Man-in-the-Network:

Network Devices are Endpoints Too

Router> show whoami

ABOUT ME

!

10+ years in information security for government and military

- Threat Hunting and Incident Response
- Detection Engineering
- Engineering data pipelines for eventlog collection

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Austin Clark
Security Engineer

U.S. Army

Router> banner login

#

“The views expressed in this presentation are those of the author and do not reflect the official policy or position of the US Army, Department of Defense or the US Government.”

#

Router> show startup-config

```
Network Device Targeting
  Network Infrastructure
  Vulnerability
  Threat
!
MITRE ATT&CK
  Overview
  Techniques
!
Detections
  Logging
  Analytics
  Tuning
!
Mitigations
```

Router> show cdp neighbors

Network Devices

- Routers, Switches, VPN, Firewalls, Wireless LAN Controllers, Access Points
  - Any infrastructure device that provides that backbone network for connectivity
  - Not necessarily Linux based
  - Applicable to varying vendors

Yes they provide a service, but they are still endpoints that can be exploited by an adversary.

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How can we detect an adversary in a network device?

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We must assume that they will circumvent the protection measures we put in place and still engineer detections.

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Router> show version

Have you patched? **Cisco IOS has 521 CVEs**

Network devices are slowly patched, and the hardware is rarely upgraded. Some devices may no longer be vendor supported.

No Anti-Virus

Multi-Factor Authentication is not common

Have you changed default credentials?

Are the configurations hardened against internal devices? The gateway of a compromised workstation is a great pivot point.

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Have you disabled cisco smart install on all devices?

Smart install is one of the most common network device exploits out today; there are many writeups on how to exploit it, commonly referencing https://github.com/Sab0tag3d/SIET .

!

Router> show ip sockets

Advanced Persistent Threats are:

- Exploiting network device vulnerabilities
- Extracting device configurations
- Harvesting credentials
- Modifying configurations to redirect or block traffic
- Replacing the IOS firmware

!

SYNFul Knock, Dragonfly 2.0/Berserk Bear, Gekko Jackal

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https://www.fireeye.com/blog/threat-research/2015/09/synful_knock_-_acis.html

https://www.darkreading.com/endpoint/privacy/russian-apt-compromised-cisco-router-in-energy-sector-attacks/d/d-id/1331306

https://go.crowdstrike.com/rs/281-OBQ-266/images/15GlobalThreatReport.pdf

http://2015.zeronights.org/assets/files/05-Nosenko.pdf

Router> enable

https://attack.mitre.org/

!

“The adversary behavior model for Network Infrastructure Devices is being developed with routers, switches, and firewalls in mind…targeting an initial release of our research in the fall [2020]”

https://medium.com/mitre-attack/2020-attack-roadmap-4820d30b38ba

!

ATT&CK Enterprise matrix currently comprises Windows, macOS, & Linux

Working towards network infrastructure subset

!

75 current techniques can apply to networking devices

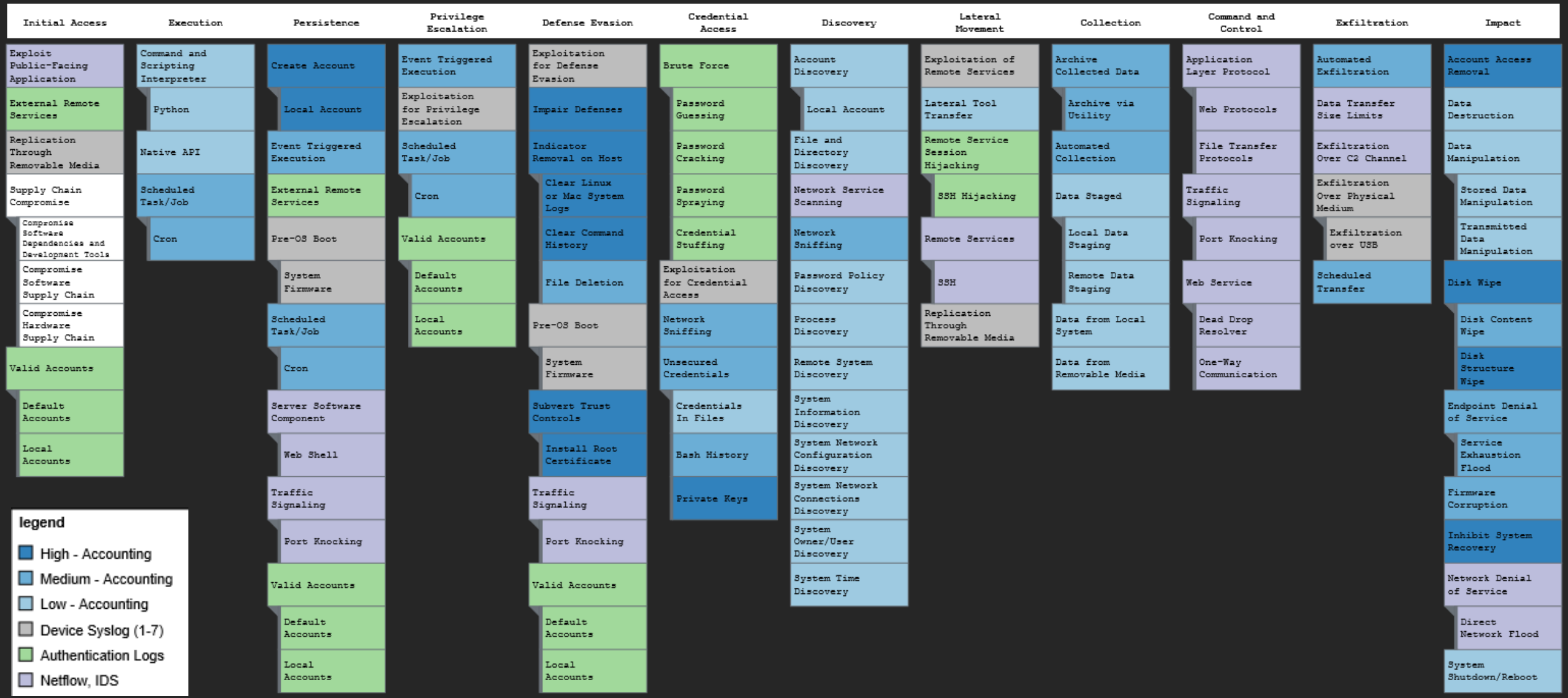
https://github.com/c2defense/network-device-logs/tree/master/mitre_attack

!

Router> show run MITRE | ATT&CK®

Label	Tactic	Technique	Sub-Technique	Data Sources	Example Commands	Comments
T1565.002	Impact	Data Manipulation	Transmitted Data Manipulation	Accounting	access-list * ip access-group *	An adversary might modify data in transit from other hosts, by modifying the configuration on a network device. They might change an ACL so the data doesn't get to it's intended destination, or change the QOS so the service delivery isn't what was originally intended. You'll want to whitelist the known authorized access list's in your baseline config.
T1074.001	Collection	Data Staged	Local Data Staging	Accounting	append * mkdir	Create or edit a file or directory locally
T1560.001	Collection	Archive Collected Data	Archive via Utility	Accounting	archive tar /create	Network devices support compressing and decompressing files to the file system.
T1490	Impact	Inhibit System Recovery		Accounting	archive maximum 1	As T1488 already covers deleting files off the filesystem, I take this technique as referring to deleting backup configurations. If the administrators are archiving locally and the adversary doesn't want to directly delete the files, they could change the maximum number of archive configurations that are kept. (A logic bomb could be done here).
T1551.003	Defense Evasion	Indicator Removal on Host	Clear Command History	Accounting	clear cli history clear archive *	A definite evasion technique, clearing the log is not often done by regular administrators and would be a good indicator of someone trying to hide.
T1551.002	Defense Evasion	Indicator Removal on Host	Clear Linux or Mac System Logs	Accounting	clear logging *	Adversaries may clear or alert the event logs to remove data indicating their presence on the system

Router# configure terminal



Router(config)# logging traps 6

Ensure logs are centralized

- Syslog can have errors from failed/successful exploitation
- Log local authentications
- Use archive to log commands locally without AAA

!

Authentication Authorization Accounting (AAA)

- Accounting logs contain command-line input
- Authentications are good for correlation

!

Example configuration:

```
archive
  log config
    logging enable
    logging size 500
    hidekeys
    notify syslog
logging enable
logging timestamp
logging host interface1 192.168.0.1 tcp/10514 format emblem
logging traps 6
```

http://itknowledgeexchange.techtarget.com/cisco/tracking-configuration-changes-with-the-cisco-ios-built-in-using-the-archive-command/

https://www.cisco.com/c/en/us/td/docs/solutions/Enterprise/Security/Baseline_Security/securebasebook/appendxA.html

https://tacacs.net/

Router(config)# monitor event-trace

Data Collection/Discovery

show *

monitor capture point

set rspan

!

95 suspicious commands can be mapped to a technique

!

11 Sigma Rules

!

Sigma by Florian Roth

https://github.com/Neo23x0/sigma/tree/master/rules/network/cisco/aaa

```
title: Cisco Sniffing
id: b9e1f193-d236-4451-aaae-2f3d2102120d
status: experimental
description: Show when a monitor or a span/rspan is setup or modified
references:
    - https://attack.mitre.org/techniques/T1040
author: Austin Clark
date: 2019/08/11
tags:
    - attack.credential_access
    - attack.discovery
    - attack.t1040
logsource:
    product: cisco
    service: aaa
    category: accounting
fields:
    - CmdSet
detection:
    keywords:
        - 'monitor capture point'
        - 'set span'
        - 'set rspan'
    condition: keywords
falsepositives:
    - Admins may setup new or modify old spans, or use a monitor for troubleshooting.
level: medium
```

Router(config)# monitor event-trace | include

Network Administrators can and do perform similar activities

- Frequency Analysis of commands

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Tune analytics for less false-positives

- Which admins have access to network devices?
- !
- Where are they remotely logging in from?
- !
- What times are the changes being made?
- !
- Is there an associated Change Control Board reference?
- !
- Is that change commonly implemented?

Router(config)# do show running config

Mitigations. Raise the bar – make the adversary work harder.

- Authorization to limit administrators' capabilities, not everyone needs Level 15, nor the ability to execute every command.
- Turn off unused and outdated services:
  - no ip http server
  - no ip http secure-server
- Disable Cisco Smart Install.

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Cisco Hardening Guide:

- https://www.cisco.com/c/en/us/support/docs/ip/access-lists/13608-21.html

Center for Internet Security Benchmarks:

- https://www.cisecurity.org/cis-benchmarks/

https://www.us-cert.gov/ncas/alerts/TA16-250A

https://cert.europa.eu/static/WhitePapers/CERT-EU_Security_Whitepaper_ND_17-004.pdf

Router(config)# exit

Network are endpoints too

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Collect Syslog and AAA logs

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Harden your devices, and write detections

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Give back to the Open Source Community

Router# end

Questions

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