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The bridge to possible

NetDevOps – Reducing the Attack Surface of IOS XE with Ansible

Tim Glen, Systems Architect

DEVNET-2111

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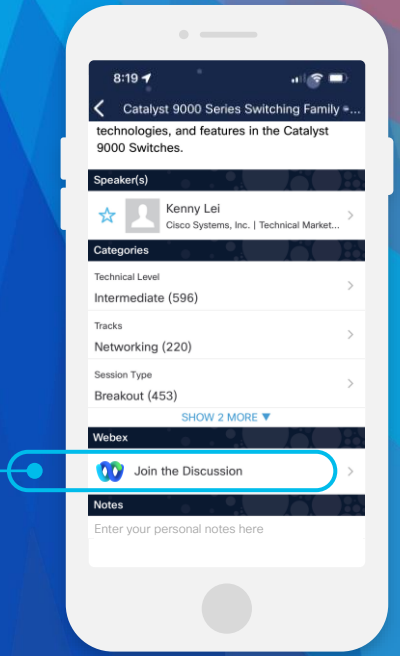

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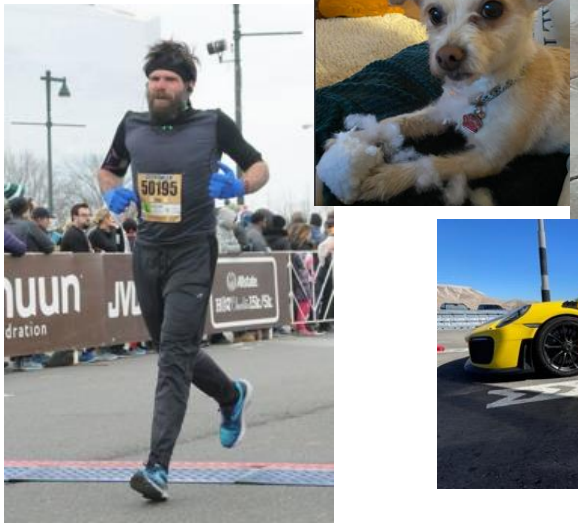
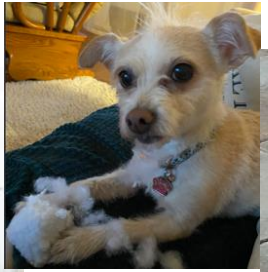
Tim Glen (Personal)

- Husband to Hillary
- Father to Jenna
- 2 Dogs (Snickerdoodle & Autumn)
- Love the Outdoors
- Fitness, Running, Hiking
- Travel
- Driving Fast Cars,
  - esp Porsche!





Tim Glen (Professional)

- Started in IT in 1995 Telephone Tech Support
- Worked 23 years at Advertising Specialty
  - Web hosting provider, 500 employees, 30,000 hosted site
  - Managed all routers, switches, firewalls, wireless, security
- Employed at Cisco 3.5 years
  - Started September 2019
  - Systems Architect in Philly Metro area

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Agenda

- Secure Ansible Usage
- IOS XE Attack Surface
- Local User Hardening
- Protocol Hardening
- Over the Wire Encryption
- Conclusion

IOS XE Day Zero Config

IOS XE Programmability and Automation

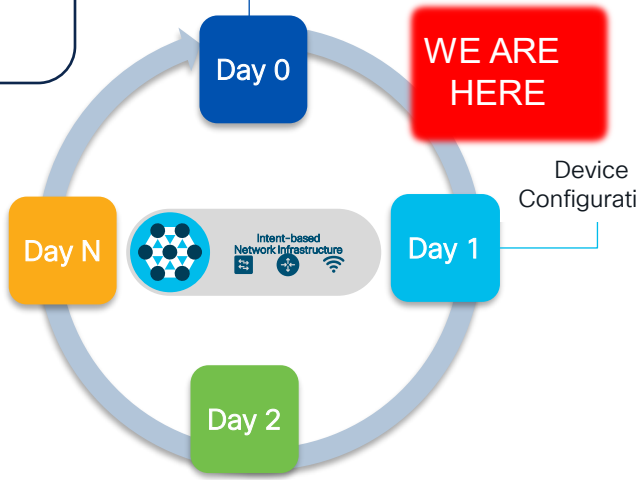
Pre-boot Execution Environment (iPXE)

Zero Touch Provisioning

Provisioning Automation

python™

Device Onboarding



WE ARE HERE

Device Configuration

Model Driven Programmability

Network Configuration Protocol (NETCONF), RESTCONF, gNMI

YANG Data Models, OpenConfig, and YANG Suite tooling

Terraform, Ansible, pyATS

Day 0 IOS XE Config (page 1)

- IP Address
- Default Gateway
- DNS
- Time Zone
- NTP

```
!
interface GigabitEthernet1/0/24
  no switchport
  ip address 10.1.1.5 255.255.255.0
!
ip route 0.0.0.0 0.0.0.0 10.1.1.3
!
ip name-server 208.67.222.222 208.67.220.220
!
clock timezone EST -5 0
clock summer-time EDT recurring
!
ntp server south-america.pool.ntp.org
ntp server europe.pool.ntp.org
ntp server pool.ntp.org
ntp server us.pool.ntp.org
ntp server north-america.pool.ntp.org
!
```

Day 0 IOS XE Config (page 2)

- AAA, Local User
- NetConf-YANG
- YANG AAA

```
!
username timmyg privilege 15 secret 8 $8$CvofI3VTja.....
!
aaa new-model
!
aaa authentication login CON-LOCAL local
aaa authorization exec CON-LOCAL local
aaa authorization console
!
line vty 0 15
 login authentication CON-LOCAL
 authorization exec CON-LOCAL
!
netconf
netconf-yang
!
yang-interfaces aaa authentication method-list CON-LOCAL
yang-interfaces aaa authorization method-list CON-LOCAL
!
```

What is the IOS XE Attack Surface

What is the IOS XE Attack Surface

- Open UDP \ TCP Ports
- Network facing services not optimized
- Insecure Username and Password
- Con, Aux, VTY lines
- Clear text data in Transit

What is the Attack Surface of IOS XE

What UDP Ports are listening ?

```
Cat9300-1#show ip sockets
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is NTP, 10:17:08.583 EDT Tue Apr 11 2023
------------------ show ip sockets  ------------------

Proto        Remote       Port      Local       Port  In Out  Stat TTY OutputIF
 17        --listen--          10.65.0.2        123   0   0 2001001   1
 17(v6)    --listen--          --any--          123   0   0 2020001   1
 17      0.0.0.0             0 10.65.0.2       2228   0   0   211   0
 17      192.168.10.24   65109 10.65.0.2        161   0   0 2001001   0
 17        --listen--          10.65.0.2        162   0   0 2001011   0
 17        --listen--          10.65.0.2      51161   0   0 2001011   0
 17(v6)    --listen--          --any--          161   0   0 2020001   0
 17(v6)    --listen--          --any--          162   0   0 2020011   0
 17(v6)    --listen--          --any--        49646   0   0 2020001   0
 17      192.168.10.11     514 10.65.0.2      50379   0   0 400210   0
Cat9300-1#
```

udp/123 - NTP

udp/2228 - L2 traceroute

udp/161, 162 - SNMP

What is the Attack Surface of IOS XE

What TCP Ports are listening ?

```
Cat9300-1#
Cat9300-1#sh tcp brief all
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is NTP, 10:25:44.229 EDT Thu Apr 13 2023
------------------ show tcp brief all  ------------------

TCB       Local Address               Foreign Address             (state)
7084B6CD29B0  10.65.0.2.22               192.168.8.70.53784          FINWAIT1
7084B6D68898  10.65.0.2.22               192.168.8.70.57451          ESTAB
7084B4759950  ::.21111                   *.*                         LISTEN
7084B4755E20  0.0.0.0.21111              *.*                         LISTEN
7084AC737C18  ::.443                     *.*                         LISTEN
7084B3BF4C18  0.0.0.0.443                *.*                         LISTEN
7084AC737000  ::.80                      *.*                         LISTEN
7084B3BF4000  0.0.0.0.80                 *.*                         LISTENLoad for five secs: 0%/0%; one minute: 0%;
Time source is NTP, 10:25:44.277 EDT Thu Apr 13 2023
------------------ show platform software portinfo TCP ------------------
% Error: Failed to open portinfo output file.


Cat9300-1#
```

Default SSH Config

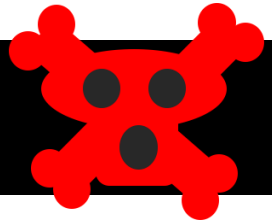
```
Cat9300-1#
Cat9300-1#sh ip ssh
Load for five secs: 0%/0%; one minute: 0%; five minutes: 0%
Time source is NTP, 10:57:00.307 EDT Mon Apr 17 2023
------------------ show ip ssh  ------------------

SSH Enabled - version 2.0
Authentication methods:publickey,keyboard-interactive,password
Authentication Publickey Algorithms:ssh-rsa,ecdsa-sha2-nistp256,ecdsa-sha2-nistp384,ecdsa
-sha2-nistp521,ssh-ed25519,x509v3-ecdsa-sha2-nistp256,x509v3-ecdsa-sha2-nistp384,x509v3-e
cdsa-sha2-nistp521,rsa-sha2-256,rsa-sha2-512,x509v3-rsa2048-sha256
Hostkey Algorithms:rsa-sha2-512,rsa-sha2-256,ssh-rsa
Encryption Algorithms:chacha20-poly1305@openssh.com,aes128-gcm@openssh.com,aes256-gcm@ope
nssh.com,aes128-gcm,aes256-gcm,aes128-ctr,aes192-ctr,aes256-ctr
MAC Algorithms:hmac-sha2-256-etm@openssh.com,hmac-sha2-512-etm@openssh.com
KEX Algorithms:curve25519-sha256,curve25519-sha256@libssh.org,ecdh-sha2-nistp256,ecdh-sha
2-nistp384,ecdh-sha2-nistp521,diffie-hellman-group14-sha256,diffie-hellman-group16-sha512
Authentication timeout: 120 secs; Authentication retries: 3
Minimum expected Diffie Hellman key size : 2048 bits
IOS Keys in SECSH format(ssh-rsa, base64 encoded): my-4096rsa-ssh-key
Modulus Size : 4096 bits
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAACAQDls7G6cS8k9ZBfgCAor2XbhQ20bidLB1gaVQ74Yon1
hPesx+LecWpSOkdA7QCWAMPDk1ARwspDChS7/8awamhpFPWZRa+msAC6nkC50KpQPR2MyqNjOeuceNn7
oLXT1/M5zYBB6D0AdNBjMA1PwoweDRqJjtXGvQZbX4daT6wvvVlAt6ZudDS1M+sTMWR6RPCgLOkdmKhM
```

Default HTTPS Config

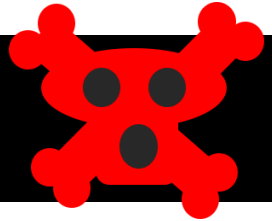
```
Cat9300-1#
Cat9300-1#sh ip http server status | beg HTTP secure
HTTP secure server capability: Present
HTTP secure server status: Enabled
HTTP secure server port: 443
HTTP secure server ciphersuite:  rsa-aes-cbc-sha2 rsa-aes-gcm-sha2
        dhe-aes-cbc-sha2 dhe-aes-gcm-sha2 ecdhe-rsa-aes-cbc-sha2
        ecdhe-rsa-aes-gcm-sha2 ecdhe-ecdsa-aes-gcm-sha2 tls13-aes128-gcm-sha256
        tls13-aes256-gcm-sha384 tls13-chacha20-poly1305-sha256
HTTP secure server TLS version:  TLSv1.3 TLSv1.2
HTTP secure server client authentication: Disabled
HTTP secure server PIV authentication: Disabled
HTTP secure server PIV authorization only: Disabled
HTTP secure server trustpoint: TP-self-signed-4033093308
HTTP secure server peer validation trustpoint:
HTTP secure server ECDHE curve: secp256r1
HTTP secure server active session modules: ALL
Cat9300-1#
```

IOS XE Local Passwords \ Secrets

```
Cat9300-1#
Cat9300-1#sh runn | inc username
username local-admin privilege 15 password 7 00071A1507545A545C
Cat9300-1#
Cat9300-1#
```



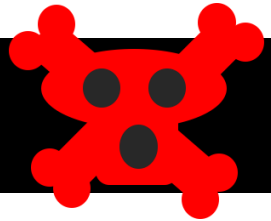
```
Cat9300-1#
Cat9300-1#sh runn | inc enable
enable secret 5 $1$ioti$MywYh5xXx4HAPpyEf77eQ.
Cat9300-1#
Cat9300-1#
```



Weak password hashing?
Weak methods for securing \ storing them?
Do these comply with business rules \ Password Compliance?

SNMPv2

```
Cat9300-1#
Cat9300-1#sh runn | inc snmp-server
snmp-server community MyBizNamePlus12345 RW
Cat9300-1#
Cat9300-1#
```



Ansible.cfg

```
timmay@ubuntu-01:/etc/ansible$
timmay@ubuntu-01:/etc/ansible$ cat ansible.cfg
[defaults]
inventory = ./inventories
timeout = 60
host_key_checking = false
forks = 25
command_timeout = 80
[persistent_connection]
connect_timeout = 60
timmay@ubuntu-01:/etc/ansible$
timmay@ubuntu-01:/etc/ansible$
```

Ansible Inventory \ Playbook Files

```yaml
---
iosxe:
  hosts:
    Cat9300-1:
      ansible_host: 10.65.0.2

  vars:
    ansible_network_os: ios
    ansible_user: ansible
    ansible_password: some-password-in-the-clear
```

Ansible Best Practices

SSH Key Checking

- Have you all seen this error ?
- First time Ansible connects to IOS XE, no host key

```
timmay@ubuntu-01:/etc/ansible$
timmay@ubuntu-01:/etc/ansible$ ansible-playbook -i inventories/cat9300-1v.yaml playbooks/show-serial.yaml --ask-vault-pass
Vault password:

PLAY [Define Parameters] ***********************************************************************************************
**************************

TASK [Get the facts] ***************************************************************************************************
***************************
fatal: [Cat9300-1]: FAILED! => {"changed": false, "msg": "\nlibssh: The authenticity of host '10.65.0.2' can't be established due to
'Host is unknown: 03:fc:b9:97:e3:42:be:1d:d4:55:19:63:88:5c:f2:e5:87:59:06:4a'.\nThe ssh-rsa key fingerprint is SHA1:s/y5l+NCvh3UVRlj
iFzy5YdZBko."}

PLAY RECAP *************************************************************************************************************
**************************
Cat9300-1                  : ok=0    changed=0    unreachable=0    failed=1    skipped=0    rescued=0    ignored=0

timmay@ubuntu-01:/etc/ansible$
```

The authenticity of host IP_ADDRESS can't be established due to Host is Unknown

SSH Key Checking

- Host key checking enabled by default

```
timmay@ubuntu-01:/etc/ansible$
timmay@ubuntu-01:/etc/ansible$ cat ansible.cfg | grep host_key_checking
host_key_checking = true
timmay@ubuntu-01:/etc/ansible$
timmay@ubuntu-01:/etc/ansible$
```

- Do NOT change this to false!
- Host keys stored in `~/.ssh/known_hosts`
- Use ssh-keyscan to ‘import’ the SSH host key!

SSH Known Hosts

- Host keys stored in ~/.ssh/known_hosts

```
GNU nano 4.8                                    /home/ciscolive/.ssh/known_hosts
```

1st host key — Hashed IP Addr \ Hostname

```
|1|cz9TY+PNWz7mm8/pQkRPWOE1oaU=|geksB4VwvGcURpXfx2u7b82eSyI= ssh-rsa AAAAB3NzaC1yc2EAAAADAQAE
```

Algorithm

2nd host key

```
10.1.1.5 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQC2Z1F8KECwluwLJ4VxeP91uHFkehyky3oxHGjLFexaKV2F
```

tcp/830 — Base64 Pub Key

```
[10.1.1.5]:830 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQC2Z1F8KECwluwLJ4VxeP91uHFkehyky3oxHGjLFe


|1|fuxSApwREqXhBANVXTMhoYq7zNk=|nt2/bcwepGjXa6DOecTbsK3l120= ssh-rsa AAAAB3NzaC1yc2EAAAADAQAE
```

5th host key, manually revoked

```
@revoked 10.1.1.55 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQDeXTjtbHdjmHGEnzpH3qzgwgwvy+BnaUBh+N
```

You can also remove known host keys

```
ssh-keygen -f "/home/ciscolive/.ssh/known_hosts" -R "10.1.1.5"
```

ssh-keyscan options

- Let's add our 'unknown' device to ~/.ssh/known_hosts

```
ssh-keyscan -H {{FQDN or IP_ADDRESS}} >> ~/.ssh/known_hosts
```

```
timmay@ubuntu-01:/etc/ansible$ ssh-keyscan -H 10.65.0.2
# 10.65.0.2:22 SSH-2.0-Cisco-1.25
|1|mhQTwJdG8uisED+KeI7XSFk2S7E=|JHOJh62hnN4DfBfMaCoukJXsEYU= ssh-rsa AAAAB3NzaC1yc2EA
```

-H parameter will add Hashed IP Addr

```
ssh-keyscan {{FQDN or IP_ADDRESS}} >> ~/.ssh/known_hosts
```

```
timmay@ubuntu-01:/etc/ansible$ ssh-keyscan 10.65.0.2
# 10.65.0.2:22 SSH-2.0-Cisco-1.25
10.65.0.2 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAACAQC4b4j3sGxsc0IuZn+pMGswd2IxQV9/VfjrDna
```

```
ssh-keyscan -p 830 {{FQDN or IP_ADDRESS}} >> ~/.ssh/known_hosts
```

```
timmay@ubuntu-01:/etc/ansible$ ssh-keyscan -p 830 10.65.0.2
# 10.65.0.2:830 SSH-2.0-OpenSSH_7.9 PKIX[11.6]
[10.65.0.2]:830 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQDbnvTIas5P5mpkrD3bdfZVrvxR4KTtWRUH/8FJ
```

NETCONF Port tcp/830

SSH Key Demo

ssh-keyscan Demo Steps

- Run simple playbook, watch fail

```
ansible-playbook -i inventories/cat9300-a.yaml playbooks/show-serial.yaml
```

- cat ~/.ssh/known_hosts
- ssh-keyscan 10.1.1.5
- ssh-keyscan 10.1.1.5 >> ~/.ssh/known_hosts
- ssh-keyscan -p 830 10.1.1.5 >> ~/.ssh/known_hosts
- nano ~/.ssh/known_hosts
- This only has to be done once!
- Run simple playbook, watch succeed

ssh-keyscan Demo Results


```
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
ciscolive@pod2-xelab:~/clus2023-devnet-2111$ ssh-keyscan 10.1.1.5
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
10.1.1.5 ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAABAQC50NZ2EKMAVofhG47Im2TAxpYfV+ZeLG7ZdYiaM6E+BJxyuj27/+V0SnTSbNbXSXEcxDXMD
nvXJ9BzxjLiN16GOW9SdfLiNl9+KSrksCh58h/+SJqdI44mrMTIRylmcxd/5nzc3RPZhz9E0ncmskpvShtjE2uFn4oTvMiqi7QOKHRrGAOoEyG++a/4ED+
uTw5IJflvBqxDRZB8J1fAbs5Yjw6QacomR+PwKGPnfegDefJ1
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
```

```
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
ciscolive@pod2-xelab:~/clus2023-devnet-2111$ ssh-keyscan 10.1.1.5 >> ~/.ssh/known_hosts
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
# 10.1.1.5:22 SSH-2.0-Cisco-1.25
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
```

Ansible Vault Demo

Ansible Vault Demo Steps

- Show Inventory File, inventories/cat9300-a.yaml
- Discuss Username & Pass in the clear
- Remove U&P from Inventory
- Copy \ Paste into vaults/ciscolive.vault

```
ansible-vault encrypt vaults/ciscolive.vault
```

- Update Playbook

```
vars_files:
  - ~/clus2023-devnet-2111/vaults/ciscolive.vault
```

Secret Strength
&
Common Criteria
&
Local Users

Cisco Password Types

scan here for
config guide!!!

- 5,6,7,8,9 ??? What do we do ?

- Type 5 – MD5 hash, outdated, replace where possible
- Type 6 - reversable, Bulk Data Encryption, RADIUS, TACACS keys
- Type 7 - obfuscation, outdated stop using immediately
- Type 8 - HA256 Hash, NIST Approved!
- Type 9 - SCRYPT Hash, not NIST approved,

Common Criteria Policy

- Allows NetEng to enforce strong password policies on local users
- Enables InfoSec & Auditors to see validate password policy

```
Cat9300-1#
Cat9300-1#sh runn | section aaa common-criteria
aaa common-criteria policy COMMON-POLICY
 min-length 12
 max-length 127
 char-changes 5
 character-repetition 2
 restrict-consecutive-letters
Cat9300-1#
Cat9300-1#
Cat9300-1#
Cat9300-1#
Cat9300-1#
```

Password must contain at least 12 characters and no more than 127

PW change req's > 5 chars changed

Same character cannot be used 3x

qwer or asdf not permitted

Local Users

- Must use strong password, Common Criteria !!!
- Must use strong hashing algorithms, Type 8 NIST approved!
- Use masked-secret so ‘secret’ is NEVER displayed in the clear

```
Cat9300-1#
Cat9300-1#conf t
Enter configuration commands, one per line.  End with CNTL/Z.
Cat9300-1(config)#username jhonny-apples common-criteria-policy COMMON-POLICY algorithm-type sha256 masked-secret
Enter secret: *****************
Confirm secret: *****************

Cat9300-1(config)#end
Cat9300-1#
Cat9300-1#show runn | inc jhonny-apples
username jhonny-apples common-criteria-policy COMMON-POLICY secret 8 $8$uDWzlCSGOwEgLE$m.QB4WF2pp1Fb2RxhYiYgw5x1wZrKE7
Cat9300-1#
```

Type 8

Password should never be displayed or logged

Secret Strength
&
Common Criteria
&
Local Users
Demo

PW Type & CC Policy User Demo Steps

- Show the PW Type & Common Criteria Playbook in VS Code
- Explain Connection Type = NETCONF
- Explain how the RPC was built in YANG Suite
- Run the PW Type & Common Criteria Playbook.

```
ansible-playbook -i inventories/cat9300-a.yaml playbooks/01-add-common-criteria-policy.yaml
```

- Note how we forgot to add --ask-vault-pass
- Run Playbook again with ask-vault this time ☺
- On Cat9K Show Common Criteria Policy

```
show runn | sec aaa common-criteria
```

Local User Demo Steps

- Creating this local user could occur on hundreds or thousands boxes
- We shouldn’t ever have the password displayed in the clear
- Show Playbook and Copy \ Paste Type 8
- Run Playbook

```
ansible-playbook -i inventories/cat9300-a.yaml playbooks/02-add-common-criteria-users.yaml --ask-vault-pass
```

- On Cat9K Show Newly Created Local User

```
show runn | inc username jhonny-apples
```

Harden
SSH & HTTPS

HTTPS Cipher Suites in IOS XE 17.11(1)

IOS XE Label	IANA Name	TLS Ver	Strength
aes-128-cbc-sha	TLS_RSA_WITH_AES_128_CBC_SHA	1.0	Weak
aes-256-cbc-sha	TLS_RSA_WITH_AES_256_CBC_SHA	1.0	Weak
dhe-aes-cbc-sha2	TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256	1.2	Weak
dhe-aes-gcm-sha2	TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	1.2	Secure
ecdhe-ecdsa-aes-gcm-sha2	TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	1.2	Recommended
ecdhe-rsa-aes-128-cbc-sha	TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA	1.0	Weak
ecdhe-rsa-aes-cbc-sha2	TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256	1.2	Weak
ecdhe-rsa-aes-gcm-sha2	TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	1.2	Secure
rsa-aes-cbc-sha2	TLS_RSA_WITH_AES_128_CBC_SHA256	1.2	Weak
rsa-aes-gcm-sha2	TLS_RSA_WITH_AES_128_GCM_SHA256	1.2	Weak
tls13-aes128-gcm-sha256	TLS_AES_128_GCM_SHA256	1.3	Recommended
tls13-aes256-gcm-sha384	TLS_AES_256_GCM_SHA384	1.3	Recommended
tls13-chacha20-poly1305-sha256	TLS_CHACHA20_POLY1305_SHA256	1.3	Recommended

CIPHERSUITE
https://ciphersuite.info

Harden SSH & HTTPS Demo

Harden SSH & HTTP Demo Steps

- Show the Hardening Playbook in VS Code
- On Cat9K Show SSH & HTTP Server Status

```
show ip http server status | sec ciphersuite

show ip ssh
```

- Run Playbooks

```
ansible-playbook -i inventories/cat9300-a.yaml playbooks/03-config-hard-ssh.yaml --ask-vault-pass

ansible-playbook -i inventories/cat9300-a.yaml playbooks/04-config-hard-https.yaml --ask-vault-pass
```

- On Cat9K Show SSH & HTTP Server Status

SNMPv2 vs SNMPv3

SNMPv2 Packet Capture

```
Tims-MacBook ~$
Tims-MacBook ~$snmpget -v2c -c cisco123 10.65.0.2 SNMPv2-SMI::enterprises.9.2.1.73.0
SNMPv2-SMI::enterprises.9.2.1.73.0 = STRING: "usbflash0:cat9k_iosxe.17.11.01.SPA.bin"
Tims-MacBook ~$
```

snmp

No.	Time	Delta	Source	SrcPort	Destination	DstPort	Protocol	Length	Info
164	2.924286	0.029298	192.168.10.181	59742	10.65.0.2	161	SNMP	89	get-request 1.3.6.1.4.1.9.2.1.73.0
165	2.925380	0.001094	10.65.0.2	161	192.168.10.181	59742	SNMP	127	get-response 1.3.6.1.4.1.9.2.1.73.0

```
> Frame 165: 127 bytes on wire (1016 bits), 127 bytes captured (1016 bits) on interface en4, id 0
> Ethernet II, Src: Cisco_4e:e6:c6 (2c:ab:eb:4e:e6:c6), Dst: Universa_b8:e0:64 (3c:e1:a1:b8:e0:64)
> Internet Protocol Version 4, Src: 10.65.0.2, Dst: 192.168.10.181
> User Datagram Protocol, Src Port: 161, Dst Port: 59742
v Simple Network Management Protocol
    version: v2c (1)
    community: cisco123
  v data: get-response (2)
    v get-response
        request-id: 857263308
        error-status: noError (0)
        error-index: 0
      v variable-bindings: 1 item
        v 1.3.6.1.4.1.9.2.1.73.0: "usbflash0:cat9k_iosxe.17.11.01.SPA.bin"
            Object Name: 1.3.6.1.4.1.9.2.1.73.0 (iso.3.6.1.4.1.9.2.1.73.0)
            Value (OctetString): "usbflash0:cat9k_iosxe.17.11.01.SPA.bin"
    [Response To: 164]
    [Time: 0.001094000 seconds]
```

SNMP Response

SNMPv3 Packet Capture

```
Tims-MacBook ~$
Tims-MacBook ~$snmpget -v3 -l authPriv -a SHA -u charlie-ReadOnly -A ciscolive123 -x AES -X ciscolive123 10.65.0.2 SNMPv2-SMI::enterprises.9.2.1.73.0

SNMPv2-SMI::enterprises.9.2.1.73.0 = STRING: "usbflash0:cat9k_iosxe.17.11.01.SPA.bin"
Tims-MacBook ~$
```

snmp

No.	Time	Delta	Source	SrcPort	Destination	DstPort	Protocol	Length	Info
51	3.175727	0.058855	192.168.10.181	49447	10.65.0.2	161	SNMP	186	encryptedPDU: privKey Unknown
52	3.176758	0.001031	10.65.0.2	161	192.168.10.181	49447	SNMP	223	encryptedPDU: privKey Unknown

```
> Frame 52: 223 bytes on wire (1784 bits), 223 bytes captured (1784 bits) on interface en4, id 0
> Ethernet II, Src: Cisco_4e:e6:c6 (2c:ab:eb:4e:e6:c6), Dst: Universa_b8:e0:64 (3c:e1:a1:b8:e0:64)
> Internet Protocol Version 4, Src: 10.65.0.2, Dst: 192.168.10.181
> User Datagram Protocol, Src Port: 161, Dst Port: 49447
v Simple Network Management Protocol
    msgVersion: snmpv3 (3)
  > msgGlobalData
  > msgAuthoritativeEngineID: 800000090300dc774c78f080
    msgAuthoritativeEngineBoots: 115
    msgAuthoritativeEngineTime: 2783
    msgUserName: charlie-ReadOnly
    msgAuthenticationParameters: fce6c75ab711a2dc760ea8cb
    msgPrivacyParameters: 271ce9e510efa310
  v msgData: encryptedPDU (1)
      encryptedPDU: fd65ee713ceda4dc42790d63e0ae409bd11203a5b1e0f56ca3ecb3e3ef3f42e2b043f46d…
```

SNMP Response

SNMPv3 Basics

- View – What OIDs can be queried
- Group – Logical grouping of users
- User – Assign a user for each SNMP Monitoring Workstation
  - Auth Protocol - MD5 \ SHA
  - Auth Key – Shared Secret, verifies the integrity of the messages
  - Privacy Protocol – DES \ AES-128 \ AES-192 \ AES-256
  - Privacy Key – Shared Secret, used for bulk data encryption

SNMPv3 Template Demo

SNMP Demo Steps

- Show SNMPv2 Config
- Run Simple SNMP Get

```
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
ciscolive@pod2-xelab:~/clus2023-devnet-2111$ snmpget -v3 -l authPriv -a SHA -U charli
snmpget:
Error generating a key (Ku) from the supplied privacy pass phrase.
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
ciscolive@pod2-xelab:~/clus2023-devnet-2111$
```

```
snmpget -v2c -c cisco123 10.1.1.5 SNMPv2-MIB::sysName.0
```

- Show SNMPv3 Playbook in VS Code
- Run Playbook

```
ansible-playbook -i inventories/cat9300-a.yaml playbooks/05-add-snmp-v3-
framework.yaml --ask-vault-pass
```

- Show SNMPv3 Config
- Run same Simple SNMP Get using SNMPv3

```
snmpget -v3 -l authPriv -a SHA -u charlie-ReadOnly -A ciscolive123 -x AES -X
ciscolive123 10.1.1.5 SNMPv2-MIB::sysName.0
```

Type 6 Encryption

Type 6 Encryption

- Supported since 2006 \ IOS 12.3 and possibly earlier
- Strong AES 128-bit encryption
- Encrypts RADIUS & TACACS, MACsec & IPsec PSK
- Type 6 passwords need to be reversed by IOS XE

Type 6 Demo

Type 6 Demo Steps

- Show Type 6 Playbook in VS Code
- Run Type 6 Playbook

```
ansible-playbook -i inventories/cat9300-a.yaml playbooks/06-config-type6.yaml --ask-vault-pass
```

- No Type 6 Passwords exist now

MACsec PSK

MACsec Switch to Switch with PSK

- Dance like no one is watching
- Encrypt like everyone is watching
- Lightweight L2 encryption
- Cat9K Line Rate encryption AES128 \ AES256
- <1% CPU Impact only during ReKey
- Bulk Data encryption occurs on PHY,

MACsec PSK Demo

MACsec Demo Steps

- Show MACsec Playbook in VS Code
- Run MACsec Playbook

```
ansible-playbook -i inventories/devnet-switches.yaml playbooks/07-config-macsec-psk.yaml --
ask-vault-pass
```

- Show MKA session on Cat9K
- Show MACsec session on Cat9K

Other Hardening Best Practices ...

- Harden NTP
  - Serve
  - Serve-Only
  - Querty
- VTY ACLs
- HTTP Modules
- Enable Config Archiving

3,2,1
Action Items

- Breathe, Relax
- Scan QR Codes
- Clone Git Repo
- Test Playbooks
- Execute

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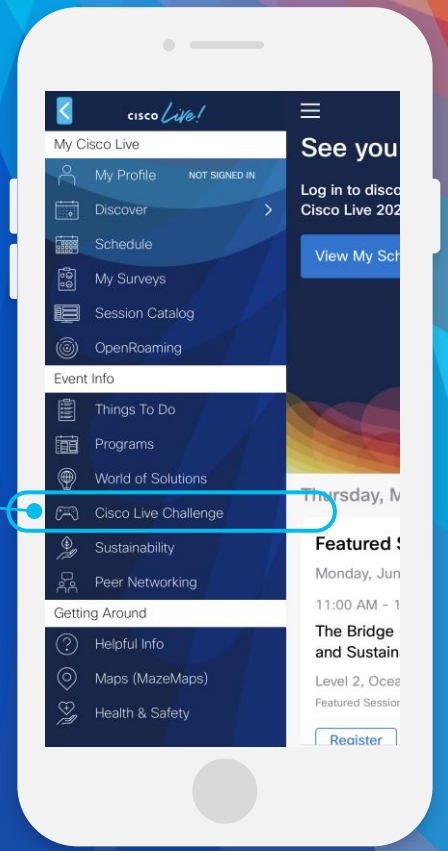

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