
1: 15:22:47.581116 10.1.1.2.31746 > 198.133.219.25.80: S
2: 15:22:47.583465 198.133.219.25.80 > 10.1.1.2.31746: S ack
3: 15:22:47.585052 10.1.1.2.31746 > 198.133.219.25.80: . ack
4: 15:22:49.223728 10.1.1.2.31746 > 198.133.219.25.80: P ack
5: 15:22:49.223758 198.133.219.25.80 > 10.1.1.2.31746: . Ack
...
```

- Select that packet to show the tracer results

```
firepower# show capture inside trace packet-number 4
```

Packet capture with trace (continued)

- Likely the **most used** datapath troubleshooting tool in the TAC
- Troubleshooting capabilities continue to be developed – major improvements in **FTD 6.2.3+**:
 - You can now capture traffic post-decryption across a VPN tunnel w/ FTD as VPN endpoint:

```
firepower# capture OUT interface outside trace include-decrypted match tcp any any
```

New option captures packets that match the criteria after decryption

New packet-tracer option to allow egress of simulated packets

```
firepower# packet-tracer input inside tcp 10.1.1.20 10000 10.1.2.100 80 transmit detailed
firepower# sh cap capout
1 packet captured
1: 12:08:30.837709 10.1.1.20.10000 > 10.1.2.100.80: S 1119191062:1119191062(0) win
```

Without this option, the packet is never transmitted onto the wire. This can be useful for troubleshooting.

Firewall Engine Debug / System Support Trace

Firewall Engine Debug (Snort)

- Shows Snort access control rule evaluation
- Indicates which rule a flow matches

```
> system support firewall-engine-debug
```

```
Please specify an IP protocol: tcp
```

```
Please specify a client IP address: 192.168.1.2
```

```
Please specify a client port: 
```

```
Please specify a server IP address:
```

```
Please specify a server port: 80
```

```
192.168.1.2-35948 > 172.16.2.10-80 6 AS 1 I 18 New session
```

```
[lines_removed]
```

```
192.168.1.2-35948 > 172.16.2.10-80 6 AS 1 I 18 match rule order 2, 'Block Port HTTP  
Traffic', action Block
```

Common IP Header "Protocol" values:

1 or "icmp"

6 or "tcp"

17 or "udp"

Leave a field blank for "any"

- Debug is written to messages log file

```
grep -i ngfwdbg /var/log/messages
```

System Support Trace (Snort)

> system support trace

- Debugs a flow in snort **per packet** (be careful!)
- Can optionally enable parallel firewall-engine-debug
- Shows preprocessor impact (Network Analysis Policy) not shown in other outputs

```
> system support trace
```

```
[lines removed]
```

```
10.2.2.2-443 - 10.1.1.1-5623 6 Packet: TCP, ACK, seq 1448114540, ack 4072763547
10.2.2.2-443 - 10.1.1.1-5623 6 Firewall: allow rule, 'Allow_Inside_to_Outside', allow
10.2.2.2-443 - 10.1.1.1-5623 6 AppID: service HTTPS (1122), application Microsoft
(1423)
10.1.1.1-5623 > 10.2.2.2-443 6 Firewall: allow rule, 'Allow_Inside_to_Outside', allow
10.1.1.1-5623 > 10.2.2.2-443 6 NAP id 2, IPS id 0, Verdict PASS
```

NAP and IPS identifiers
`/var/sf/detection_engines/UUID/snort.conf`

Snort verdict sent to DAQ/PDTS

Troubleshooting Protocol Preprocessors

Use system support trace to find blocks by preprocessors

Trace



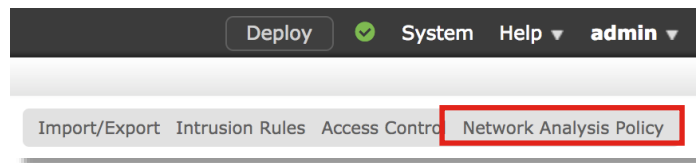
```
> system support trace
```

```
[omitted for brevity...]
```

```
172.16.111.226-51174 - 50.19.123.95-443 6 Packet: TCP, ACK, seq 3849839667, ack 1666843207
172.16.111.226-51174 - 50.19.123.95-443 6 Stream: TCP normalization error in timestamp, window, seq, ack,
fin, flags, or unexpected data, drop
172.16.111.226-51174 - 50.19.123.95-443 6 AppID: service unknown (0), application unknown (0)
172.16.111.226-51174 > 50.19.123.95-443 6 AS 4 I 0 Starting with minimum 3, 'block urls', and SrcZone first
with zones -1 -> -1, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0, client
0, misc 0, user 9999997, icmpType 0, icmpCode 0
172.16.111.226-51174 > 50.19.123.95-443 6 Firewall: starting rule matching, zone -1 -> -1, geo 0 -> 0, vlan
0, sgt 65535, user 9999997, icmpType 0, icmpCode 0
172.16.111.226-51174 > 50.19.123.95-443 6 AS 4 I 0 pending rule order 3, 'block urls', URL
172.16.111.226-51174 > 50.19.123.95-443 6 Firewall: pending rule-matching, 'block urls', pending URL
172.16.111.226-51174 > 50.19.123.95-443 6 Snort: processed decoder alerts or actions queue, drop
172.16.111.226-51174 > 50.19.123.95-443 6 IPS Event: gid 129, sid 14, drop
172.16.111.226-51174 > 50.19.123.95-443 6 NAP id 1, IPS id 0, Verdict BLOCK
172.16.111.226-51174 > 50.19.123.95-443 6 ==> Blocked by Stream
```


Policies > Access Control > Intrusion

Disable Inline
Mode



Edit or create a
Network Analysis Policy

Policy Information

Name

Description

Inline Mode



Uncheck this box to
disable Inline Mode

<u>Inline Result</u> x	<u>Source IP</u> x	<u>Destination IP</u> x	<u>Source Port / ICMP Type</u> x	<u>Destination Port / ICMP Code</u> x	<u>Message</u> x
	172.16.111.226	50.19.123.95	51177 / tcp	443 (https) / tcp	STREAM5_NO_TIMESTAMP (129:14:2)
	172.16.111.226	50.19.123.95	51174 / tcp	443 (https) / tcp	STREAM5_NO_TIMESTAMP (129:14:2)

Inline Mode disabled = No Inline Result

Inline Mode enabled = "Dropped" Inline Result

Troubleshooting Protocol Preprocessors

Network
Analysis
Configuration



Edit Policy: My Custom NAP

View preprocessors

Currently Enabled

Enabled with non-default settings

Enabled with default settings

Policy Information

- Settings**
- Back Orifice Detection
- DCE/RPC Configuration
- DNS Configuration
- FTP and Telnet Configurati
- GTP Command Channel Cc
- HTTP Configuration
- Inline Normalization
- IP Defragmentation
- Packet Decoding
- SIP Configuration
- SMTP Configuration
- SSH Configuration
- SSL Configuration
- Sun RPC Configuration
- TCP Stream Configuration
- UDP Stream Configuration

Policy Layers

- My Changes**
- Inline Normalization
- TCP Stream Configurati
- Security Over Connectivity**
- Back Orifice Detection
- Checksum Verification

Settings < Back

Application Layer Preprocessors

DCE/RPC Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
DNS Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
FTP and Telnet Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
HTTP Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
Sun RPC Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
SIP Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
GTP Command Channel Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
IMAP Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
POP Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
SMTP Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
SSH Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit
SSL Configuration	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit

SCADA Preprocessors

Modbus Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
DNP3 Configuration	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	

Transport/Network Layer Preprocessors

Checksum Verification	<input type="radio"/> Enabled <input checked="" type="radio"/> Disabled	
Inline Normalization	<input checked="" type="radio"/> Enabled <input type="radio"/> Disabled	Edit

Filter:

Intrusion Policy

12 selected rules of 19

Rule State Event Filtering Dynamic State Alerting Comments

Generate Events
Drop and Generate Events
Disable

Rule ID	Rule Name
129 4	STREAM5_BAD_TIMESTAMP
129 5	STREAM5_BAD_SEGMENT
129 6	STREAM5_WINDOW_TOO_LARGE
129 7	STREAM5_EXCESSIVE_TCP_OVERLAPS
129 8	STREAM5_DATA_AFTER_RESET
129 9	STREAM5_SESSION_HIJACKED_CLIENT
129 10	STREAM5_SESSION_HIJACKED_SERVER
129 11	STREAM5_DATA_WITHOUT_FLAGS
129 12	STREAM5_SMALL_SEGMENT
129 13	STREAM5_4WAY_HANDSHAKE
129 14	STREAM5_NO_TIMESTAMP
129 15	STREAM5_BAD_RST
129 16	STREAM5_BAD_FIN
129 17	STREAM5_BAD_ACK
129 18	STREAM5_DATA_AFTER_RST_RCVD
129 19	STREAM5_WINDOW_SLAM

Inline Normalization



Policy Information

Settings

- Back Orifice Detection
- DCE/RPC Configuration
- DNS Configuration
- FTP and Telnet Configuration
- GTP Command Channel Configuration
- HTTP Configuration
- Inline Normalization**
- IP Defragmentation
- Packet Decoding
- SIP Configuration
- SMTP Configuration
- SSH Configuration
- SSL Configuration
- Sun RPC Configuration
- TCP Stream Configuration
- UDP Stream Configuration

Policy Layers

Inline Normalization

Normalize IPv4	<input type="checkbox"/>
Normalize Don't Fragment Bit	<input type="checkbox"/>
Normalize Reserved Bit	<input type="checkbox"/>
Normalize TOS Bit	<input type="checkbox"/>
Normalize Excess Payload	<input type="checkbox"/>
Normalize IPv6	<input type="checkbox"/>
Normalize ICMPv4	<input type="checkbox"/>
Normalize ICMPv6	<input type="checkbox"/>
Normalize/Clear Reserved Bits	<input checked="" type="checkbox"/>
Normalize/Clear Option Padding Bytes	<input checked="" type="checkbox"/>
Clear Urgent Pointer if URG=0	<input checked="" type="checkbox"/>
Clear Urgent Pointer/URG on Empty Payload	<input checked="" type="checkbox"/>
Clear URG if Urgent Pointer Is Not Set	<input checked="" type="checkbox"/>
Normalize Urgent Pointer	<input type="checkbox"/>
Normalize TCP Payload	<input checked="" type="checkbox"/>
Remove Data on SYN	<input type="checkbox"/>
Remove Data on RST	<input type="checkbox"/>
Trim Data to Window	<input type="checkbox"/>
Trim Data to MSS	<input type="checkbox"/>
Block Unresolvable TCP Header Anomalies	<input checked="" type="checkbox"/>

Network Analysis Policy

Still drops after
setting to
generate



Inline × Result	Source IP ×	Destination × IP	Source Port / ICMP Type	Destination Port / ICMP Code	Message ×
↓	172.16.111.226	50.19.123.95	51174 / tcp	443 (https) / tcp	STREAM5_NO_TIMESTAMP (129:14:2)
↓	172.16.111.226	50.19.123.95	51174 / tcp	443 (https) / tcp	STREAM5_NO_TIMESTAMP (129:14:2)

Inline
Normalization



Check configuration guide for relative protocols/preprocessors:

Block Unresolvable TCP Header Anomalies

When you enable this option, the system blocks anomalous TCP packets that, if normalized, would be invalid and likely would be blocked by the receiving host. For example, the system blocks any SYN packet transmitted subsequent to an established session.

The system also drops any packet that matches any of the following TCP stream processor rules, regardless of whether the rules are enabled:

- 129:1
- 129:3
- 129:4
- 129:6
- 129:8
- 129:11
- 129:14 through 129:19

The Total Blocked Packets performance graph tracks the number of packets blocked in inline deployments and, in passive deployments and inline deployments in tap mode, the number that would have been blocked in an inline deployment.

Config guides: <http://www.cisco.com/c/en/us/support/security/defense-center/products-installation-and-configuration-guides-list.html>

TCP Ping

- Powerful troubleshooting tool in FTD
- Verify bi-directional TCP connectivity from FTD to a remote server using injected packet
- Provides FTD policy and upstream path verification without client host access
 - TCP RST and ICMP error responses are intercepted and displayed as well



Example: TCP Ping

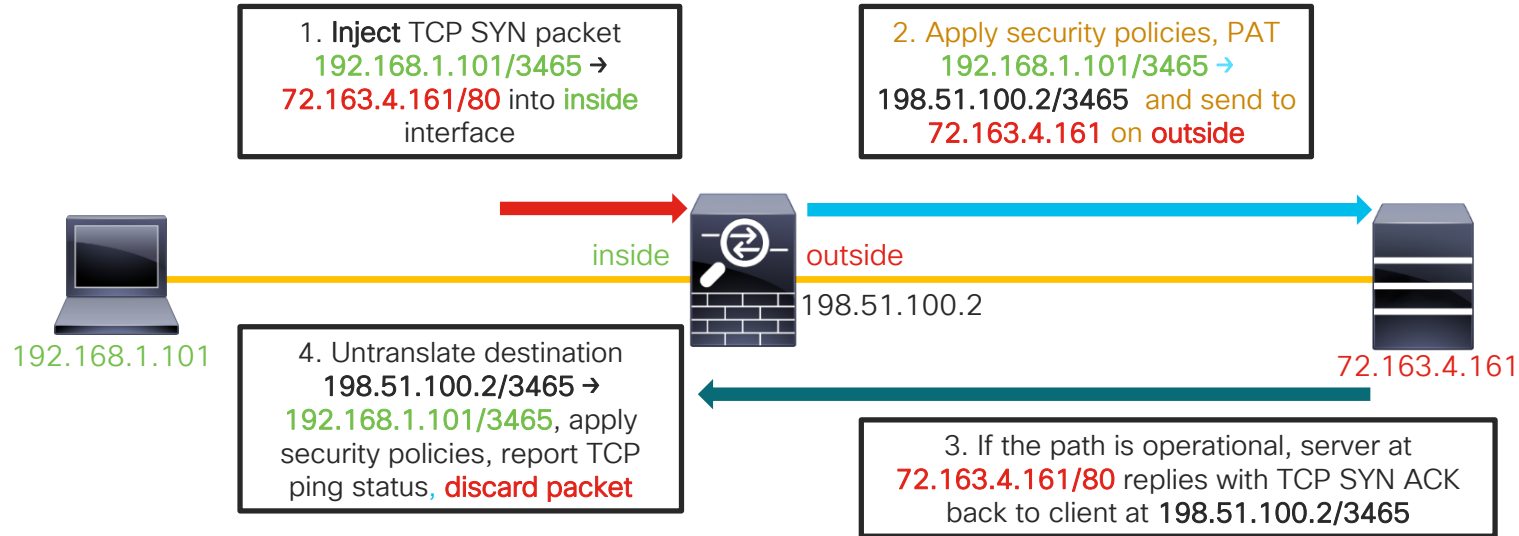
```
firepower# ping tcp
Interface: inside
Target IP address: 72.163.4.161
Target IP port: 80
Specify source? [n]: y
Source IP address: 192.168.1.101
Source IP port: [0]
Repeat count: [5]
Timeout in seconds: [2]
Type escape sequence to abort.
Sending 5 TCP SYN requests to 72.163.4.161 port 80
from 192.168.1.101 starting port 3465, timeout is 5 seconds:
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/1 ms
```

Interface where the test host resides

Real IP address of the test host; the host does not have to be online or even connected

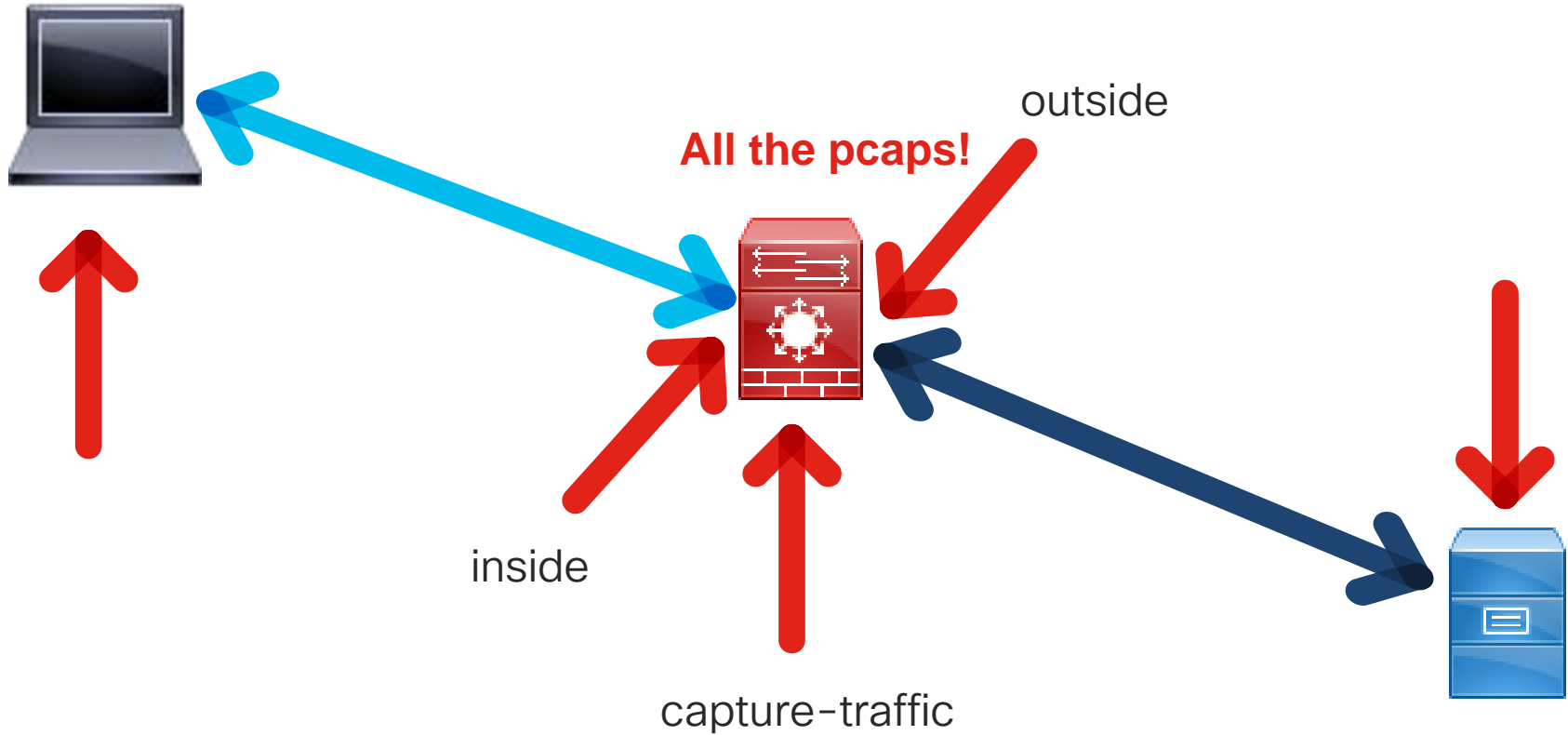


Example: TCP Ping



Packet Captures for SSL Decryption

Pcaps



Full handshake (Wireshark view)

Client Hello

443 → 55401 [ACK] Seq=1 Ack=206 Win=65535 Len=0

Server Hello

Certificate




55401 → 443 [ACK] Seq=206 Ack=1817 Win=64860 Len=0

Server Hello Done

Client Key Exchange, Change Cipher Spec, Encrypted Han...

Change Cipher Spec

Other common handshakes

- Client Certificate request 
- Session Reuse 
 - Client Hello Modification required
- Certificate Pinning 
 - Phone applications

Pcap investigation Client Hello

- Identify Handshake
- Session ID

```
▼ Secure Sockets Layer
  ▼ TLSv1.2 Record Layer: Handshake Protocol: Client Hello
    Content Type: Handshake (22)
    Version: TLS 1.0 (0x0301)
    Length: 200
    ▼ Handshake Protocol: Client Hello
      Handshake Type: Client Hello (1)
      Length: 196
      Version: TLS 1.2 (0x0303)
      > Random
      Session ID Length: 0
      Cipher Suites Length: 28
      > Cipher Suites (14 suites)
```

Pcap investigation Client Hello continued

- Session ID
- Server Name
- Known problems
- Potential problems

```
Version: TLS 1.2 (0x0303)
> Random
Session ID Length: 0
Cipher Suites Length: 28
> Cipher Suites (14 suites)
Compression Methods Length: 1
> Compression Methods (1 method)
Extensions Length: 127
> Extension: Unknown 23130
> Extension: renegotiation_info
> Extension: server name
> Extension: Extended Master Secret
> Extension: SessionTicket TLS
> Extension: signature_algorithms
> Extension: status_request
> Extension: signed_certificate_timestamp
> Extension: Application Layer Protocol Negotiation
> Extension: channel_id
> Extension: ec_point_formats
> Extension: elliptic_curves
> Extension: Unknown 39578
```

Pcap investigation: Server Hello

- Identify Handshake
- Session ID

```
▼ Secure Sockets Layer
  ▼ TLSv1.2 Record Layer: Handshake Protocol: Server Hello
    Content Type: Handshake (22)
    Version: TLS 1.2 (0x0303)
    Length: 81
  ▼ Handshake Protocol: Server Hello
    Handshake Type: Server Hello (2)
    Length: 77
    Version: TLS 1.2 (0x0303)
    > Random
    Session ID Length: 32
    Session ID: cdc9863a507daa0f1470ca0e19a4b3771a6a3ecf0ff3121d...
    Cipher Suite: TLS_RSA_WITH_AES_256_CBC_SHA (0x0035)
    Compression Method: null (0)
    Extensions Length: 5
    > Extension: renegotiation_info
```

Pcap investigation: Certificate

- Length
- Issuer

```
▼ Certificates (1718 bytes)
  Certificate Length: 1715
  ▼ Certificate: 308206af30820497a0030201020208150130034f311
    ▼ signedCertificate
      version: v3 (2)
      serialNumber: 1513543740544848183
      > signature (sha256WithRSAEncryption)
      ▼ issuer: rdnSequence (0)
        > rdnSequence: 6 items (id-at-commonName=Iseeyou.)
        > validity
        > subject: rdnSequence (0)
        > subjectPublicKeyInfo
        > extensions: 5 items
```

tcp.stream eq 8

No.	Time	Source	Destination	Protocol	Length	Info	SRC PORT	New Column
1775	10.260709	192.168.1.200	172.217.8.10	TCP	66	59117 → 443 [SYN] Seq=0 Win=8192 Len=...	59117	443
1776	10.315668	172.217.8.10	192.168.1.200	TCP	66	443 → 59117 [SYN, ACK] Seq=0 Ack=1 W...	443	59117
1777	10.316186	192.168.1.200	172.217.8.10	TCP	54	59117 → 443 [ACK] Seq=1 Ack=1 Win=662...	59117	443
1778	10.318029	192.168.1.200	172.217.8.10	TLSv1.2	243	Client Hello	59117	443
1779	10.372759	172.217.8.10	192.168.1.200	TLSv1.2	373	Server Hello	443	59117
1780	10.373985	172.217.8.10	192.168.1.200	TCP	1514	[TCP segment of a reassembled PDU]	443	59117
1781	10.374095	172.217.8.10	192.168.1.200	TCP	1514	[TCP segment of a reassembled PDU]	443	59117
1782	10.374187	172.217.8.10	192.168.1.200	TLSv1.2	313	Certificate	443	59117
1783	10.374228	172.217.8.10	192.168.1.200	TLSv1.2	392	Server Key Exchange	443	59117
1784	10.374273	172.217.8.10	192.168.1.200	TLSv1.2	63	Server Hello Done	443	59117
1785	10.374302	172.217.8.10	192.168.1.200	TCP	54	59117 → 443 [RST] Seq=3837 Win=838848...	59117	443
1786	10.374322	192.168.1.200	172.217.8.10	TCP	54	59117 → 443 [RST] Seq=190 Win=262140 ...	59117	443

Decryption fails



Frame 1784: 63 bytes on wire (504 bits), 63 bytes captured (504 bits)
 Ethernet II, Src: Vmware_22:01:06 (00:0c:29:22:01:06), Dst: Vmware_16:ac:87 (00:0c:29:22:01:06)
 Internet Protocol Version 4, Src: 172.217.8.10, Dst: 192.168.1.200
 Transmission Control Protocol, Src Port: 443 (443), Dst Port: 59117 (59117), Seq: 59117, Len: 66
 Secure Sockets Layer
 TLSv1.2 Record Layer: Handshake Protocol: Server Hello Done
 Content Type: Handshake (22)
 Version: TLS 1.2 (0x0303)
 Length: 4
 Handshake Protocol: Server Hello Done
 Handshake Type: Server Hello Done (14)
 Length: 0



tcp.stream eq 10

No.	Time	Source	Destination	Protocol	Length	Info	SRC PORT	New Column
56	8.311365	192.168.1.200	98.138.199.240	TCP	66	59113 → 443 [SYN] Seq=0 Win=8192 Len=...	59113	443
57	8.383913	98.138.199.240	192.168.1.200	TCP	66	443 → 59113 [SYN, ACK] Seq=0 Ack=1 W...	443	59113
59	8.385263	192.168.1.200	98.138.199.240	TCP	54	59113 → 443 [ACK] Seq=1 Ack=1 Win=662...	59113	443
60	8.399074	192.168.1.200	98.138.199.240	TLSv1.2	239	Client Hello	59113	443
61	8.408633	98.138.199.240	192.168.1.200	TLSv1.2	124	Server Hello	443	59113
62	8.520860	98.138.199.240	192.168.1.200	TCP	1514	[TCP segment of a reassembled PDU]	443	59113
63	8.520986	98.138.199.240	192.168.1.200	TCP	1514	[TCP segment of a reassembled PDU]	443	59113
64	8.521085	98.138.199.240	192.168.1.200	TLSv1.2	433	Certificate	443	59113
65	8.521132	98.138.199.240	192.168.1.200	TLSv1.2	392	Server Key Exchange	443	59113
66	8.521251	98.138.199.240	192.168.1.200	TLSv1.2	63	Server Hello Done	443	59113
68	8.527142	192.168.1.200	98.138.199.240	TLSv1.2	129	Client Key Exchange	59113	443
69	8.613024	192.168.1.200	98.138.199.240	HTTP	809	POST /comet HTTP/1.1 (application/js...	59113	443
89	8.734453	98.138.199.240	192.168.1.200	TCP	294	[TCP segment of a reassembled PDU]	443	59113
90	8.734703	98.138.199.240	192.168.1.200	TCP	59	[TCP segment of a reassembled PDU]	443	59113
91	8.734878	98.138.199.240	192.168.1.200	TCP	1135	[TCP segment of a reassembled PDU]	443	59113
95	8.735212	98.138.199.240	192.168.1.200	HTTP	61	HTTP/1.1 200 OK (application/json)	443	59113
176	20.281141	192.168.1.200	98.138.199.240	HTTP	809	POST /comet HTTP/1.1 (application/js...	59113	443
177	20.429652	98.138.199.240	192.168.1.200	TCP	294	[TCP segment of a reassembled PDU]	443	59113

Frame 69: 809 bytes on wire (6472 bits), 809 bytes captured (6472 bits)
 Ethernet II, Src: Vmware_16:ac:87 (00:0c:29:16:ac:87), Dst: Vmware_22:01:06 (00:0c:29:22:01:06)
 Internet Protocol Version 4, Src: 192.168.1.200, Dst: 98.138.199.240
 Transmission Control Protocol, Src Port: 59113 (59113), Dst Port: 443 (443), Seq: 261, Ack: 3717, Len: 755
 Hypertext Transfer Protocol
 [Expert Info (Warn/Security): Unencrypted HTTP protocol detected over encrypted port, could indicate a dangerous misconfiguration.]
 [Unencrypted HTTP protocol detected over encrypted port, could indicate a dangerous misconfiguration.]
 [Severity Level: Warn]
 [Group: Security]
 POST /comet HTTP/1.1\r\n
 [Expert Info (Chat/Sequence): POST /comet HTTP/1.1\r\n\r\n]
 [POST /comet HTTP/1.1\r\n\r\n]
 [Severity Level: Chat]
 [Group: Sequence]

Decryption succeeds

cisco Live!

Client Hello Modification (6.1.0+)

Before

No.	Time	Source	Src Port	Destination
314	3.970446	192.168.1.200	63232	172.217.5
324	4.003952	192.168.1.200	63232	172.217.5
325	4.004944	192.168.1.200	63232	172.217.5
332	4.062085	192.168.1.200	63232	172.217.5
336	4.067959	192.168.1.200	63232	172.217.5
338	4.072598	192.168.1.200	63232	172.217.5
339	4.081448	192.168.1.200	63232	172.217.5
340	4.081463	192.168.1.200	63232	172.217.5

▼ Handshake Protocol: Client Hello
Handshake Type: Client Hello (1)
Length: 208
Version: TLS 1.2 (0x0303)
▶ Random
Session ID Length: 0
Cipher Suites Length: 28
▶ Cipher Suites (14 suites)
Compression Methods Length: 1
▶ Compression Methods (1 method)
Extensions Length: 139
▶ Extension: Unknown 6682
▶ Extension: renegotiation_info
▶ Extension: server_name
▶ Extension: Extended Master Secret
▶ Extension: SessionTicket TLS
▶ Extension: signature_algorithms
▶ Extension: status_request
▶ Extension: signed_certificate_timestamp
▶ Extension: Application Layer Protocol Negotiation
▶ Extension: channel_id
▶ Extension: ec_point_formats
▶ Extension: elliptic_curves
▶ Extension: Unknown 56026

After

707	12.608129	192.168.1.200	63232	172.217.5.226	443	66	63232 → 443 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS
717	12.634388	192.168.1.200	63232	172.217.5.226	443	54	63232 → 443 [ACK] Seq=1 Ack=1 Win=66240 Len=0
718	12.636387	192.168.1.200	63232	172.217.5.226	443	253	Client Hello
730	12.672869	192.168.1.200	63232	172.217.5.226	443	54	63232 → 443 [ACK] Seq=200 Ack=2761 Win=66240 Len=0
734	12.697358	192.168.1.200	63232	172.217.5.226	443	54	63232 → 443 [ACK] Seq=200 Ack=4297 Win=66240 Len=0
738	12.711685	192.168.1.200	63232	172.217.5.226	443	180	Client Key Exchange, Change Cipher Spec, Encrypted
739	12.712021	192.168.1.200	63232	172.217.5.226	443	107	Application Data
740	12.712097	192.168.1.200	63232	172.217.5.226	443	110	Application Data

Version: TLS 1.0 (0x0301)
Length: 194
▼ Handshake Protocol: Client Hello
Handshake Type: Client Hello (1)
Length: 190
Version: TLS 1.2 (0x0303)
▶ Random
Session ID Length: 0
Cipher Suites Length: 22
▶ Cipher Suites (11 suites)
Compression Methods Length: 1
▶ Compression Methods (1 method)
Extensions Length: 127
▶ Extension: Unknown 6682
▶ Extension: renegotiation_info
▶ Extension: server_name
▶ Extension: SessionTicket TLS
▶ Extension: signature_algorithms
▶ Extension: status_request
▶ Extension: signed_certificate_timestamp
▶ Extension: Application Layer Protocol Negotiation
▶ Extension: ec_point_formats
▶ Extension: elliptic_curves
▶ Extension: Unknown 56026

Identity Troubleshooting Tools

Firewall engine debug

Firewall Engine Debug is the right tool to identify what is happening within the Access Control Policy

```
> system support firewall-engine-debug
```

```
Please specify an IP protocol: tcp
```

```
Please specify a client IP address: 172.16.1.2
```

```
Please specify a client port:
```

```
Please specify a server IP address: 192.168.0.10
```

```
Please specify a server port: 8081
```

```
Monitoring firewall engine debug messages
```

```
172.16.1.2-54255 > 192.168.0.10-8081 6 AS 1 I 0 New session
172.16.1.2-54255 > 192.168.0.10-8081 6 AS 1 I 0 Starting with minimum 4, 'Allow_Group2', and
IPProto first with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0,
svc 0, payload 0, client 0, misc 0, user 1, icmpType 0, icmpCode 0
172.16.1.2-54255 > 192.168.0.10-8081 6 AS 1 I 0 rule order 4, 'Allow_Group2', did not match
group 2
172.16.1.2-54255 > 192.168.0.10-8081 6 AS 1 I 0 no match rule order 4, 'Allow_Group2', user
1, realm 2
172.16.1.2-54255 > 192.168.0.10-8081 6 AS 1 I 0 match rule order 5, id 268434432 action Allow
172.16.1.2-54255 > 192.168.0.10-8081 6 AS 1 I 0 allow action
```

ID of currently mapped user:

1 - 999999X = Downloaded User
9999995 = Pending User
9999996 = Guest
9999997 = No Auth Required
9999998 = Failed Authentication
9999999 = Unknown

Identity-debug

The Identity-debug tool allows the user to troubleshoot the Identity Policy.

```
> system support identity-debug
```

```
Please specify an IP protocol: tcp
```

```
Please specify a client IP address: 172.16.1.2
```

```
Please specify a client port:
```

```
Please specify a server IP address: 192.168.0.10
```

```
Please specify a server port: 8081
```

```
Monitoring identity debug messages
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 Starting authentication (sfAuthCheckRules params)
with zones 2 -> 3, port 43490 -> 8081, geo 16429296 -> 16429314
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 Starting Auth SrcZone first with zones 2 -> 3, geo
2 -> 3, vlan 0
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 Matched rule order 1, id 1, authRealmId 2, AD
Domain fire.int
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 found captive portal session
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 returning captive portal session
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 found active binding for user_id 1
```

```
172.16.1.2-43490 > 192.168.0.10-8081 6 AS 1 I 0 matched auth rule id = 1 user_id = 1 realm_id = 2
```

The user_map_query script

```
root@FTD# user_map_query.pl -h
```

Options:

<code>--dump-data <pre_str></code>	Dumps all troubleshooting data for user/group mapping. If provided, the output files will be prepended with "<pre_str>_"
<code>-d, --debug</code>	enable debug logging (off by default)
<code>-g, --group</code>	Displays the users associated to the group(s) specified (can not be passed with <code>-i</code> or <code>-u</code>)
<code>-h, -?, --help</code>	Print usage information
<code>-i, --ip-addr</code>	Displays the users associated to the IPv4 address(es) specified (can not be passed with <code>-g</code> or <code>-u</code>)
<code>--iu</code>	Include unified file data
<code>--outfile</code>	Dumps the output to the specified file
<code>-s, --snort</code>	Include data from snort's mapping
<code>-u, --user</code>	Displays the IP addresses associated to the user(s) specified (can not be passed with <code>-g</code> or <code>-i</code>)
<code>--unified-all</code>	Displays all of the unified data per record regardless of the type of query
<code>--unified-dir</code>	The directory to look for unified files (default is <code>/var/sf/user_enforcement</code>)
<code>--use-id</code>	Treats the values passed as IDs (only relevant for user and group queries)

Collect All Data

Troubleshoot Live

Finding who that User ID belongs to

```
root@FTD# user_map_query.pl --use-id -u 1
```

```
Current Time: 01/17/2019 15:54:38 UTC
```

```
Getting information on username(s)...
```

```
User #1: test1
```



Username

```
ID:          1
Last Seen:   Unknown
for_policy:  0
Realm ID:    2
```

```
=====
|           Database           |
=====
```

```
##) IP Address [Realm ID]
1) ::ffff:172.16.1.2 [2]
```



Currently Mapped IP Address(s)

```
##) Group Name (ID)
1) Test (3)
```



Groups user belongs to

Comparing Database and Snort output

```
root@FTD/home/admin# user_map_query.pl -s -u test1
```

```
Would you like to dump user data from snort now? (Current Time: 01/17/2019 16:08:03 UTC) [y,n]: y
```

```
Successfully commanded snort.
```

```
Current Time: 01/17/2019 16:08:05 UTC
```

```
Getting information on username(s)...
```

```
User #1: test1
```

```
---
```

```
ID:          1
Last Seen:   Unknown
for_policy:  0
Realm ID:    2
```

```
=====
|           Database           |
=====
```

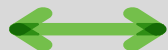
```
##) IP Address [Realm ID]
1) ::ffff:172.16.1.2 [2]
```

```
##) Group Name (ID)
1) Test (3)
```

```
=====
|           Snort              |
=====
```

```
##) IP Address [Realm ID] (instances)
1) ::ffff:172.16.1.2 [2] (instance 1)
```

```
##) Group Name (ID) (instances)
1) Test (3) (instance 1)
```



Collect data to give to TAC

```
root@FTD# user_map_query.pl --dump-data CiscoLive
```

```
Would you like to dump user data from snort now? (Current Time: 01/17/2019 17:44:27 UTC) [y,n]: y
```

```
Successfully commanded snort.
```

```
Current Time: 01/17/2019 17:44:30 UTC
```

```
Getting database dumps...
```

```
Dumping table user_group_map...Done
```

```
Dumping table realm_info...Done
```

```
Dumping table user_identities...Done
```

```
Dumping table user_group...Done
```

```
Dumping table estreamer_bookmark...Done
```

```
Dumping table current_user_ip_map...Done
```

```
Dumping table user_ip_map...Done
```

```
Dumping table user_identities...Done
```

```
Done getting database dumps.
```

```
Added /var/sf/user_enforcement/* files.
```

```
Added snort data dumps
```

```
Compressing data...Done!
```

```
File: /var/tmp/CiscoLive_utd.a76e92ea-aaab-11e7-be62-c7b57db57e79.1547747070.tar.gz
```

```
Cleaning up...Done!
```

Give this to TAC



Captive Portal packet captures



Lina Capture ➡ Tun1 Capture ➡ TEST ➡ Stop Tun1 Cap ➡ Stop Lina Cap ➡ Copy Lina Cap

```
> capture ins_captport interface inside buffer 1000000 match tcp host 172.16.1.2 any
```

```
> expert
```

```
root@FTD1:# tcpdump -i tun1 -s 1518 -w /ngfw/var/common/captive_portal.pcap
```

```
HS_PACKET_BUFFER_SIZE is set to 4.tcpdump:
```

```
listening on tun1, link-type RAW (Raw IP), capture size 1518 bytes
```

```
[TEST AUTHENTICATION]
```

```
^C
```

```
99 packets captured
```

```
99 packets received by filter
```

```
0 packets dropped by kernel
```

```
root@FTD1:# exit
```

```
> capture ins_captport stop
```

```
> copy /noconfirm /pcap capture:ins_captport ins_captport.pcap
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!
```

```
398 packets copied in 0.80 secs
```

Lina Capture location: /mnt/disk0/ins_captport.pcap

Tun1 Capture location: /ngfw/var/common/captive_portal.pcap

The captures at an initial glance



ins_captport.pcap

No.	Destination	Source	Protocol	Length	Info
261	172.16.1.1	172.16.1.2	TCP	66	52441 → 885 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 W
262	172.16.1.2	172.16.1.1	TCP	66	885 → 52441 [SYN, ACK] Seq=0 Ack=1 Win=14600 Len=
263	172.16.1.1	172.16.1.2	TCP	54	52441 → 885 [ACK] Seq=1 Ack=1 Win=65536 Len=0
264	172.16.1.1	172.16.1.2	TCP	233	52441 → 885 [PSH, ACK] Seq=1 Ack=1 Win=65536 Len=
265	172.16.1.2	172.16.1.1	TCP	54	885 → 52441 [ACK] Seq=1 Ack=180 Win=15744 Len=0
266	172.16.1.2	172.16.1.1	TCP	723	885 → 52441 [PSH, ACK] Seq=1 Ack=180 Win=15744 Le
267	172.16.1.1	172.16.1.2	TCP	268	52441 → 885 [PSH, ACK] Seq=180 Ack=670 Win=65024
268	172.16.1.2	172.16.1.1	TCP	336	885 → 52441 [PSH, ACK] Seq=670 Ack=394 Win=16768
269	172.16.1.1	172.16.1.2	TCP	571	52441 → 885 [PSH, ACK] Seq=394 Ack=952 Win=64512
270	172.16.1.2	172.16.1.1	TCP	54	885 → 52441 [ACK] Seq=952 Ack=911 Win=17920 Len=0
273	172.16.1.2	172.16.1.1	TCP	816	885 → 52441 [PSH, ACK] Seq=952 Ack=911 Win=17920

Before bltd NAT

After bltd NAT

No.	Destination	Source	Protocol	Length	Info
63	169.254.0.1	169.254.3.88	TCP	52	52441 → 885 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 W
64	169.254.3.88	169.254.0.1	TCP	52	885 → 52441 [SYN, ACK] Seq=0 Ack=1 Win=14600 Len=
65	169.254.0.1	169.254.3.88	TCP	40	52441 → 885 [ACK] Seq=1 Ack=1 Win=65536 Len=0
66	169.254.0.1	169.254.3.88	TCP	219	52441 → 885 [PSH, ACK] Seq=1 Ack=1 Win=65536 Len=
67	169.254.3.88	169.254.0.1	TCP	40	885 → 52441 [ACK] Seq=1 Ack=180 Win=15744 Len=0
68	169.254.3.88	169.254.0.1	TCP	709	885 → 52441 [PSH, ACK] Seq=1 Ack=180 Win=15744 L
69	169.254.0.1	169.254.3.88	TCP	254	52441 → 885 [PSH, ACK] Seq=180 Ack=670 Win=65024
70	169.254.3.88	169.254.0.1	TCP	322	885 → 52441 [PSH, ACK] Seq=670 Ack=394 Win=16768
71	169.254.0.1	169.254.3.88	TCP	557	52441 → 885 [PSH, ACK] Seq=394 Ack=952 Win=64512
72	169.254.3.88	169.254.0.1	TCP	40	885 → 52441 [ACK] Seq=952 Ack=911 Win=17920 Len=0
73	169.254.3.88	169.254.0.1	TCP	802	885 → 52441 [PSH, ACK] Seq=952 Ack=911 Win=17920

captive_portal.pcap

The captures may need to be decoded



Right click..

Protocol Preferences
Decode As...
Show Packet in New Window



Choose SSL for each port

Field	Value	Type	Default	Current
TCP port	52441	Integer, base 10	(none)	SSL
TCP port	885	Integer, base 10	(none)	SSL

Raw

Protocol	Length	Info
TCP	52	52441 → 885 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS=256 SA
TCP	52	885 → 52441 [SYN, ACK] Seq=0 Ack=1 Win=14600 Len=0 MSS=14
TCP	40	52441 → 885 [ACK] Seq=1 Ack=1 Win=65536 Len=0
TCP	219	52441 → 885 [PSH, ACK] Seq=1 Ack=1 Win=65536 Len=179
TCP	40	885 → 52441 [ACK] Seq=1 Ack=180 Win=15744 Len=0
TCP	709	885 → 52441 [PSH, ACK] Seq=1 Ack=180 Win=15744 Len=669
TCP	254	52441 → 885 [PSH, ACK] Seq=180 Ack=670 Win=65024 Len=214
TCP	322	885 → 52441 [PSH, ACK] Seq=670 Ack=394 Win=16768 Len=282
TCP	557	52441 → 885 [PSH, ACK] Seq=394 Ack=952 Win=64512 Len=517
TCP	40	885 → 52441 [ACK] Seq=952 Ack=911 Win=17920 Len=0
TCP	802	885 → 52441 [PSH, ACK] Seq=952 Ack=911 Win=17920 Len=762



Decoded

Protocol	Length	Info
TCP	52	52441 → 885 [SYN] Seq=0 Win=8192 Len=0 MSS=1460 WS
TCP	52	885 → 52441 [SYN, ACK] Seq=0 Ack=1 Win=14600 Len=0
TCP	40	52441 → 885 [ACK] Seq=1 Ack=1 Win=65536 Len=0
TLSv1.2	219	Client Hello
TCP	40	885 → 52441 [ACK] Seq=1 Ack=180 Win=15744 Len=0
TLSv1.2	709	Server Hello, Certificate, Server Hello Done
TLSv1.2	254	Client Key Exchange, Change Cipher Spec, Finished
TLSv1.2	322	New Session Ticket, Change Cipher Spec, Finished
TLSv1.2	557	Application Data
TCP	40	885 → 52441 [ACK] Seq=952 Ack=911 Win=17920 Len=0
TLSv1.2	802	Application Data, Application Data

Decrypting the captures provides even more insight



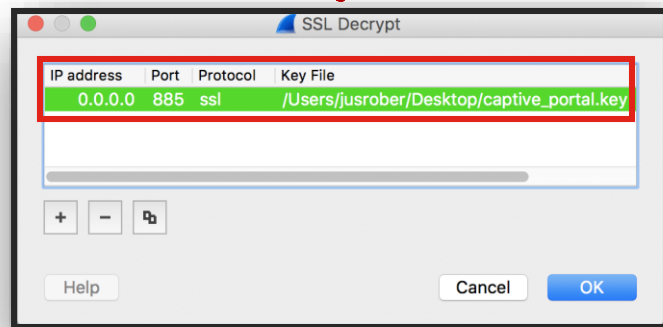
1. While testing captive portal, have sessions write out key information (Windows):

- Set environment variable to create a premaster secret file:

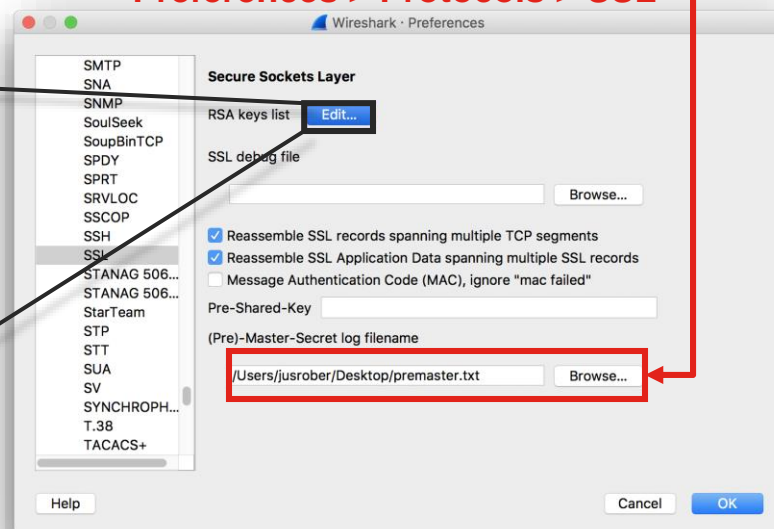
setx SSLKEYLOGFILE "%HOMEPATH%\Desktop\premaster.txt"

- Open a private / incognito window and test

2. Use RSA private key (Captive Portal private key)



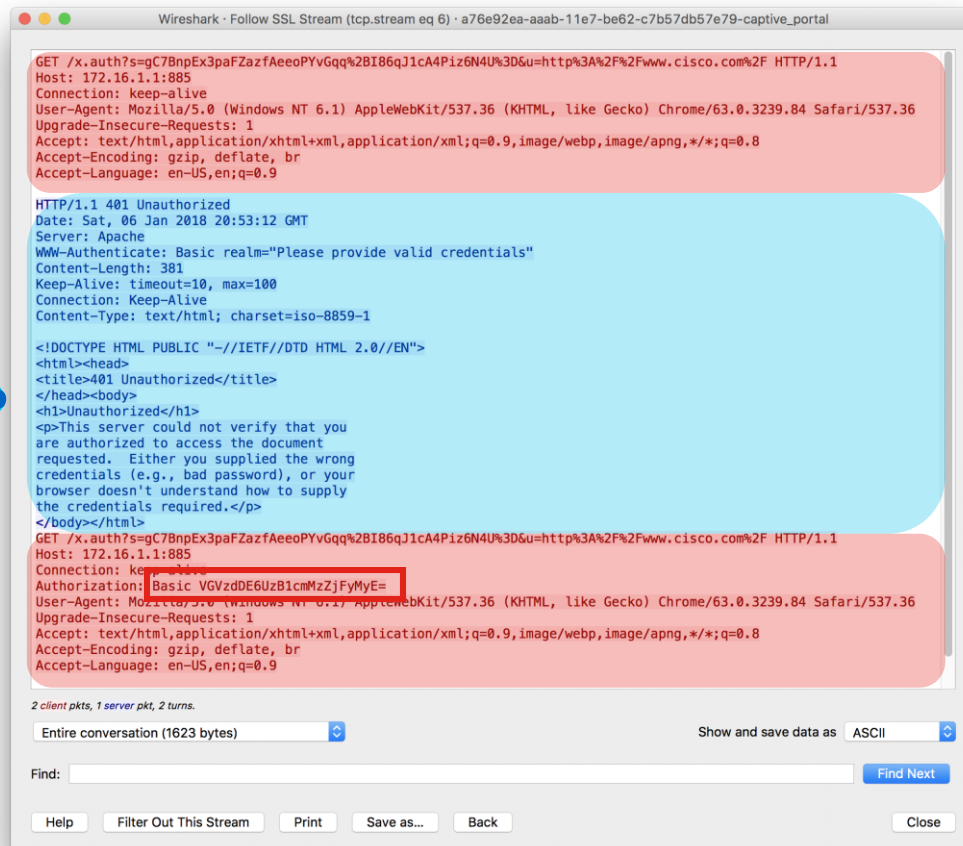
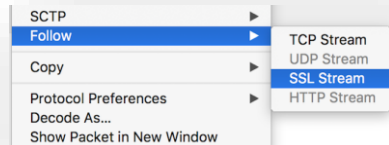
Preferences > Protocols > SSL



You can now follow the SSL Stream



(Right click any SSL Packet)



GET request
after initial redirect

401 Unauthorized
Challenge Response

Captured
Credentials

Redirect back to original destination



```
GET /x.auth?s=gC7BnpEx3paFZazfAeeoPYvGqq%2BI86qJ1cA4Piz6N4U%3D&u=http%3A%2F%2Fwww.cisco.com%2F HTTP/1.1
Host: 172.16.1.1:885
Connection: keep-alive
Authorization: Basic VGVzdDE6UzB1cmMzJFyMyE=
User-Agent: Mozilla/5.0 (Windows NT 6.1) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/63.0.3239.84 Safari/537.36
Upgrade-Insecure-Requests: 1
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,image/apng,*/*;q=0.8
Accept-Encoding: gzip, deflate, br
Accept-Language: en-US,en;q=0.9
```

```
HTTP/1.1 307 Temporary Redirect
Date: Sat, 06 Jan 2018 20:53:22 GMT
Server: Apache
```

```
Location: http://www.cisco.com/
```

← Original Destination

```
Content-Length: 231
Keep-Alive: timeout=10, max=100
Connection: Keep-Alive
Content-Type: text/html; charset=iso-8859-1
```

```
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
<title>307 Temporary Redirect</title>
</head><body>
<h1>Temporary Redirect</h1>
<p>The document has moved <a href="http://www.cisco.com/">here</a>.</p>
</body></html>
```

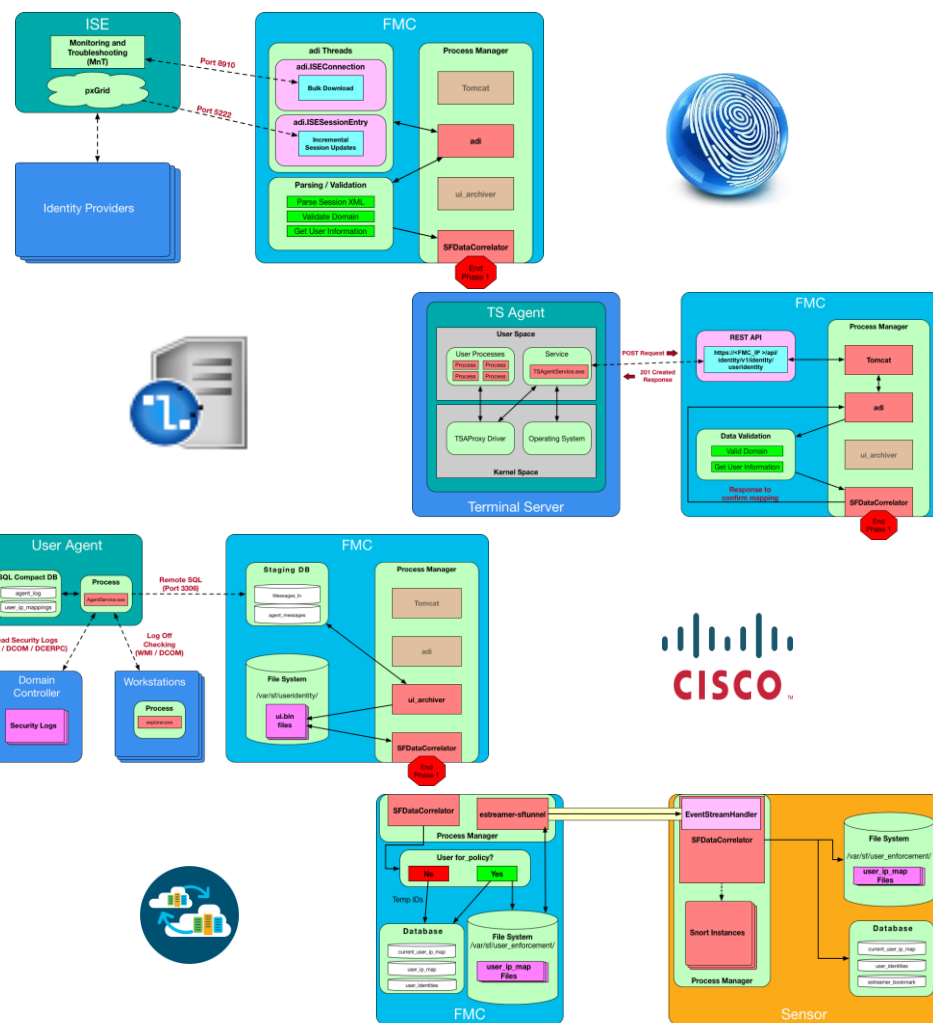
Want more on Identity?

Check the Cisco Live
On-Demand Catalog for:

BRKSEC-3227

Integrating & Troubleshooting
Identity Features on the
Firepower System

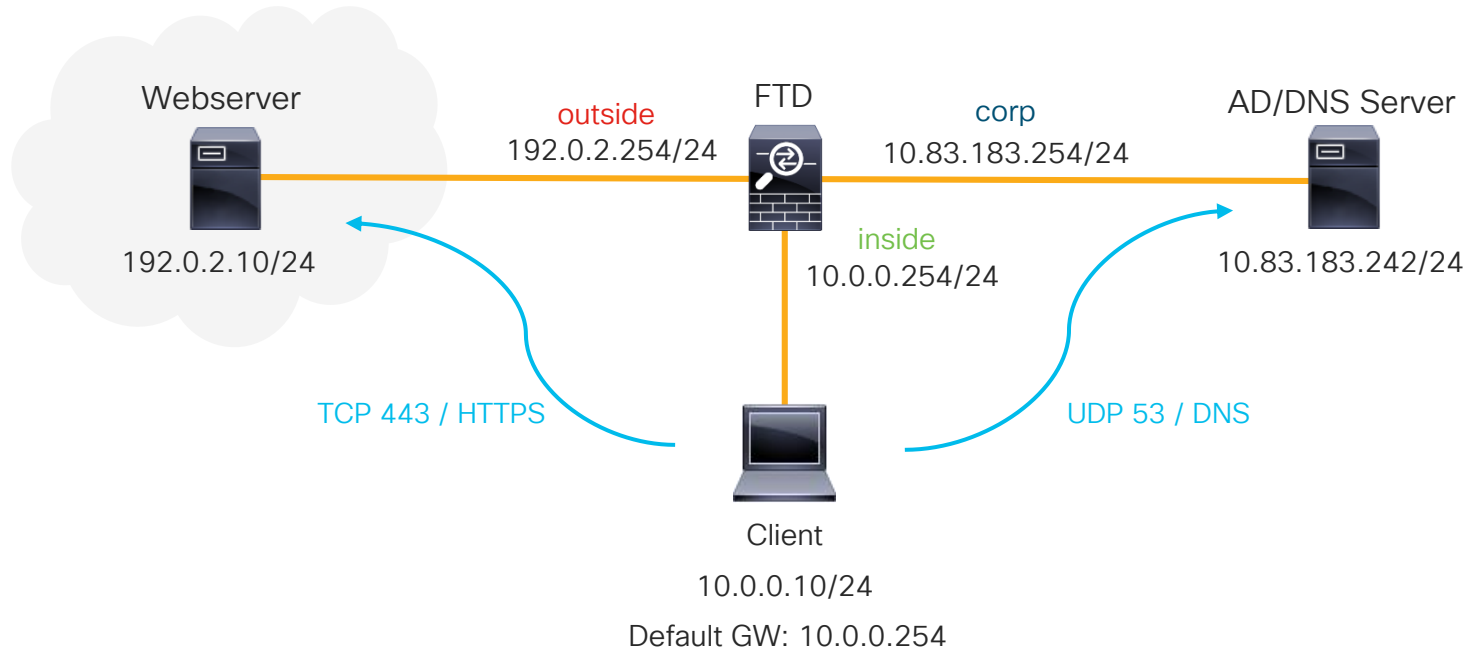
cisco *Live!*



Interactive Troubleshooting

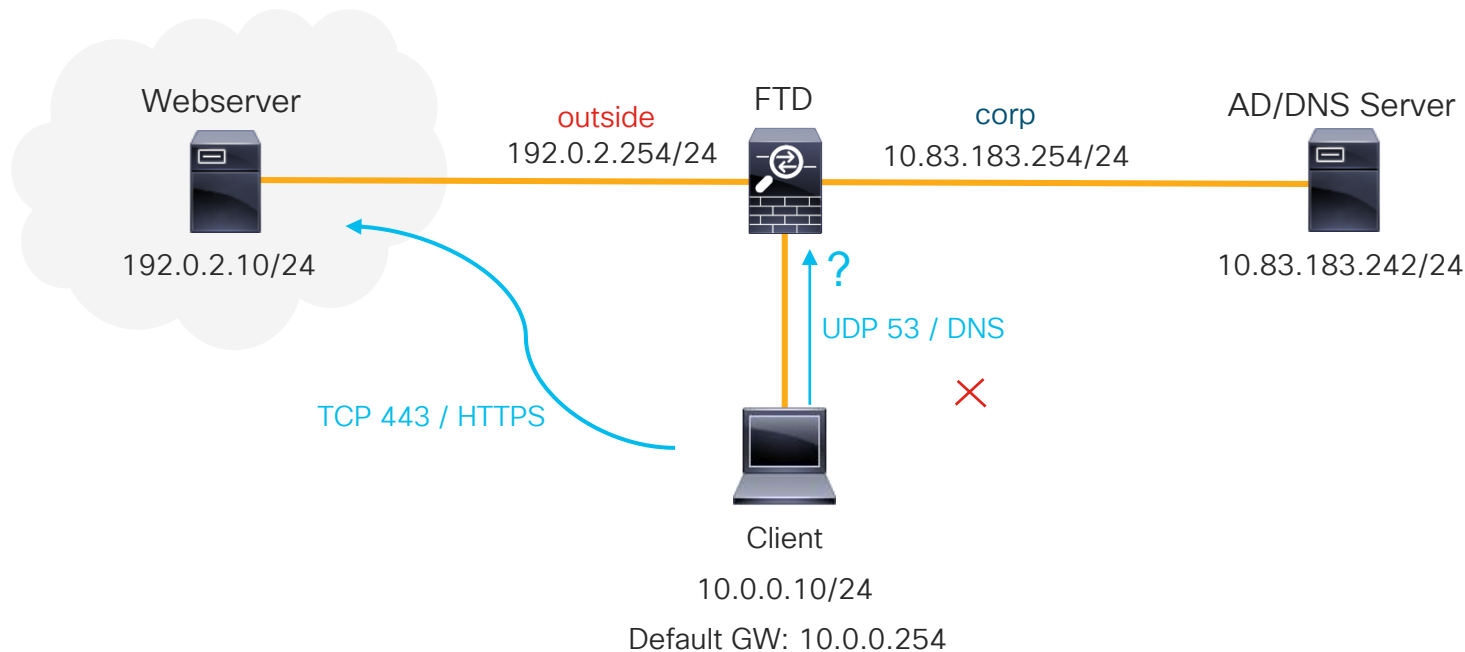
Scenario Topology

- Goal: Client to retrieve a file from an external webserver via HTTPS through FTD

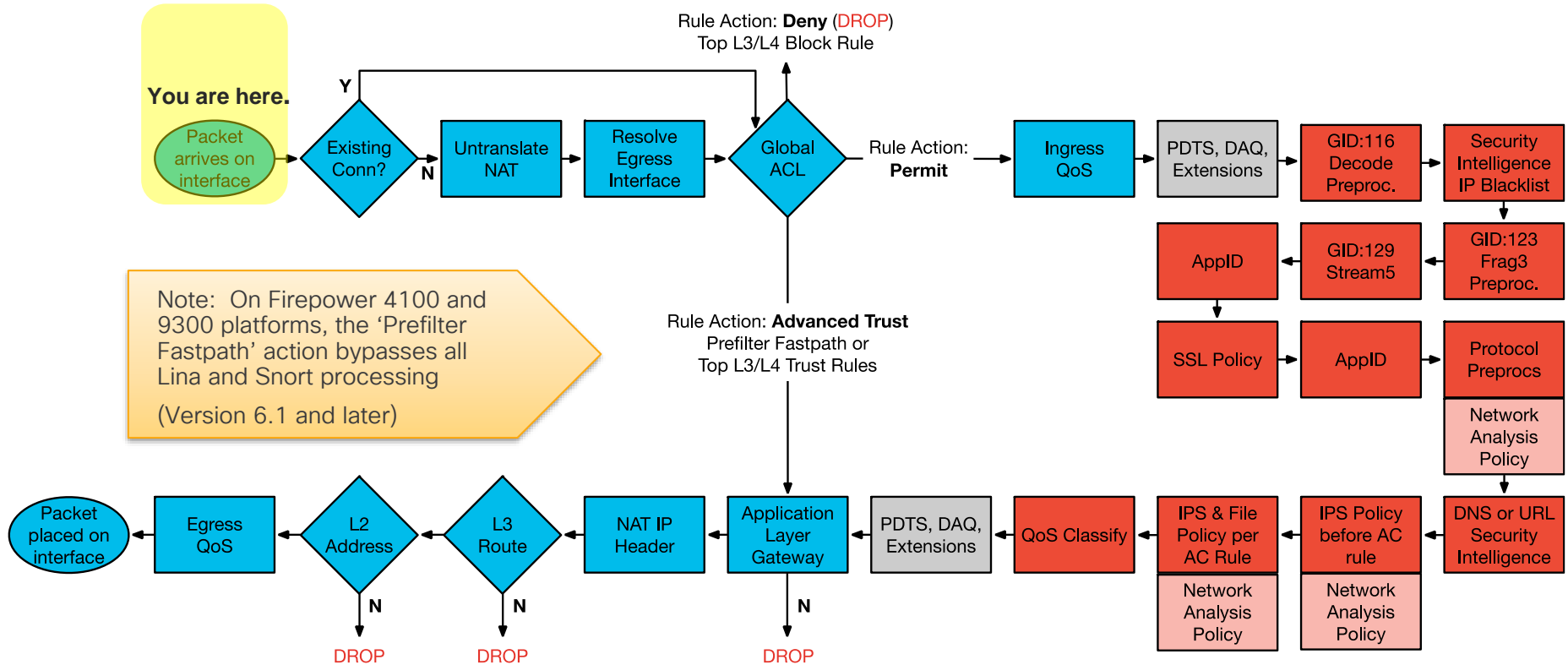


Stage 1: DNS resolution failure (client ARP)

- Client cannot reach the DNS server because of a bad static ARP entry for its default gateway



Reference Slide: Routed FTD Path of Packet

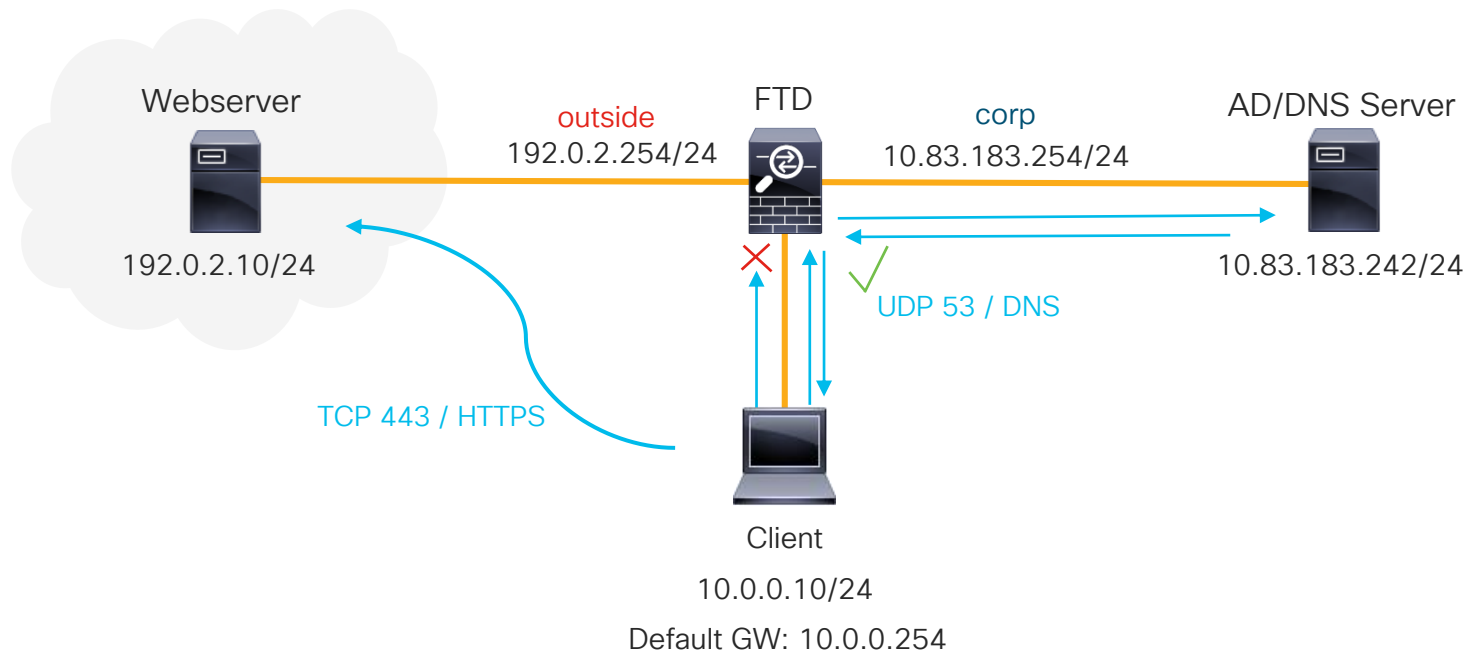


LINA ASA Engine = BLUE

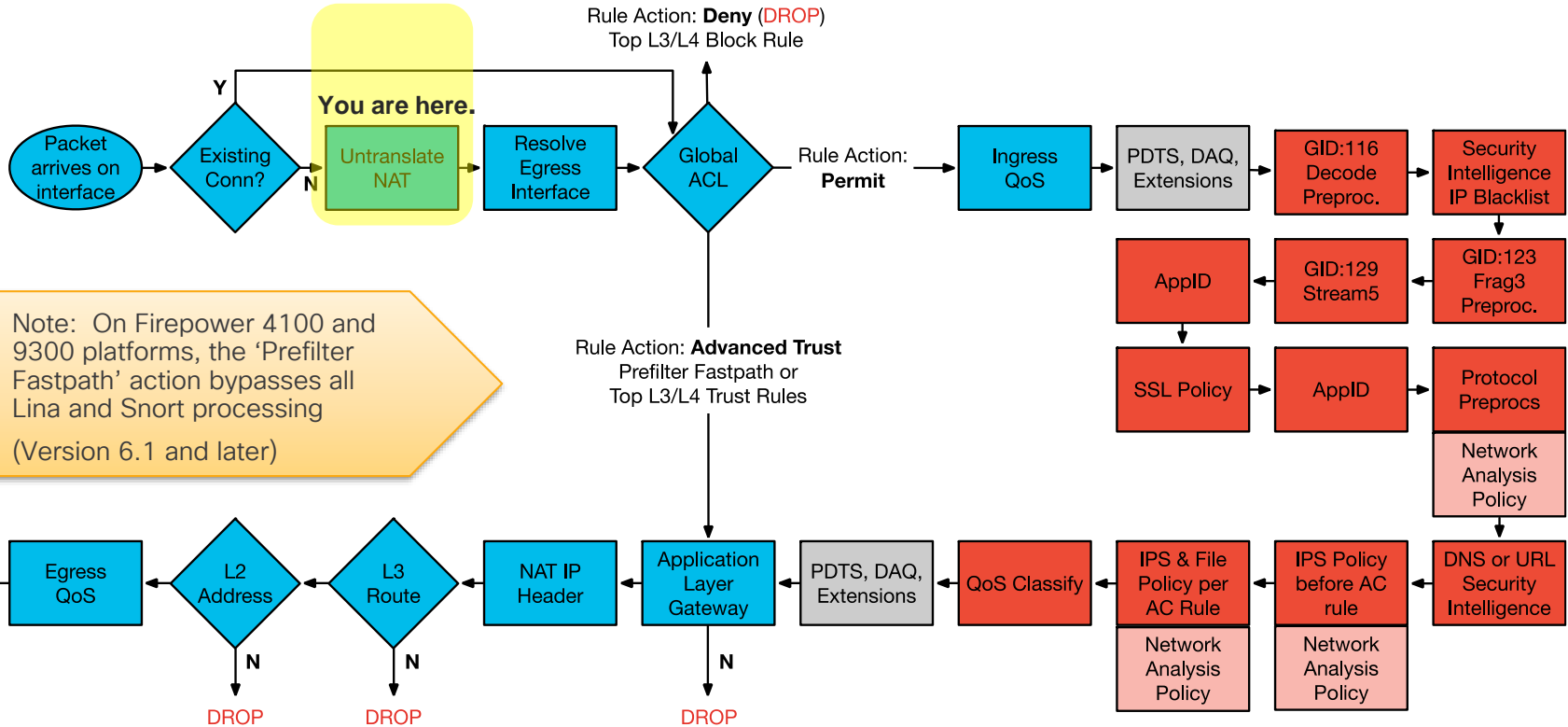
Snort Engine = RED

Stage 2: Connection Fails (Bad Static NAT)

- A static NAT rule was configured to send traffic out of the wrong interface (corp)



Reference Slide: Routed FTD Path of Packet

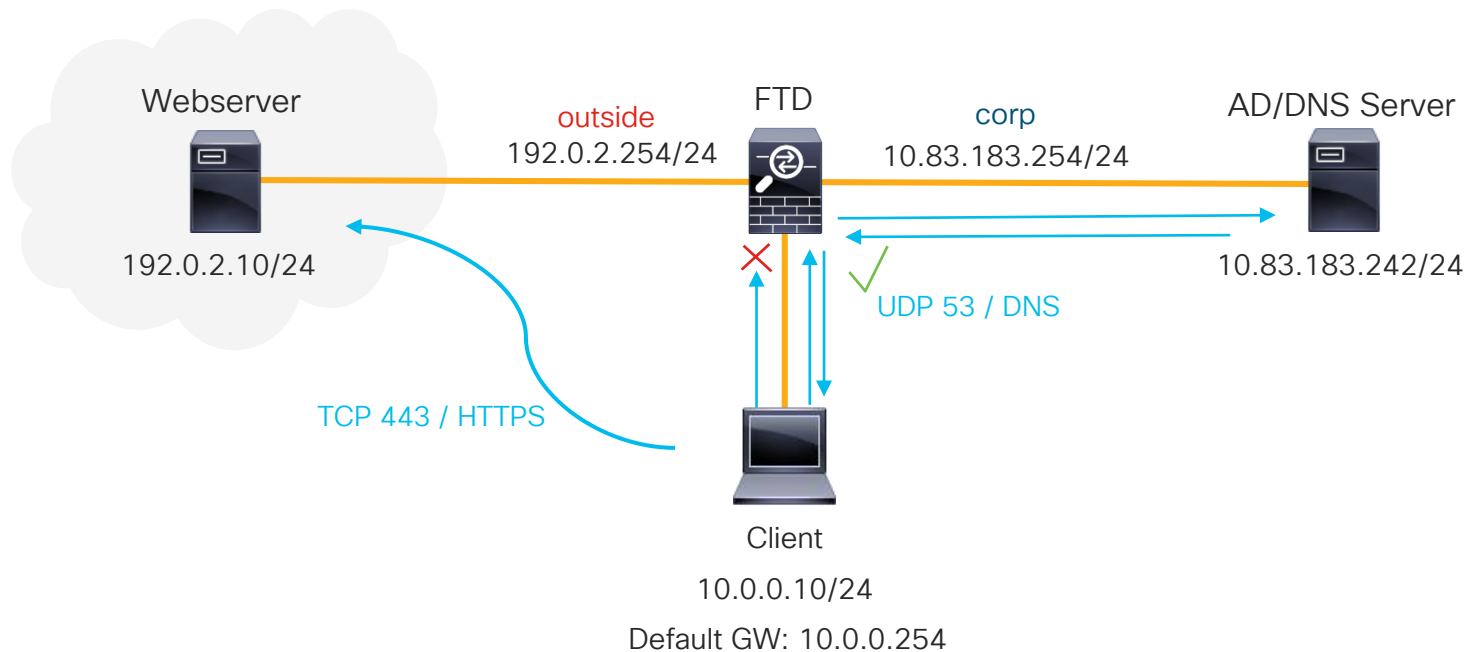


LINA ASA Engine = BLUE

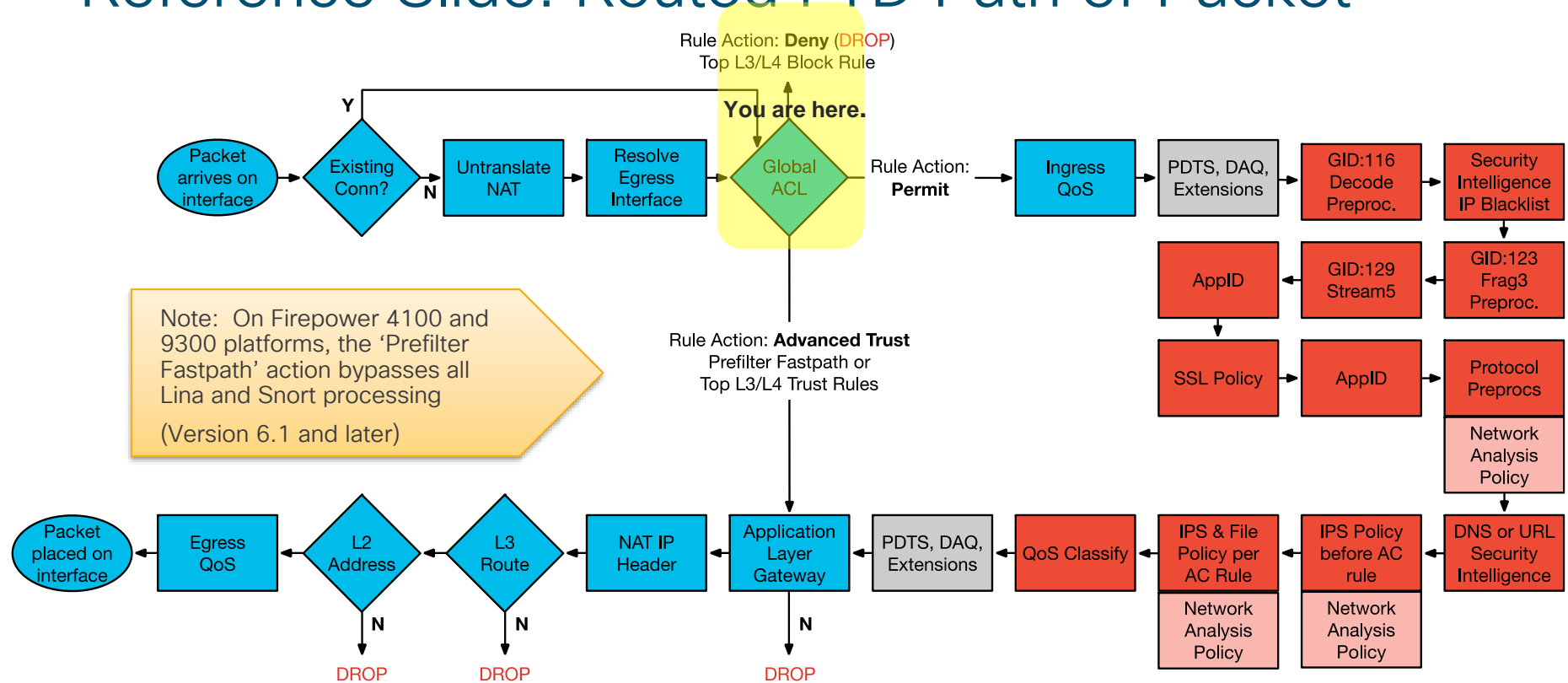
Snort Engine = RED

Stage 3: Packet dropped by FTD (ACL Block)

- A pre-filter rule was configured to block all traffic from the Client to the Webserver



Reference Slide: Routed FTD Path of Packet

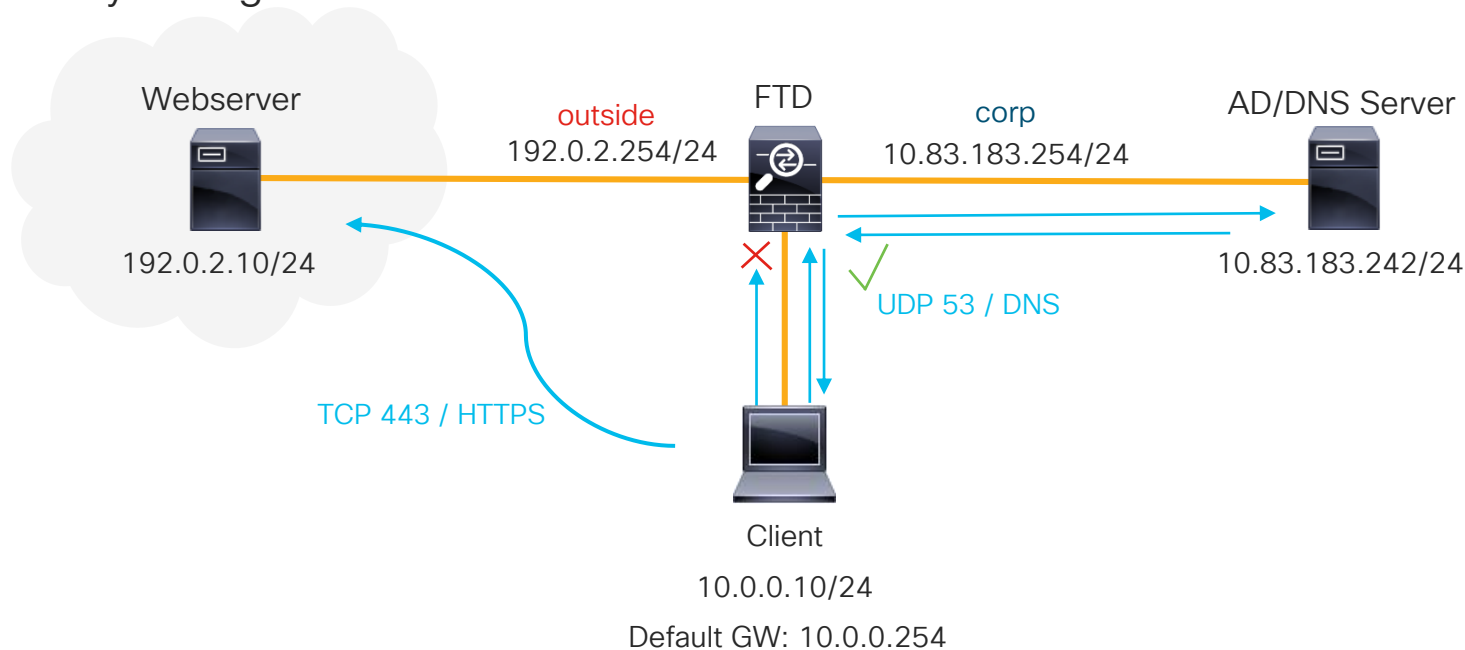


LINA ASA Engine = BLUE

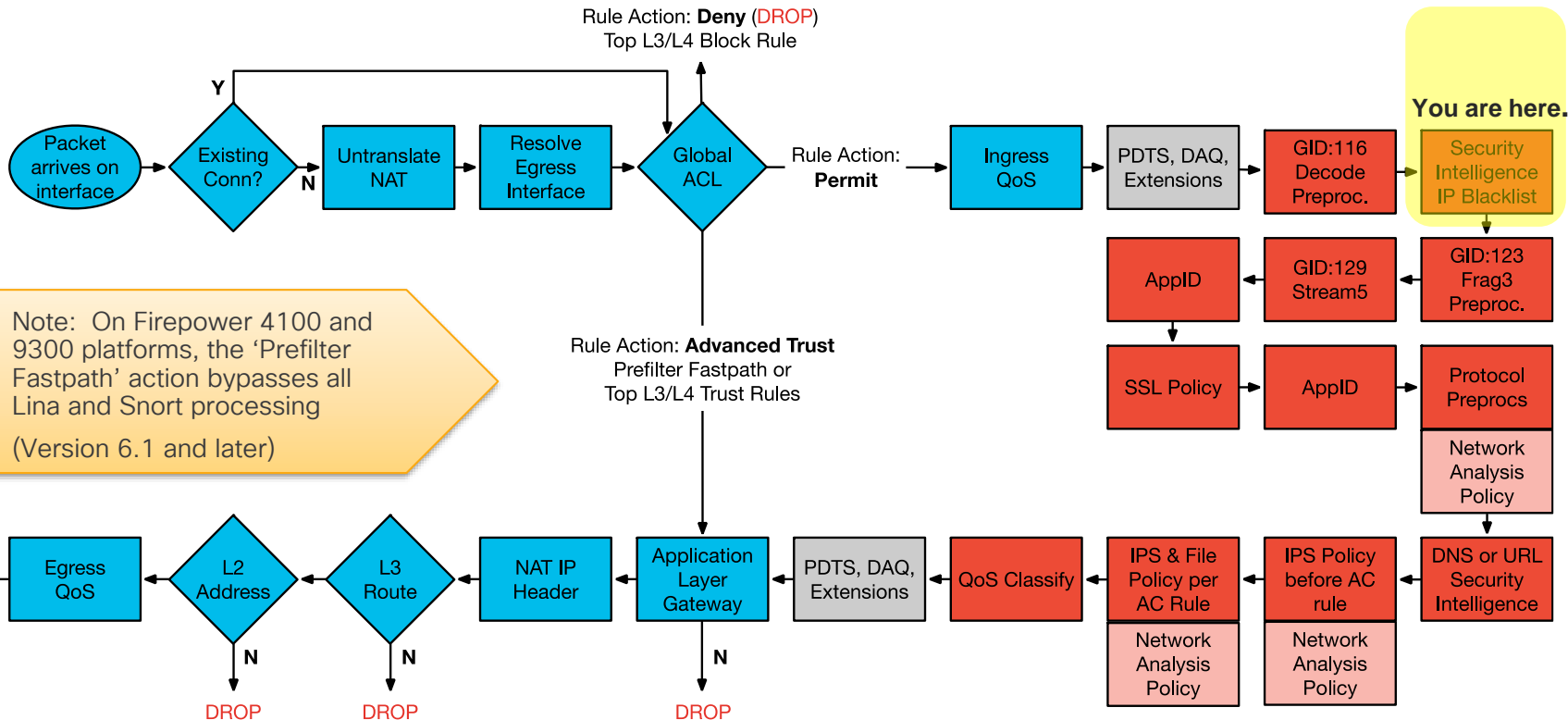
Snort Engine = RED

Stage 4: Packet dropped by Snort (SI Block)

- The Webservers IP address (192.0.2.10) was included in the custom blacklist for security intelligence



Reference Slide: Routed FTD Path of Packet

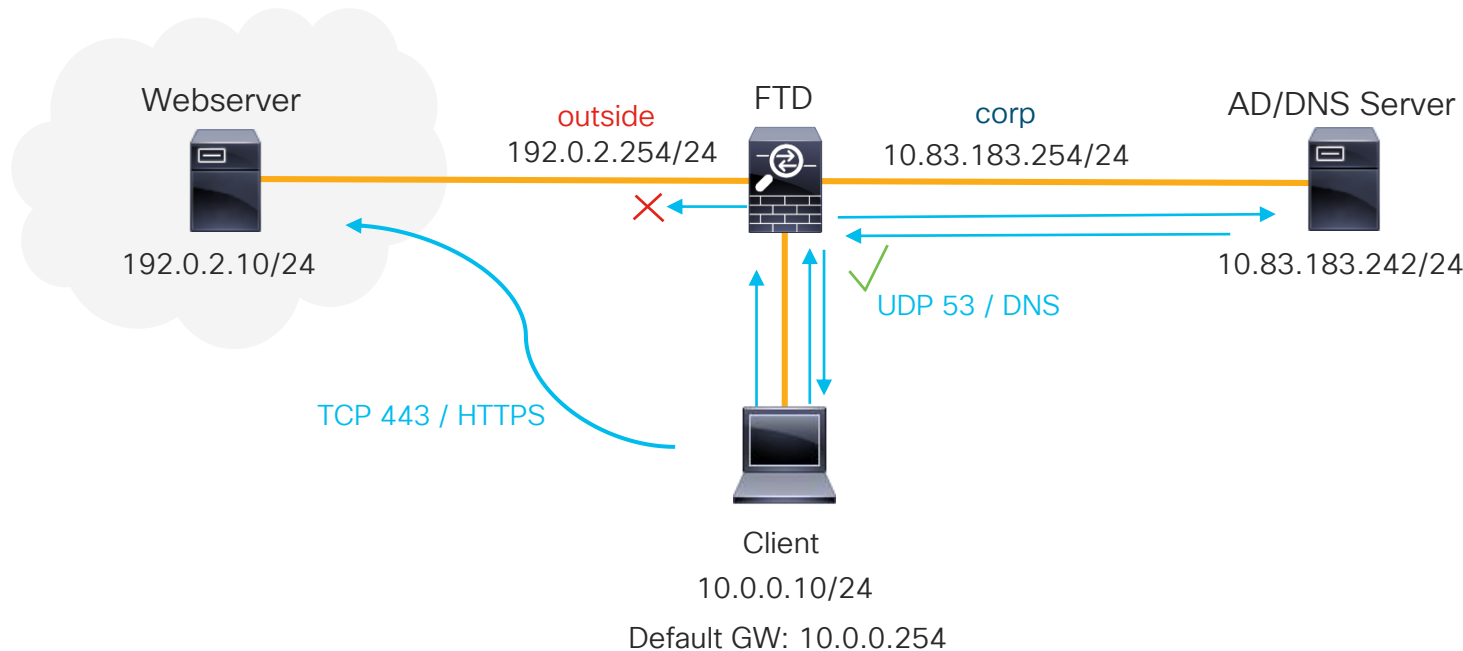


LINA ASA Engine = BLUE

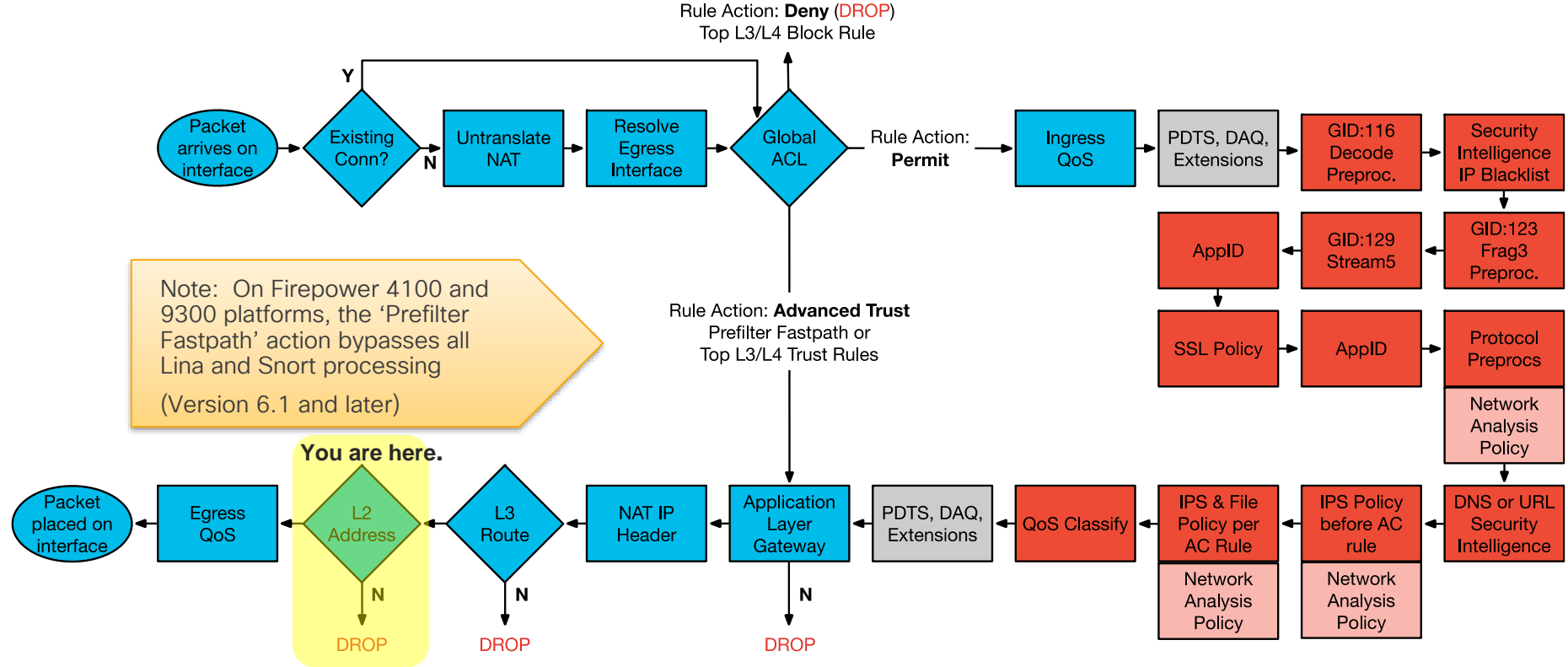
Snort Engine = RED

Stage 5: Packet doesn't egress (No next hop ARP)

- FTD has a static route for 192.0.2.10 with a next hop that does not exist. This results in an L2 Adjacency failure and the packet does not egress on the outside



Reference Slide: Routed FTD Path of Packet

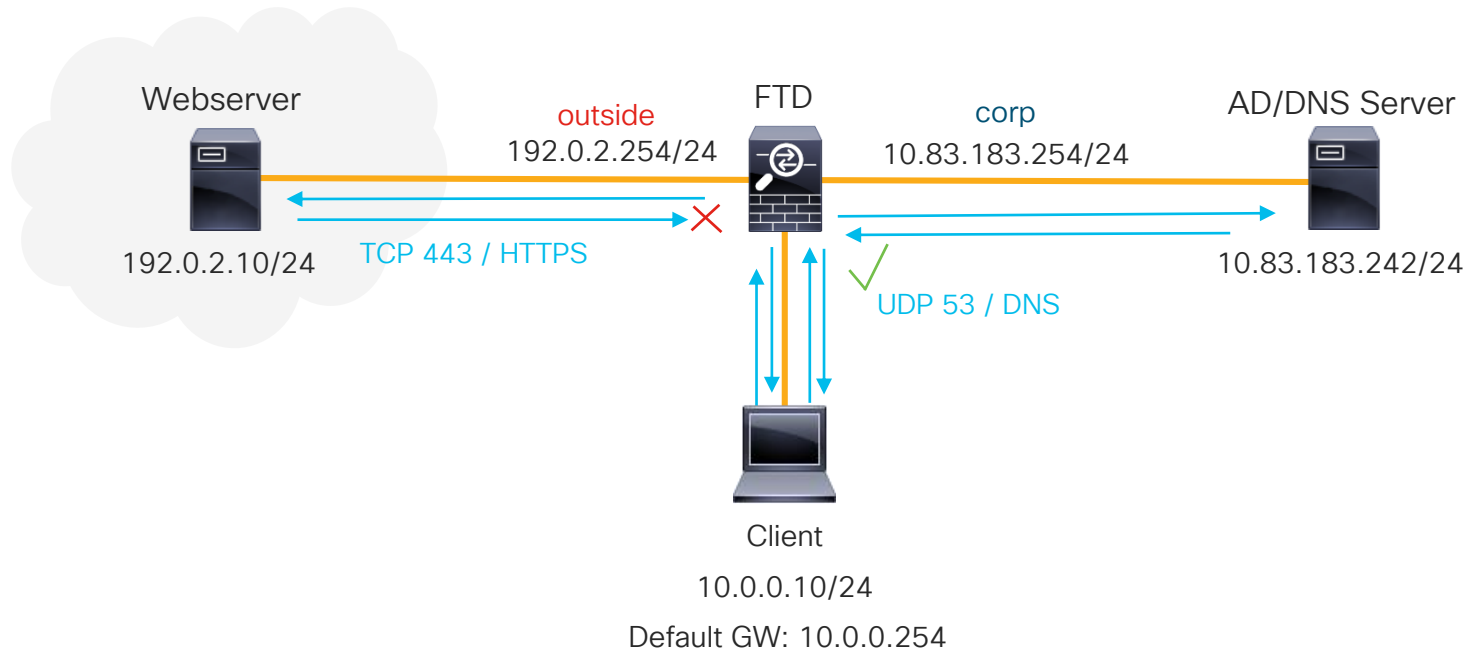


LINA ASA Engine = BLUE

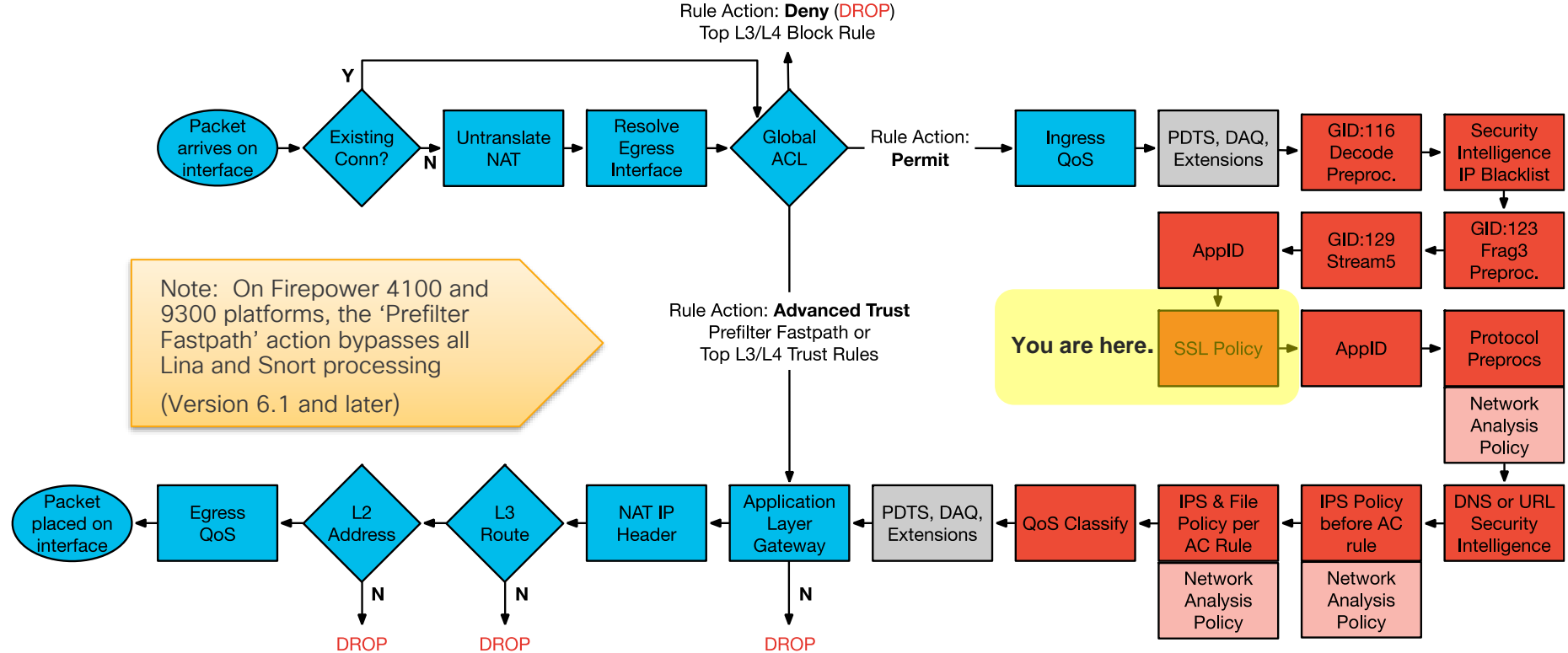
Snort Engine = RED

Stage 6: TLS connection reset (SSL Block)

- TLS connection to Webserver fails because of a “Block w/ reset” rule in the SSL Policy set to match on the CN of the servers certificate

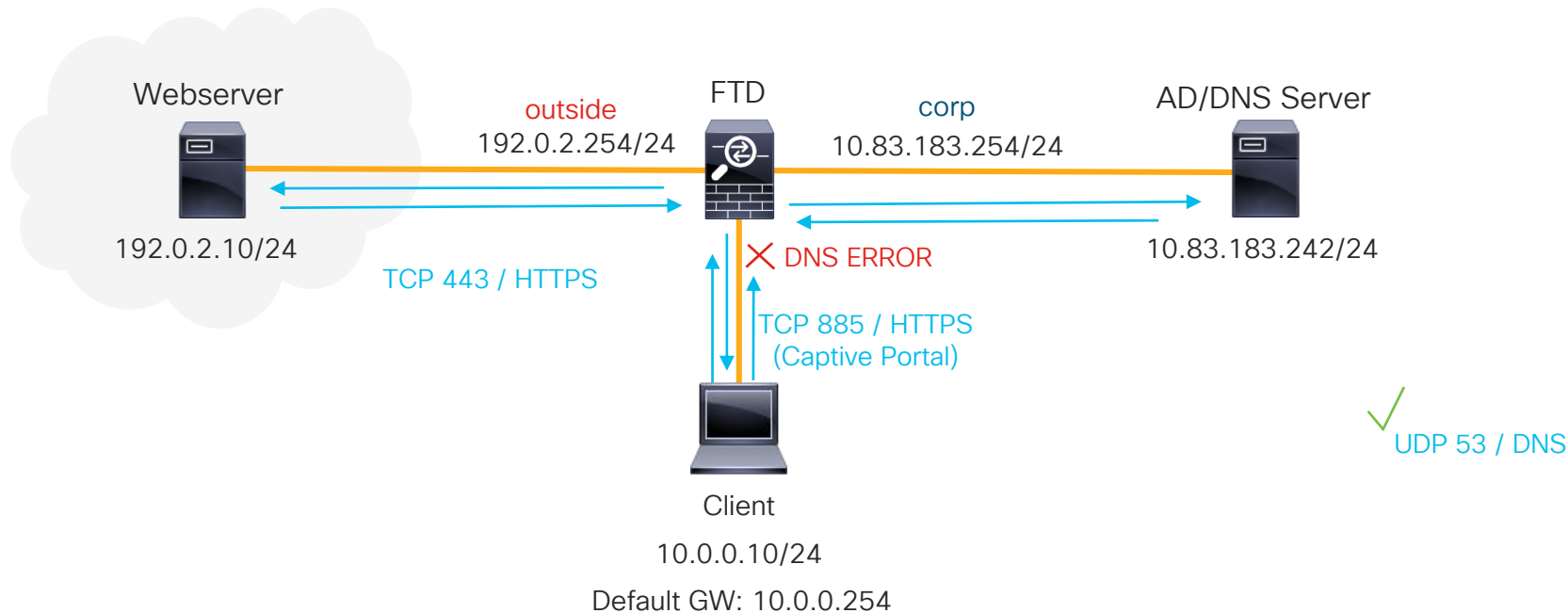


Reference Slide: Routed FTD Path of Packet

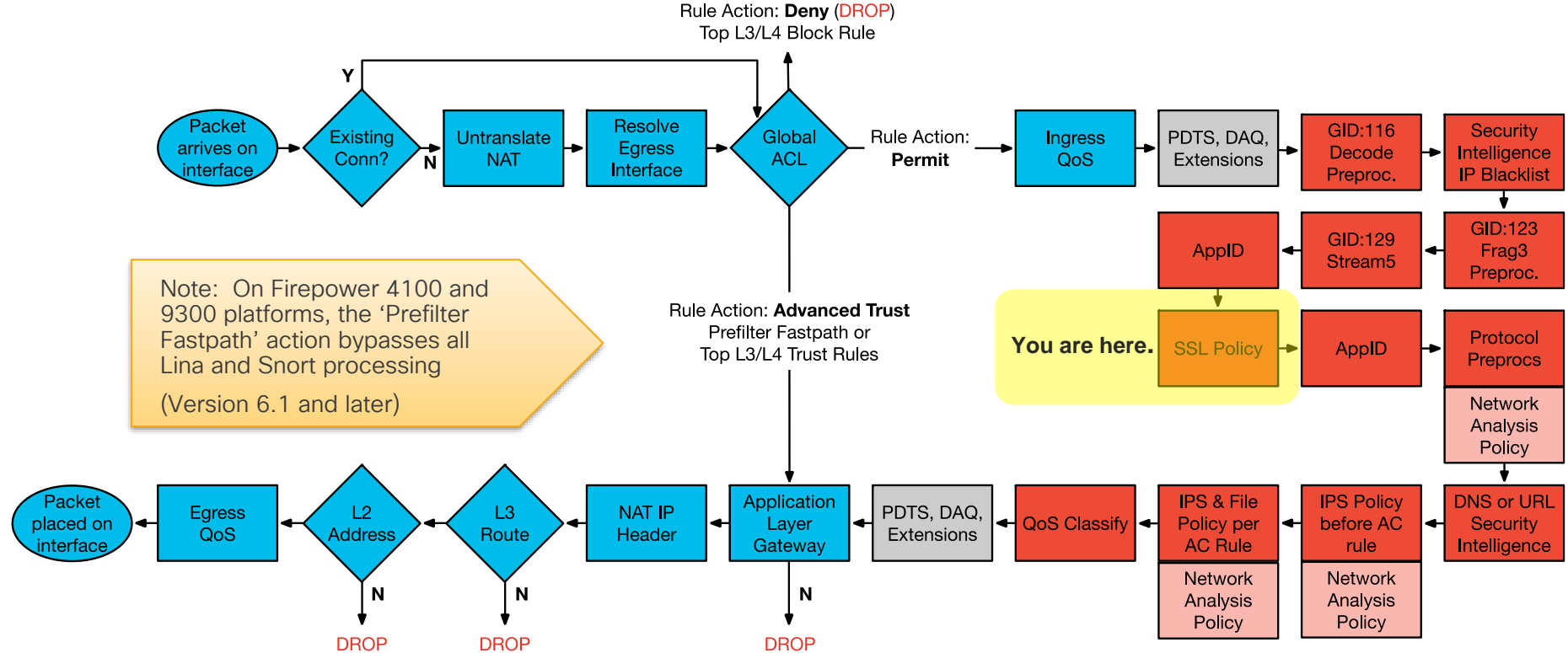


Stage 7: Captive Portal redirect (DNS failure)

- Captive portal intercepts the connection and redirects the user to its hostname. This redirect fails on name resolution because there is no A-record in the DNS server for this host



Reference Slide: Routed FTD Path of Packet

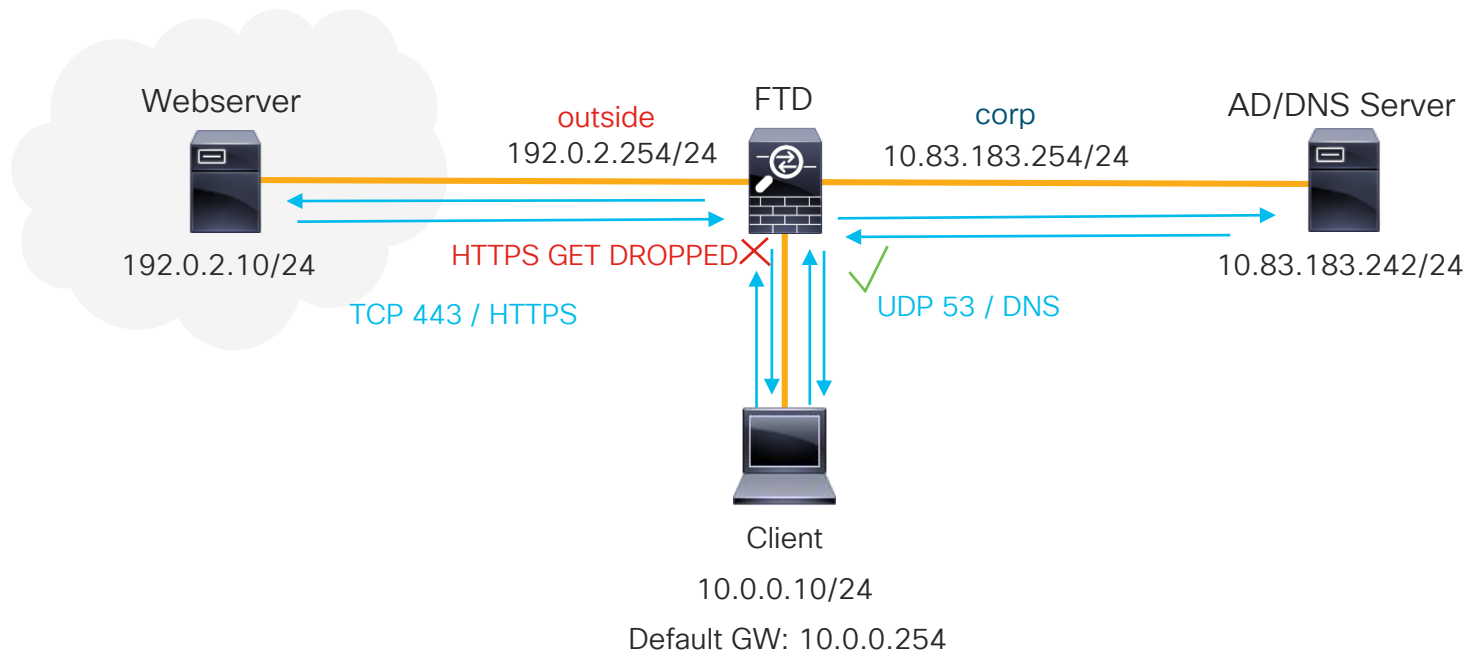


LINA ASA Engine = BLUE

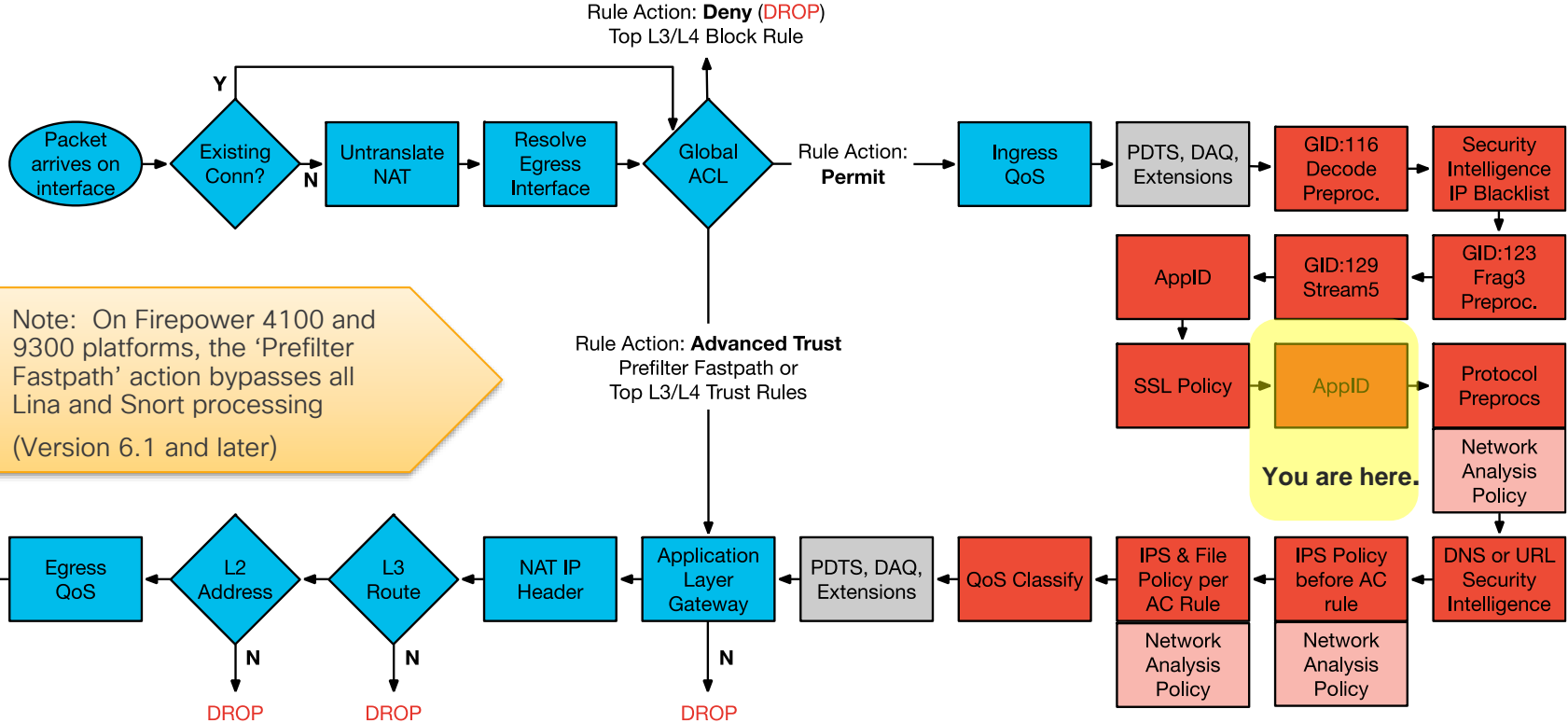
Snort Engine = RED

Stage 8: HTTP GET is dropped (AppID Block Rule)

- Use 'system support trace' w/ firewall-engine-debug enabled



Reference Slide: Routed FTD Path of Packet

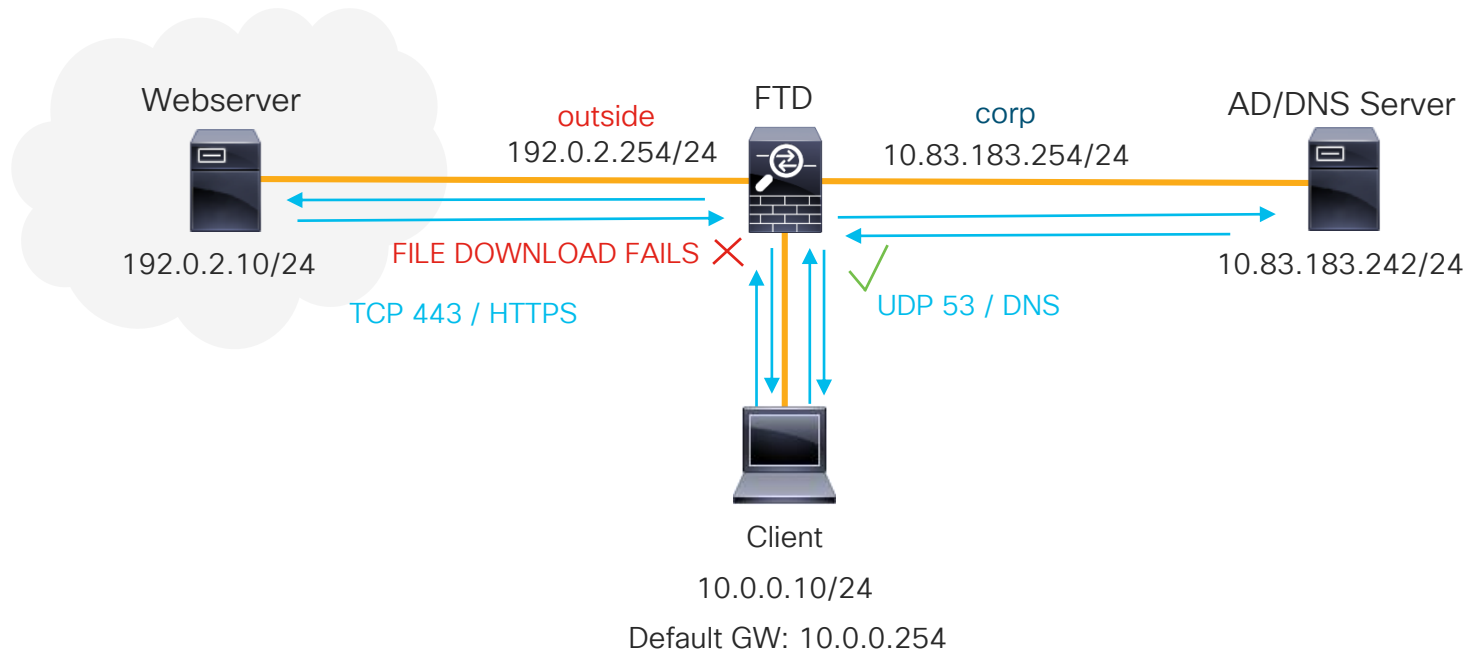


LINA ASA Engine = BLUE

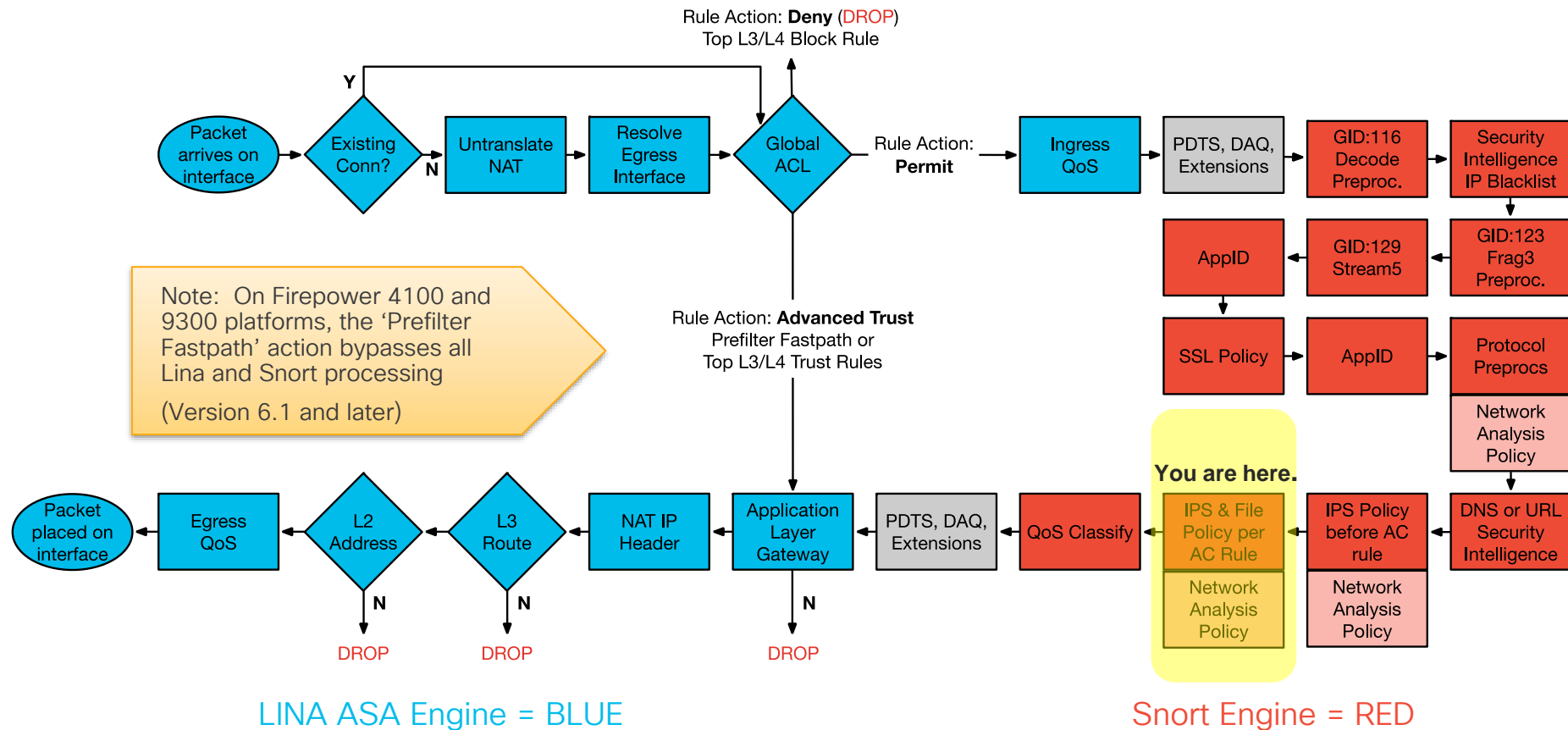
Snort Engine = RED

Stage 9: File Download blocked (Snort rule)

- A local rule was enabled in the Intrusion Policy to “Drop and Generate events” that matched the URI of the download request for “my_important_doc.pdf”



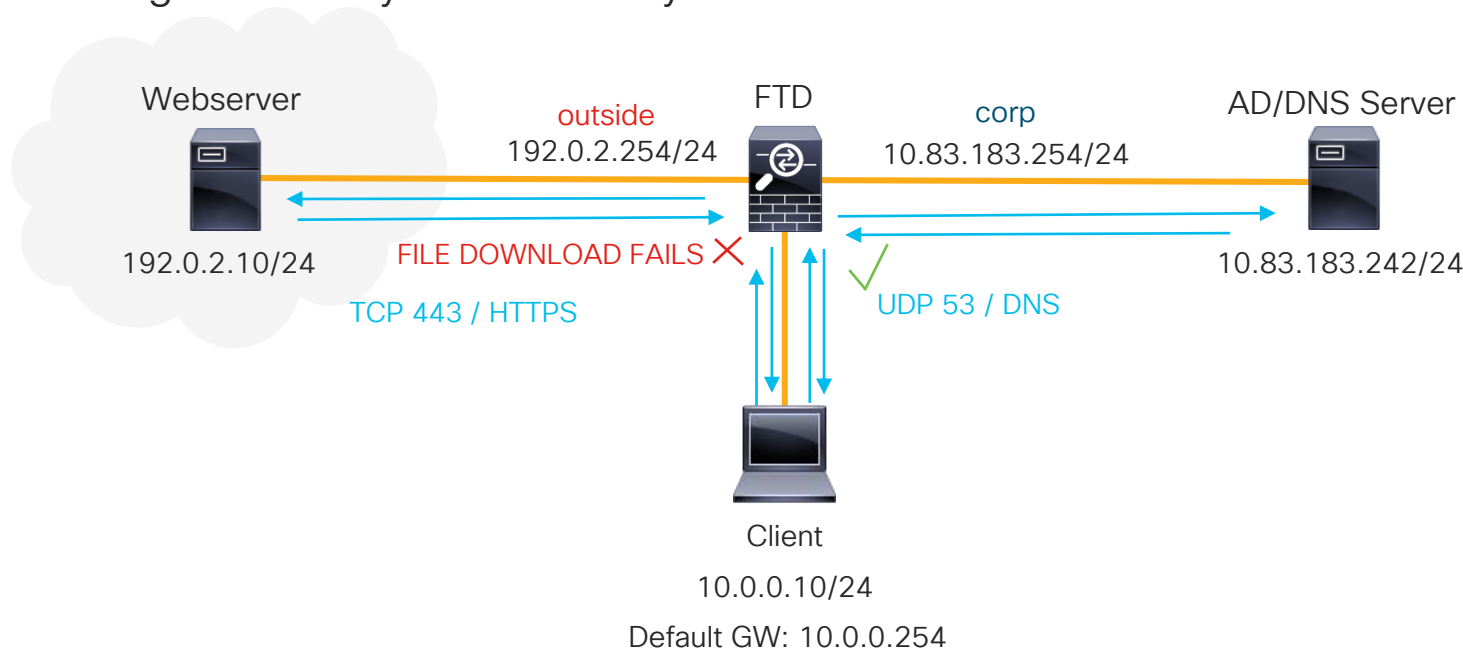
Reference Slide: Routed FTD Path of Packet



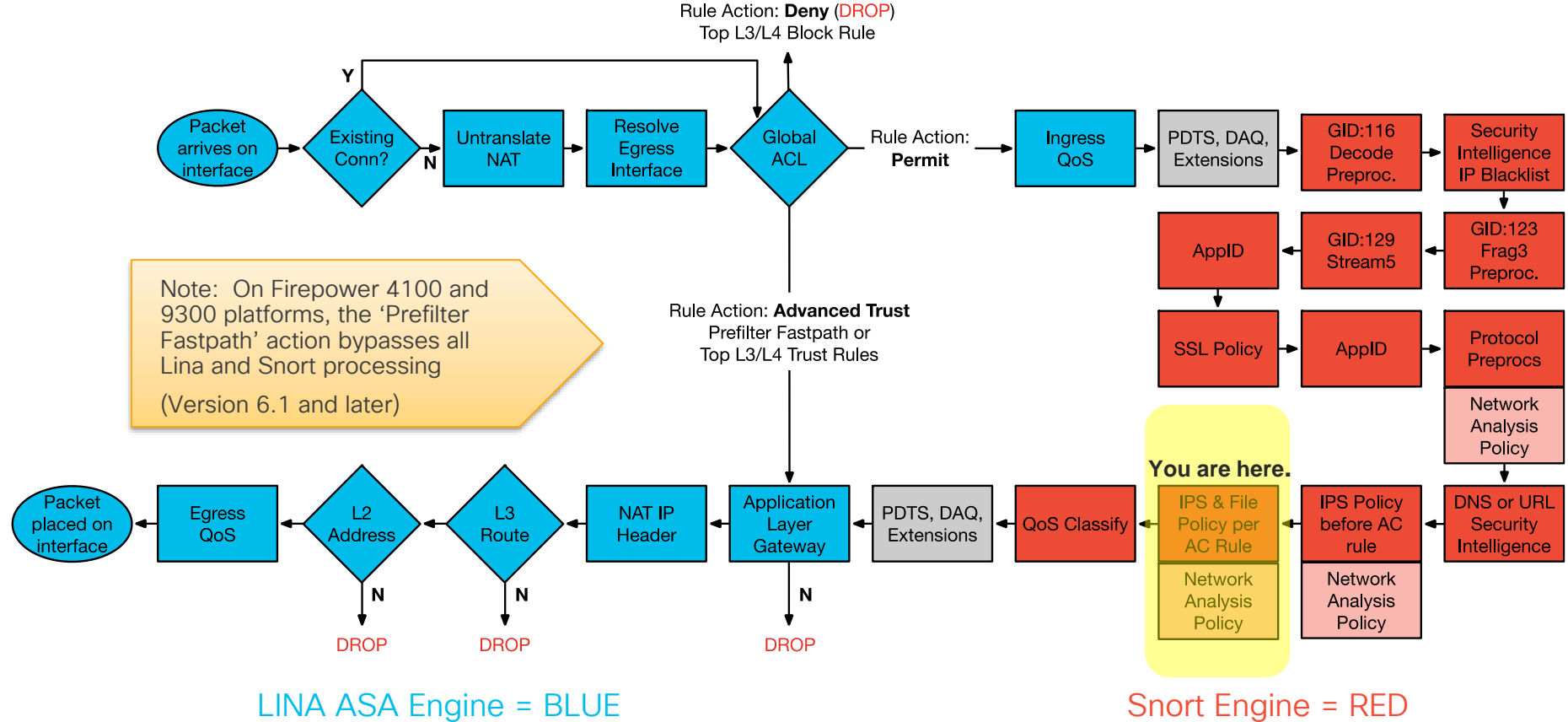
Stage 10

Stage 10: File Download blocked (File Policy)

- The hash of "my_important_doc.pdf" was present in the custom detection file list and was being blocked by the File Policy



Reference Slide: Routed FTD Path of Packet



Questions & Answers

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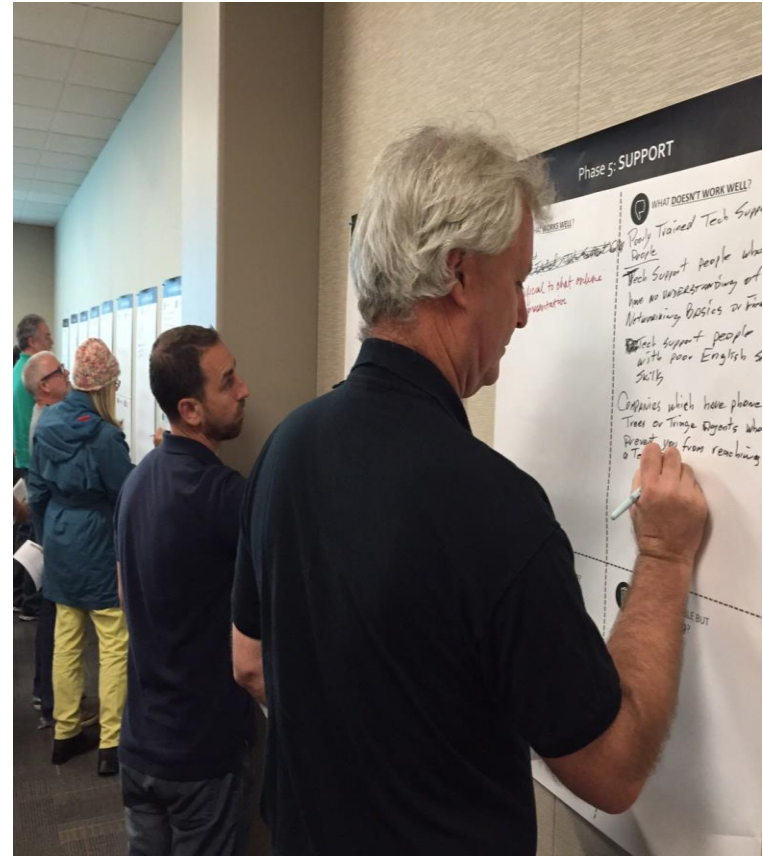


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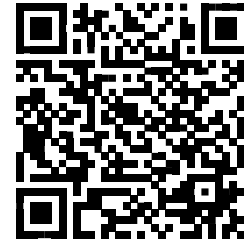


1



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Wrapping it up

- Apply new skills to your daily FTD troubleshooting.
- Check out the additional resources and slides for future reference purposes.
- Although FTD is complex, you should now have a better understanding of the product architecture, traffic flow, and troubleshooting tools that are available to help you quickly resolve issues.
- If you leverage those newfound skills and resources, before you know it you'll be troubleshooting FTD like a TAC engineer!

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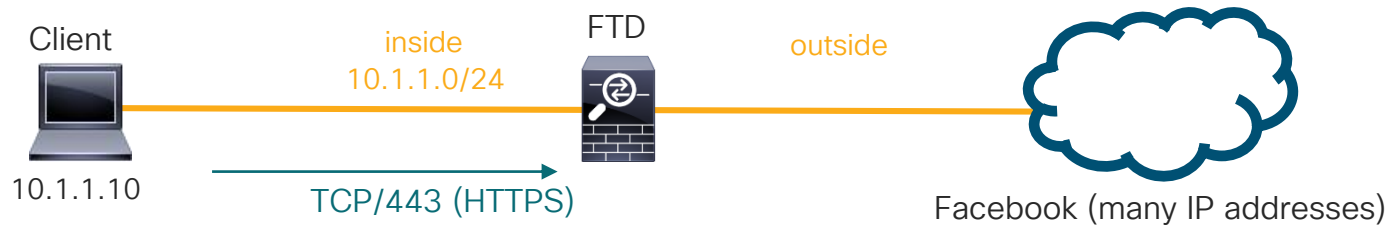


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Appendix

Troubleshooting Walkthroughs

Scenario 1: Facebook is not blocked as expected and CNN is unexpectedly being blocked



The customer on 10.1.1.10 is able to access Facebook.com, whereas this client should be blocked from all Social Networking sites.















The customer's Access Control Policy is many pages long!

Let's troubleshoot this using a systematic approach to FTD troubleshooting

Using our FTD troubleshooting tools

Remember: Always check events and syslogs! FMC: Analysis ➡ Connections ➡ Events

No connection events for 10.1.1.10 navigating to Facebook. We must not be logging the rule which allows it.

<input type="checkbox"/> NetBIOS <input type="checkbox"/> SMTP											
7	Block Auction URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Auctions (Any Re Any  Block
8	Block Games URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Games (Any Repi Any  Block
9	Block Hacking URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Hacking (Any Re Any  Block
10	Block Job Search URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Job Search (Any Any  Block
11	Block Malware URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Malware Sites (A Any  Block
12	Block Parked Domains URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Parked Domains Any  Block
13	Block Social Networking URL	Any	Any	Any	Any	Any	Any	Any	Any	Any	 Social Network (Any  Block

The rule we expect traffic to hit

Firewall engine debug

At this point, we suspect there is a problem with rule evaluation.

Firewall Engine Debug is the right tool to identify what is happening within the Access Control Policy

```
> system support firewall-engine-debug
```

```
Please specify an IP protocol: tcp
```

```
Please specify a client IP address: 192.168.1.10
```

```
Please specify a client port:
```

```
Please specify a server IP address:
```

```
Please specify a server port: 443
```

```
Monitoring firewall engine debug messages
```

```
192.168.1.10-49986 > 31.13.69.228-443 6 AS 1 I 1 New session
```

```
192.168.1.10-49986 > 31.13.69.228-443 6 AS 1 I 1 Starting with minimum 2, 'Allow Facebook', and SrcZone  
first with zones 4 -> 3, geo 0(0) -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 1122,  
payload 629, client 1296, misc 0, user 9999997, url facebook.com, xff
```

```
192.168.1.10-49986 > 31.13.69.228-443 6 AS 1 I 1 match rule order 2, 'Allow Facebook', action Allow
```

```
192.168.1.10-49986 > 31.13.69.228-443 6 AS 1 I 1 allow action
```

Whoops... we must have forgotten about an earlier rule.

Revisiting the Access Control Policy

Rule 2 (Allow application Facebook) is not logging, so connection events are not generated

Index	Rule Name	Category	Source	Destination	Port	Protocol	Action	Enabled	Priority	Icon
1	Trust Backup Servers	Any	Any	Any	10	10	Any	Any	Any	Any
2	Allow Facebook	Any	Any	Any	Any	Any	Facebook	Any	Any	Any
3	Block Example.com	Any	Any	Any	Any	Any	example.com	Any	Any	Any
4	Block Gambling Sites	Any	Any	Any	Any	Any	Gambling (Any R)	Any	Any	Any
5	Safesearch test	Any	Any	Any	Any	Any	Any	Any	Any	Any
6	File Inspection	Any	Any	Any	Any	Any	Any	Any	Any	Any
7	Block Auction URL	Any	Any	Any	Any	Any	Any Re	Any	Any	Any
8	Block Games URL	Any	Any	Any	Any	Any	Games (Any Rep)	Any	Any	Any

Cut
Copy
Paste Above
Paste Below
Edit...
Delete

State ▶

Disable
Enable

Key Takeaway: Firewall Engine Debug shows rule evaluation, even if logging is not enabled

Check Application Categories and Tags

Connection
Events



▼ First Packet ×	Last Packet ×	Action ×	Initiator IP ×	Responder IP ×	Source Port / ICMP Type ×	Destination Port / ICMP Code ×	Application Protocol ×	Web Application ×	Application Risk ×	Business Relevance ×	URL ×
2017-05-19 16:02:29		Block	192.168.62.63	151.101.65.67	54308 / tcp	80 (http) / tcp	HTTP	CNN.com	Medium	Medium	http://cnn.com/

CNN.com

Turner Broadcasting System's news website.

Type Web Application

Risk Very Low

Business Relevance High

Categories **multimedia (TV/video)**, news

Tags displays ads



Context Explorer



Wikipedia



Google



Yahoo!



Bing

Check Application Categories and Tags

firewall-engine-
debug



```
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 New session
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 Starting with minimum 4, 'block by category', and SrcZone
first with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0,
client 0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 pending rule order 4, 'block by category', AppID
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 Starting with minimum 4, 'block by category', and SrcZone
first with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0,
client 0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 pending rule order 4, 'block by category', AppID
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 Starting with minimum 4, 'block by category', and SrcZone
first with zones 1 -> 2, geo 0 -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 0, payload 0,
client 0, misc 0, user 9999997, icmpType 0, icmpCode 0
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 pending rule order 4, 'block by category', AppID
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 URL SI: ShmDBLookupURL("http://cnn.com/") returned 0
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 Starting with minimum 4, 'block by category', and SrcZone
first with zones 1 -> 2, geo 0(0) -> 0, vlan 0, inline sgt tag: untagged, ISE sgt id: 0, svc 676, payload
1190, client 638, misc 0, user 9999997, url http://cnn.com/, xff
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 match rule order 4, 'block by category', action Block
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 sending block response of 605 bytes
192.168.62.63-54308 > 151.101.65.67-80 6 AS 1 I 0 Deleting session
```

Scenario 2: Network traffic failure through FTD

The customer states that FTD is causing network performance problems after a weekend migration from another vendor firewall

What we know:

1. The problem began right around the time users started arriving to the office.
2. Users are unable to open web sites.
3. The engineer is unable to join a WebEx.
4. The engineer states that Snort is “stuck at 100% utilization”

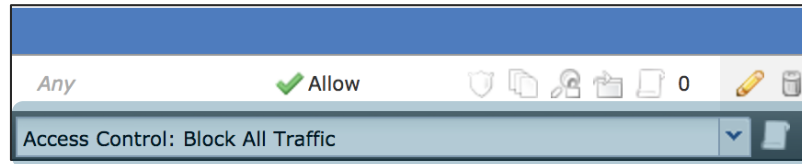
So, what does a “systemic approach to FTD troubleshooting” look like in this scenario?

Network traffic failure through FTD

Step 1: Given the impact and since we have no access to troubleshoot directly, we enable a Prefilter policy for all traffic to temporarily stop sending traffic to Snort.

This alleviates the problem and the engineer is able to join a WebEx.
Since a Prefilter policy improved the situation, we suspect a Snort oversubscription or policy issue.

Step 2: Visually review policy to determine what rule traffic would match



Customer had a “Block All” rule that was unintentional

What troubleshooting tool would have shown this without a visual inspection?

Network traffic failure through FTD

Minutes later, intermittent connectivity issues continue. Engineer's PC loses connectivity to Exchange.

```
capture capin type raw-data buffer 33000000 trace interface Inside  
[Capturing - 25500768 bytes] match tcp host 10.0.10.1 any eq https
```

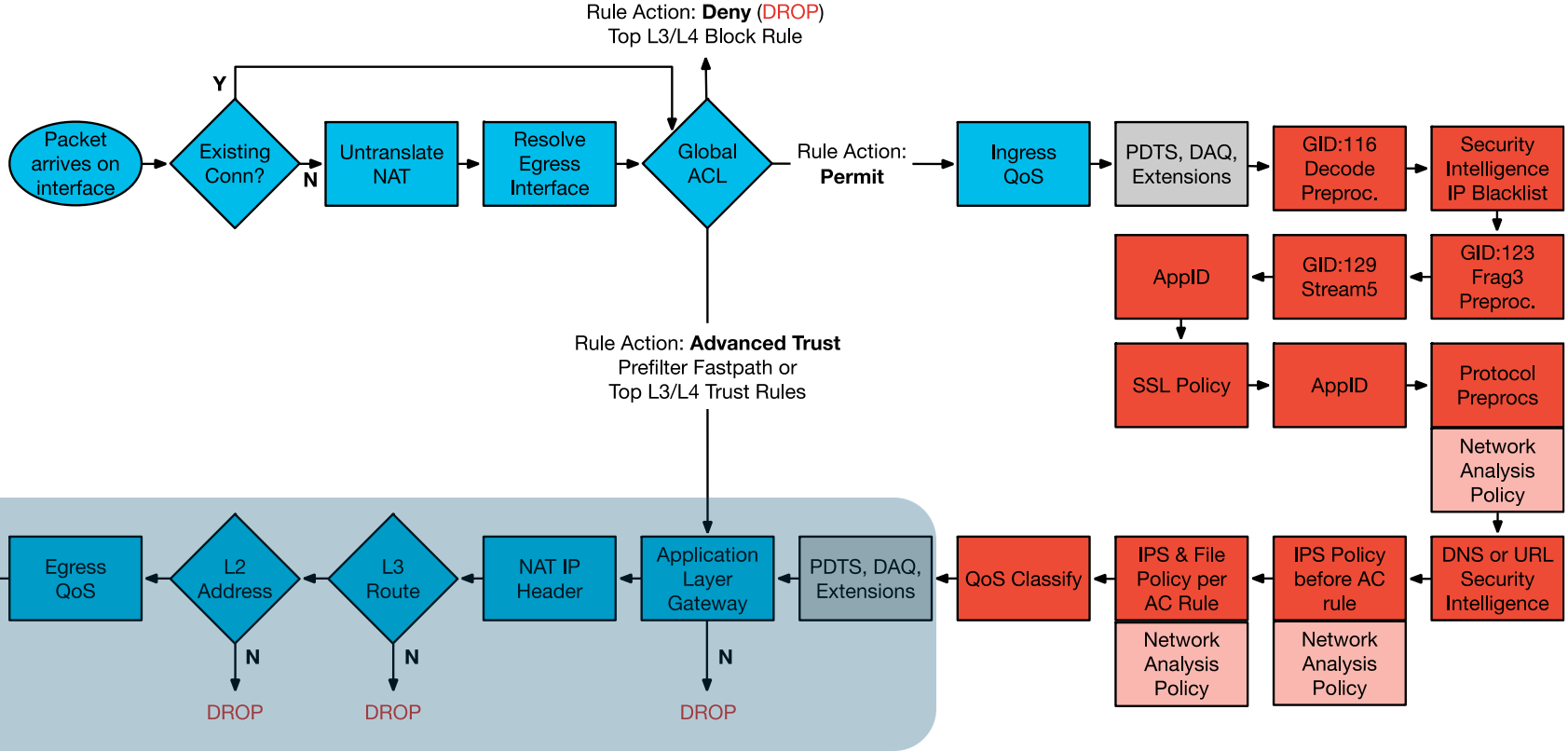
Enable capture for failing flow

```
firepower# sh cap capin | i S  
3: 13:23:11.905669 10.0.10.1.5377 > 192.0.2.194.443: S 2773524504:2773524504(0) win 8192  
19: 13:23:12.514499 10.0.10.1.5386 > 192.0.2.18.443: S 1117279318:1117279318(0) win 8192  
30: 13:23:12.797398 10.0.10.1.5379 > 192.0.2.98.443: S 3103152246:3103152246(0) win 8192  
32: 13:23:13.123650 10.0.10.1.5389 > 192.0.2.194.443: S 3496291677:3496291677(0) win 8192  
34: 13:23:13.163733 10.0.10.1.5387 > 192.0.2.194.443: S 3669311460:3669311460(0) win 8192  
43: 13:23:13.306411 10.0.10.1.5381 > 192.0.2.194.443: S 1115384746:1115384746(0) win 8192  
44: 13:23:13.446372 10.0.10.1.5390 > 192.0.2.194.443: S 3466698234:3466698234(0) win 8192
```

Identify instance of TCP connection attempt (SYN)

Based on what we learned today, what should we check next?

Reference Slide: Routed FTD Path of Packet



LINA ASA Engine = BLUE

Snort Engine =

Network traffic failure through FTD

Packet tracer output for affected traffic:

```
firepower# show capture capin trace pack 19
56752 packets captured

  19: 13:23:12.514499      10.0.10.1.5386 > 192.0.2.18.443: S 1117279318:1117279318(0) win
8192 Phase: 1
Type: CAPTURE
Subtype:
Result: ALLOW
Config:
Additional Information:
MAC Access list
...
Result:
input-interface: Inside
input-status: up
input-line-status: up
output-interface: Outside
output-status: up
output-line-status: up
Action: drop
Drop-reason: (nat-xlate-failed) NAT failed
```

Here we see that we have a NAT problem that is unrelated to Snort policy.

Network traffic failure through FTD

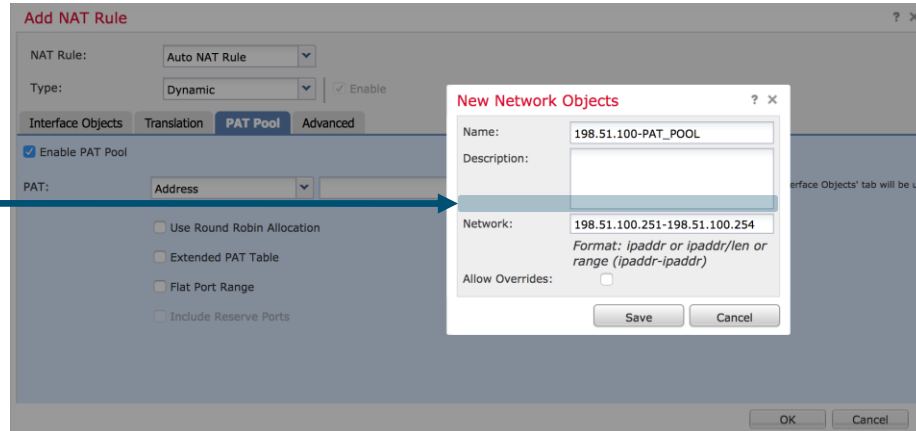
Check NAT pool allocations:

```
firepower# show nat pool
TCP PAT pool Outside, address 198.51.100.251, range 1-511, allocated 0
TCP PAT pool Outside, address 198.51.100.251, range 512-1023, allocated 0
TCP PAT pool Outside, address 198.51.100.251, range 1024-65535, allocated 64512
UDP PAT pool Outside, address 198.51.100.251, range 1-511, allocated 2
UDP PAT pool Outside, address 198.51.100.251, range 512-1023, allocated 0
UDP PAT pool Outside, address 198.51.100.251, range 1024-65535, allocated 23
firepower#
```

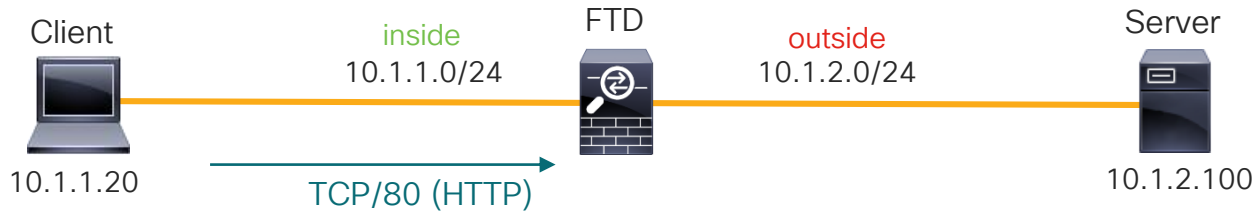
PAT pool port exhaustion

Solution:

Add more IP addresses to
PAT pool



Scenario 3: Clients cannot reach server



The customer states that clients traversing FTD are **not** able to access an internal web server. However, other clients on the server subnet (10.1.2.0/24) **are** able to access the server.

Let's troubleshoot this using a systematic approach to FTD troubleshooting

Using our FTD troubleshooting tools

Remember: Always check events and syslogs! FMC: Analysis ➡ Connections ➡ Events

No events found! (Always make sure you're logging the rule that you expect to be hitting!)

Fortunately, we did enable Lina syslogs to an external server. Here's what we found:

```
%ASA-6-302013: Built inbound TCP connection 46927 for inside:10.1.1.20/2286 (10.1.1.20/2286) to outside:10.1.2.100/80 (10.1.2.100/80)
%ASA-6-302014: Teardown TCP connection 46927 for inside:10.1.1.20/2286 to outside:10.1.2.100/80 duration 0:00:30 bytes 0 SYN Timeout
```

So, now we know that we are receiving the packet but either the server is not responding or FTD is not forwarding it. Let's dig deeper. Maybe snort is dropping it...

```
> system support firewall-engine-debug

Please specify an IP protocol: tcp
Please specify a client IP address: 10.1.1.20
...
10.1.1.20-2286 > 10.1.2.100-80 6 AS 1 I 16 New session
10.1.1.20-2286 > 10.1.2.100-80 6 AS 1 I 16 using HW or preset rule
order 5, 'Allow_Inside_to_Outside', action Allow and prefilter rule 0
10.1.1.20-2286 > 10.1.2.100-80 6 AS 1 I 16 allow action
```

It looks like
Snort allows it.
So what next?

Packet Captures – The single source of truth

What do we know at this point?

FTD **is** receiving the packet. We **are** building the TCP connection for the flow. Snort is **NOT** dropping the packet.

The next step here is to determine if FTD is actually **forwarding** the packet.
Let's use our awesome packet capture tools for this.

Verify ingress captures so we can line them up with egress captures:

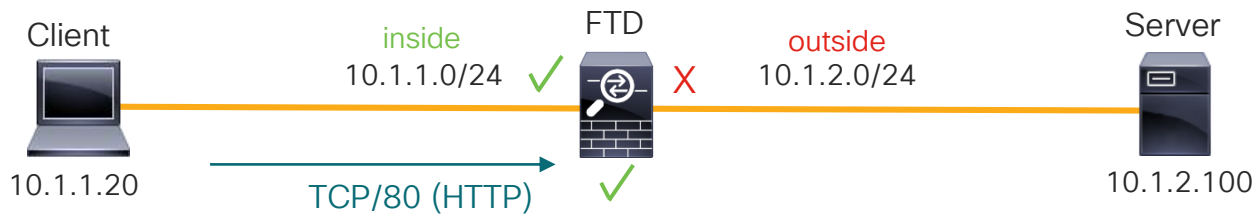
```
firepower# show capture
capture capin type raw-data trace interface inside [Buffer Full - 524216 bytes]
  match tcp host 10.1.1.20 host 10.1.2.100 eq www
firepower# sho cap capin | i 2286
322: 13:04:56.926786      802.1Q vlan#36 P0 10.1.1.20.2286 > 10.1.2.100.80: S
1336706021:1336706021(0) win 512
firepower#
```

```
capture capout type raw-data interface outside
[Capturing - 0 bytes]
match tcp any host 10.1.2.100 eq www
```

Houston...we have a
problem.

No packets going to the
destination server?

Visual troubleshooting recap



- Packet **is** received
- Lina **is** building connection
- Snort is **not** dropping
- However, FTD is **not forwarding**

Let's review! What are possible reasons that FTD may drop traffic without a Lina syslog or snort verdict indicating a drop?

Checking Lina inspection and L2 adjacency

Remember, we can use packet capture with the 'trace' command to see policy decisions.

```
firepower# show cap capin trace packet-number 1

7084 packets captured

  1: 13:04:12.548204      802.1Q vlan#36 P0 10.1.1.20.2286
> 10.1.2.100.80: S 1277167793:1277167793(0) win 512
...
Phase: 14
Type: ROUTE-LOOKUP
Subtype: Resolve Egress Interface
Result: ALLOW
Config:
Additional Information:
found next-hop 10.1.2.50 using egress ifc  outside
Result:
...
output-interface: outside
...
Action: allow
```

We can see that configured policies are not dropping the packet. However, it is strange that our next hop is **not** the directly-connected server.

Let's investigate this...

Next-hop ARP resolution?

```
firepower# sh arp | i 10.1.2.50
firepower#
```

Check for ARP entry. Does not exist.

Reason for packet drop:

```
firepower# debug arp
debug arp  enabled at level 1
arp-req: generating request for 10.1.2.50 at interface outside
arp-req: request for 10.1.2.50 still pending
```

We can see that ARP resolution is failing for this host. Therefore FTD cannot egress the packet.

Root cause:

```
firepower# show route
...
S      10.1.2.100 255.255.255.255 [1/0] via 10.1.2.50, outside
```

A static, more specific /32 route to the server via 10.1.2.50 is configured and that host is not responding to ARP.



You make **possible**