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Software Supply Chain Risks and Mitigations for NERC CIP-010-3 R1, 1.6

August 12, 2020

Presented by: Energy Central

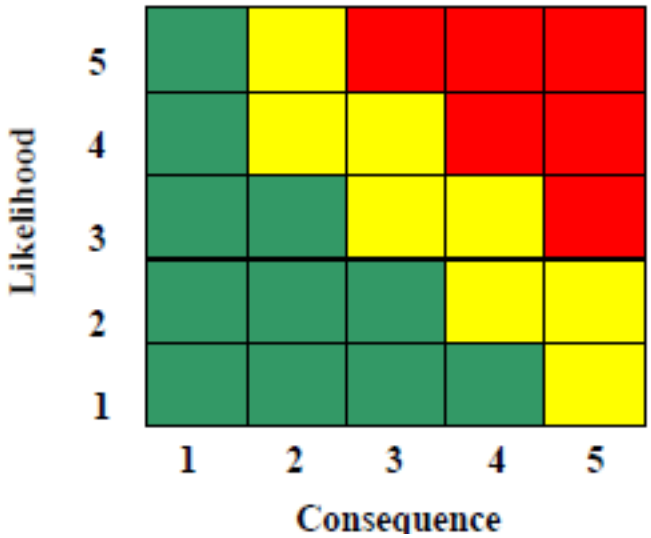
Thank you to our sponsor

Topics

- Software Supply Chain Risks and Threats
- Software Risks
- Value at Risk
- Risk Assessment Steps for NERC CIP-010-3 1.6
- Constant improvement is REQUIRED
- Summary

Definition of Risk

- The Department of Defense (DOD) Office for the Undersecretary of Defense for Acquisition defines risk as ***Risk = Likelihood x Consequence*** **of a "future root cause (yet to happen), which if eliminated or corrected, would prevent a potential consequence from occurring" (OSD/ATL-ED, 2006)**.

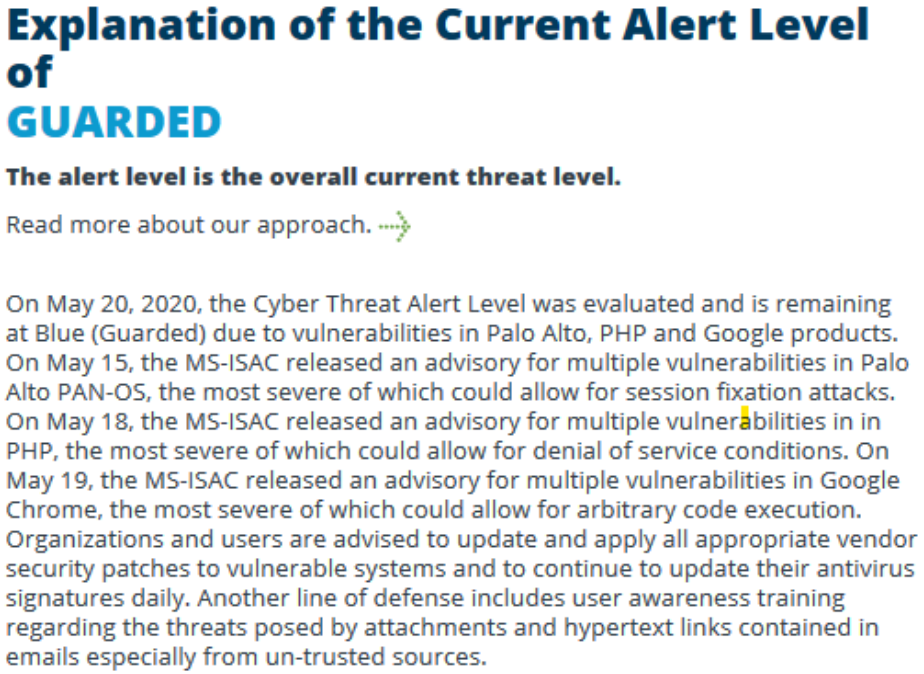


Red = High
Yellow = Medium
Green = Low

https://www.acq.osd.mil/damir/documents/DAES_2006_RISK_GUIDE.pdf

Definition of Threats

- Real tactics, techniques and procedures (TTP) that are proven to successfully carry out a cyber attack, by parties at various skill levels with the intent, capability and opportunity to do so.
- Some threats are known, some are not (i.e. 0-day exploits)



Explanation of the Current Alert Level of

GUARDED

The alert level is the overall current threat level.

Read more about our approach.

On May 20, 2020, the Cyber Threat Alert Level was evaluated and is remaining at Blue (Guarded) due to vulnerabilities in Palo Alto, PHP and Google products. On May 15, the MS-ISAC released an advisory for multiple vulnerabilities in Palo Alto PAN-OS, the most severe of which could allow for session fixation attacks. On May 18, the MS-ISAC released an advisory for multiple vulnerabilities in in PHP, the most severe of which could allow for denial of service conditions. On May 19, the MS-ISAC released an advisory for multiple vulnerabilities in Google Chrome, the most severe of which could allow for arbitrary code execution. Organizations and users are advised to update and apply all appropriate vendor security patches to vulnerable systems and to continue to update their antivirus signatures daily. Another line of defense includes user awareness training regarding the threats posed by attachments and hypertext links contained in emails especially from un-trusted sources.

https://www.cisecurity.org/cybersecurity-threats/

Providing Context

ID.RA-5: Threats, vulnerabilities, likelihoods, and impacts are used to determine risk

NIST Cybersecurity Framework V1.1
https://doi.org/10.6028/NIST.CSWP.04162018

A ***threat actor*** carrying out a ***threat action*** by exploiting a ***vulnerability*** resulting in a ***Consequence*** that causes an ***impact*** in the production process.

Sinclair Koelemij
https://otcybersecurity.blog/2020/06/17/consequence-with-capital-c/
June 17, 2020

Key Concept:
The higher the risk, the lower the trust; Increased risks negatively impact trustworthiness

Software Supply Chain Risks

- Risks that exist when acquiring a software object via an Internet Download
  - Spoofed download sites: http://downloads.Microsoft.con
  - Watering holes
  - Man in the middle attacks
  - Open Source binary distributions
  - Fakes
  - Equifax blamed its breach on a flaw in outside software it was using. It then blamed a **malicious download link on its website to yet another vendor**.
- Software/Supplier Risks
  - Third Party software embedded in a Vendor offering
  - Embedded open source software within a vendor product
- A software vendor may not be aware they have been hacked and are distributing tainted software to their customers:
  - ASUS March 29, 2019
  - Sophos Threat Report 2020

https://www.ncsc.gov.uk/collection/supply-chain-security


HACKER COMBAT
COMMUNITY
Common Types of Malware
@Hackercombat
Virus
Spreads with your action
Trojan
Disguised as legitimate software
Worms
Spreads automatically
Spyware
Monitors your activity
@Hackercombat
Rootkit
Hides deep within your computer
Adware
Maliciously serves you ads
Exploit Kit
Hunts software vulnerabilities
Ransomware
Blocks access to your files/ computer

NERC Supply Chain Risk Alert

Alerts

To acknowledge, respond to, or approve of an alert, please click here.

Alerts

Date	Description	Responsible Entities
2020 Alerts (2)		
7/8/2020	**Industry Recommendation:** Supply Chain Risk - III	Balancing Authority, Distribution Provider, Distribution Provider-UFLS, Frequency Response Sharing Group, Generator Owner, Generator Operator, Planning Authority, Reliability Coordinato Resource Planner, Regulation Reserve Sharing Grou Reserve Sharing Group, Transmission Owner, Transmission Operator, Transmission Planner, Transmission Service Provider

ZDNet Security

July 1, 2020

Ransomware is now your biggest online security nightmare. And it's about to get worse

https://www.zdnet.com/article/ransomware-is-now-your-biggest-online-security-nightmare-and-its-about-to-get-worse/

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Atlantic Council

ISSUES REGIONS INSIGHTS & IMPACT PEOPLE PROGRAMS EVENTS

Breaking trust: Shades of crisis across an insecure software supply chain

Software supply chain security remains an under-appreciated domain of national security policymaking. Working to improve the security of software supporting private sector enterprise as well as sensitive Defense and Intelligence organizations requires more coherent policy response together industry and open source communities. This report profiles 115 attacks and disclosures against the software supply chain from the past decade to highlight the need for action and presents recommendations to both raise the cost of these attacks and limit their harm.

https://www.atlanticcouncil.org/programs/scowcroft-center-for-strategy-and-security/cyber-statecraft-initiative/breaking-trust/

Key Trends

- **Deep Impact from State Actors:** There were *at least* **27 different state attacks** against the software supply chain
- **Abusing Trust in Code Signing:** These attacks undermine public key cryptography and certificates used to ensure the integrity of code
- **Hijacking Software Updates: 27% of these attacks targeted software updates** to insert malicious code against sometimes **millions of targets**
- **Poisoning Open-Source Code:** These incidents saw attackers either modify open-source code by gaining account access or post their own packages with names similar to common examples
- **Targeting App Stores: 22% of these attacks targeted app stores** like the Google Play Store, Apple's App Store, and other third-party app hubs to spread malware

https://www.atlanticcouncil.org/programs/scowcroft-center-for-strategy-and-security/cyber-statecraft-initiative/breaking-trust/

CIP-010-3 NERC Guidance

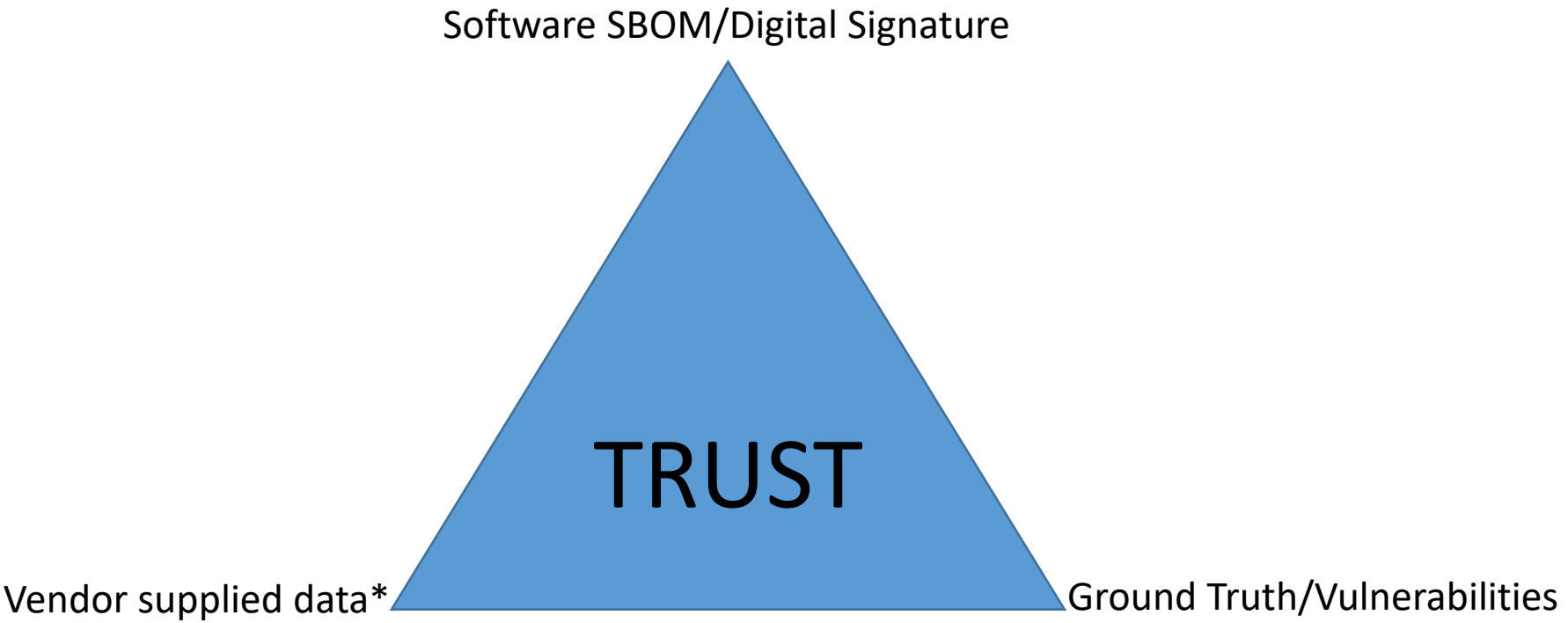
- The concept of software verification (**verifying the identity of the software source and the integrity of the software obtained from the software source) is a key control in preventing the introduction of malware or counterfeit software.**
- **Processes or procedural controls that require users to obtain software directly from the developer or vendor's preferred delivery methods.**
- A Responsible Entity may demonstrate compliance with CIP-010-3 R1, Part 1.6 by using processes for software updates that technically enforce that only digitally signed software is installed.
  - **This guidance could lead to some really bad outcomes!**
  - **See Common Misconceptions later in the presentation to see why.**

https://www.nerc.com/pa/comp/guidance/EROEndorsedImplementationGuidance/CIP-010-3%20R1.6%20Software%20Integrity%20and%20Authenticity.pdf
https://www.nerc.com/pa/Stand/Reliability%20Standards%20Complete%20Set/RSCompleteSet.pdf

FERC White Paper and NIST CSF

- NIST Cybersecurity Framework V1.1, April 2018
- FERC Cybersecurity White Paper 6/18/2020
- NIST CSF, a framework to implement best practices
- FERC WP, suggests that NIST CSF may be appropriate for "cybersecurity best practices" in the Bulk Electric System
- The software risk assessment approach described in this webinar follows the NIST CSF Identify function (ID.RA, ID.RM and ID.SC) and Protect function PR.DS-6
- The risk assessment approach described in this session may serve as an example of a cybersecurity control that could be eligible for additional incentive compensation (2%), if FERC proceeds with it's proposal in the white paper

Evaluating Risk and Establishing Trust Triangulating Corroborating Evidence



* Refer to EEI Supply Chain Procurement Model for details

Software Risks

- Risks inherent in a software object, regardless of where it was acquired
  - Embedded malware (i.e. RATs, Ransomware, mining, worms, etc.)
  - Vulnerabilities and Exploits
  - Fakes
  - Backdoors
  - Third Party embedded objects (Open Source)
  - External Dependencies, i.e. WEB API's
  - Others, yet to be discovered (inevitable)

Value at Risk

- Understanding the risk associated with your supply chain is key to ensuring security measures and mitigations are proportionate, effective and responsive
- Credit Rating Agencies beginning to factor-in cybersecurity controls in GRC assessments, i.e. Moody's/Team8 Cyber Assessments startup
- Board of Directors and Executives care deeply about credit ratings!
- Cost of a breach: $730k – $1.4M
  - Norsk Hydro, estimated at $64 - 76M
  - MAERSK Not Petya attack: $200-300M

Cyber Insurance Realities

It wasn't enough. Some 35,000 employees were locked out of the company's network, and Hydro had to shut down several manufacturing plants in Europe and the U.S. The ones still operating had to figure out how to do so without any computers. In the end, the attack would cost the company more than $60 million—way more than the $3.6 million the insurance policy has paid out so far, according to an earnings report. It was, according to the prosecutor investigating the breach, the worst cyberattack in Norway's history.

https://www.bloomberg.com/news/features/2020-07-23/how-to-survive-ransomware-attack-without-paying-ransom

Software Risk Assessment Steps

1. Perform introspection of software object (SBOM)
2. Verify Download Server Source Location/Certificate
3. Perform Virus Scan for known malware
4. Verify Digital Signature of software object
5. Perform Vulnerability (CVE) Search
6. Perform Vendor Verification using available data
7. Perform Provenance Check
8. Generate a Trustworthiness Score based on risk assessment
9. Save all findings and results in an evidence file

Software introspection

- After acquiring a software object, perform a deep inspection
  - Create, download or open a software Bill of Materials (SBOM) and investigate each potentially dangerous component searching for risk
  - Akin to an FDA food label listing ingredients contained in a food product
  - Identify the Manufacturer/Developer of the SW
  - Determine the name of the product associated with the software along with the version
  - Verify that the developer and product information match the information acquired during procurement discussions with the vendor, refer to EEI model

What is an SBOM (NTIA Definition)

What is a Software Bill of Materials?

An SBOM is effectively a nested inventory: a list of ingredients that make up software components. An SBOM identifies and lists software components, information about those components, and the supply chain relationships between them.

Baseline Software Component Information
Supplier Name
Component Name
Unique Identifier
Version String
Component Hash
Relationship
Author Name

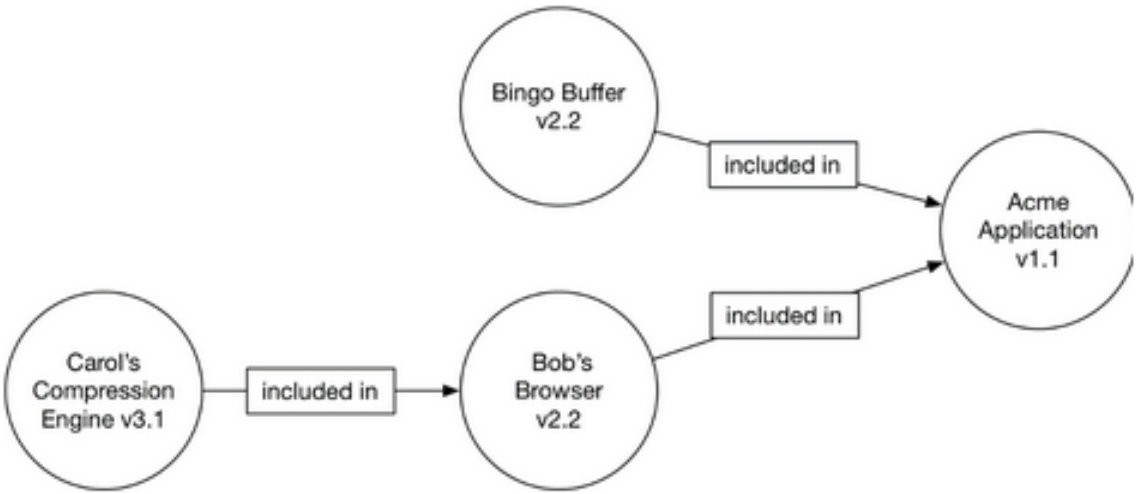


Figure 1: The baseline SBOM includes components in their assembled relationship. Each component has enough information to "uniquely and unambiguously identify" it (left), and the relationship of what upstream or child components are "included in" downstream or parent components (right).[2]

NTIA 6/15/2020: https://docs.google.com/document/d/1IqLsYshdvnxmvAx7hhdEUMRw30PauP5QRkcZh8t1QXI/edit#

CycloneDX History

- Origins in the OWASP community
- Designed in May 2017
- Initial release in March 2018
- OWASP Dependency-Track was first adopter, many others followed
- CycloneDX v1.1 released in March 2019
- CycloneDX v1.2 released in May 2020
- Formal CycloneDX working group and standardization process in 2020
- Members of CycloneDX Core working group are OWASP leaders/members

CycloneDX slides provided by Steve Springett; Steve leads the OWASP Dependency-Track project, OWASP Software Component Verification Standard (SCVS) project, **CycloneDX software bill of materials standard**, and participates in several related projects and working groups.

The CycloneDX Approach

- Easy to adopt – easy to contribute
- Identify risk to as many adopters as possible, as quickly as possible
- Avoid any/all blockers that prevent the identification of risk
- Continuous improvement – Innovate quickly, improve over time
- Encourage innovation and competition through extensions
- Produce immutabe and backward compatible releases
- Facts first – Dynamic facts and observations enabled through extensions
- Automation and optimization of BOM creation
- Full-stack BOM specification

Achievable Use Cases

- Describe complete and accurate inventory
- Security vulnerability analysis
- Integrity verification
- Software package evaluation
- License identification and compliance
- Describe complex component assemblies
- Capture dependency relationships
- Describe component pedigree
- Describe component provenance
- Describe reliance on services

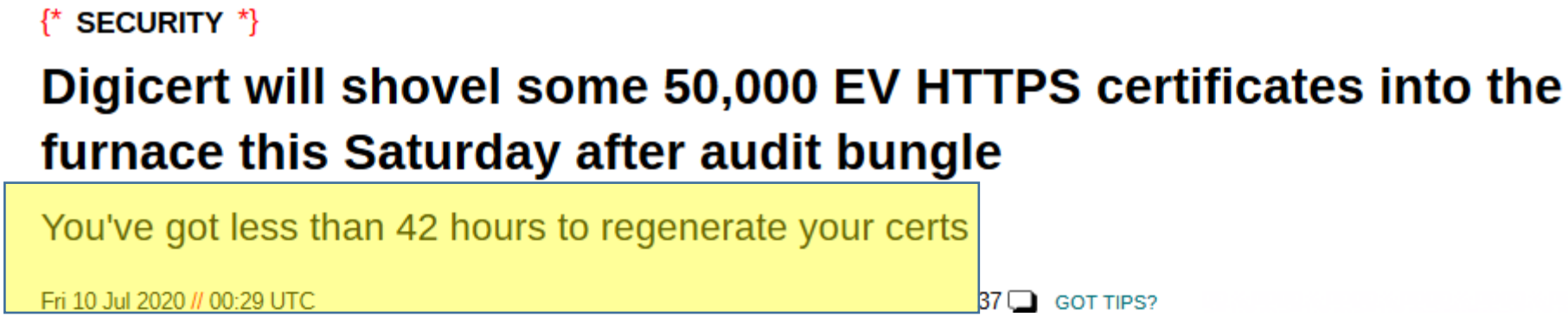
SBOM Examples

- https://github.com/CycloneDX/sbom-examples

Verify Source Location/Vendor

- Parse the SSL digital certificate for identification information; is the issuing CA performing thorough investigations of identity before issuing the certificate
- NAESB Accredited CA's offer the best protection; require your software vendor to acquire their digital signing and SSL/TLS certificates from a NAESB ACA, such as Globalsign
- Verify the validity of the digital certificate
- Confirm that the vendor and source location information match what was agreed to during procurement discussions
- Source Locations that lack SSL digital certificates should never be trusted

Be selective when choosing a CA



https://www.theregister.com/2020/07/10/digicert_pulls_certs/

Malware and Vulnerabilities

- Malware is a deliberate attempt by a hacker to implant software in a victims computing ecosystem in order to gain a foothold to perform nefarious acts, Examples:
  - Not Petya
  - WannaCry
  - Too many to list…
- Vulnerabilities are unintentional software imperfections which a hacker uses to access a victims computing ecosystem, using known exploits, in order to gain a foothold to perform nefarious acts.
  - OSIsoft PI vulnerabilities advisory from CISA: https://www.us-cert.gov/ics/advisories/icsa-20-133-02
  - Pal Alto Networks vulnerabilities from NIST: https://nvd.nist.gov/vuln/detail/CVE-2020-2018
- Vulnerability exploits are often used to implant malware; They are not mutually exclusive risks

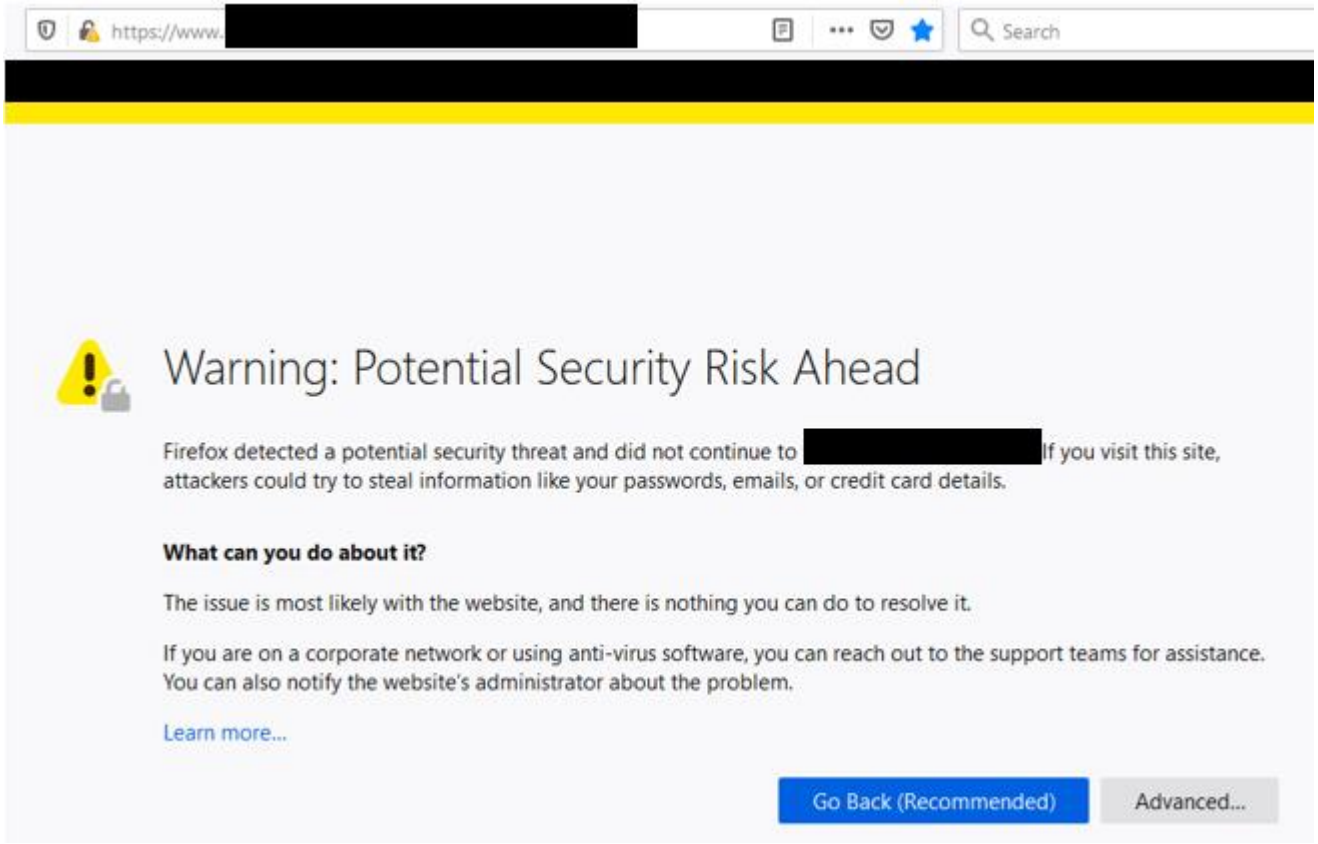
Malware and Vulnerabilities

- Perform a malware scan using trusted and up to date antivirus software; any discovered malware automatically results in a trust score of ZERO
- Perform a search for known vulnerabilities and exploits
  - Signup to receive CISA alerts and advisories
  - Search known vulnerability databases, i.e. Mitre CVE and NIST NVD
  - I've proposed changes to Rapid7 to improve AttackerKB search results
- Any discovered malware or vulnerability risks results in a trust score of ZERO

Software Object Provenance

- Look for man in the middle risks, i.e. Blacklisted IP addresses and foreign risks
- Examine a digital signature, if present:
  - Look for any indication of expired certificates
  - Look for “freshness” of the digital certificate, if it’s too old then it may not be trustworthy; check timestamps
  - Verify digital signature information with data acquired during procurement discussions and contract signing
- Lack of a digital certificate reduces trust to zero
- A matching hash value will improve the integrity score, but offers no assurance for identity/authentication

Real Experiences; Bad SSL Cert



Untrustworthy SSL/TLS Certs

- Let’s Encrypt
- Let's Encrypt issued 3,048,289 TLS certificates without checking the CAA field for the requesting domain.
- https://www.zdnet.com/article/lets-encrypt-to-revoke-3-million-certificates-on-march-4-due-to-bug/

Embedded Malware

```
Performing Malware Scan(this takes a few moments...)
('---->Engine: ESET-NOD32', 'result:', True, 'reason:', 'a variant of Win64/WinDivert.A potentially unsafe')
('---->Engine: Emsisoft', 'result:', True, 'reason:', 'Application.WinDivert.B (B)')
('---->Engine: Fortinet', 'result:', True, 'reason:', 'Adware/WinDivert')
('---->Engine: Qihoo-360', 'result:', True, 'reason:', 'Generic/Application.918')
---->Vulnerabilities found: 4 Total Scans performed:  42
A trust score of: 0 has been calculated for this step. Do you wish to assign a passing grade (Y)/N?
```

```
Performing Malware Scan(this takes a few moments...)
('---->Engine: ClamAV', 'result:', True, 'reason:', 'Win.Trojan.Agent-7477406-0')
---->Vulnerabilities found: 1 Total Scans performed:  73
```

Digital Signature Risks

```
----> :    Issued by: VeriSign Class 3 Public Primary Certification Authority - G5

----> :    Expires:   Wed Jul 16 19:59:59 2036

----> :    SHA1 hash: 4EB6D578499B1CCF5F581EAD56BE3D9B6744A5E5

----> :        Issued to: VeriSign Class 3 Code Signing 2010 CA

----> :        Issued by: VeriSign Class 3 Public Primary Certification Authority - G5

----> :        Expires:   Fri Feb 07 19:59:59 2020

------------->WARNING: An expired Cert is in the signature chain
Press Enter to acknowledge this warning and continue...
----> :        SHA1 hash: 495847A93187CFB8C71F840CB7B41497AD95C64F

----> :            Issued to: TeamViewer

----> :            Issued by: VeriSign Class 3 Code Signing 2010 CA

----> :            Expires:   Thu Aug 07 19:59:59 2014

----> :            SHA1 hash: 34DB009ABDE83388E437A4CDF44EE43DF3DB1505

----> :The signature is timestamped: Thu Nov 03 16:38:35 2011

------------->WARNING: This signature is more than one year in the past
Press Enter to acknowledge this warning and continue...
```


NOTE: Verisign is NOT a NAESB Accredited Certificate Authority

Vulnerabilities and Exploits

- **ICS Advisory (ICSA-20-133-02)**
- **OSIsoft PI System**
- Original release date: May 12, 2020

1. EXECUTIVE SUMMARY

- CVSS v3 7.8
- **ATTENTION:** Exploitable remotely/low skill level to exploit
- **Vendor:** OSIsoft
- **Equipment:** PI System
- **Vulnerabilities:** Uncontrolled Search Path Element, Improper Verification of Cryptographic Signature, Incorrect Default Permissions, Uncaught Exception, Null Pointer Dereference, Improper Input Validation, Cross-site Scripting, Insertion of Sensitive Information into Log File

- Exploits; Top Ten List

Top 10 Most Exploited Vulnerabilities 2016–2019

U.S. Government reporting has identified the top 10 most exploited vulnerabilities by state, nonstate, and unattributed cyber actors from 2016 to 2019 as follows: CVE-2017-11882, CVE-2017-0199, CVE-2017-5638, CVE-2012-0158, CVE-2019-0604, CVE-2017-0143, CVE-2018-4878, CVE-2017-8759, CVE-2015-1641, and CVE-2018-7600.

Provenance Risks

- Man in the middle attacks

```
Performing Man in the Middle Trace(this takes a few moments...): ut.ac.ir
----> ('<DNSBLResult: 80.66.177.54 [BLACKLISTED] (1/52)>', 'UT-AS, IR')
---->WARNING: Above location is BLACKLISTED
---->WARNING: Above location is outside of the United States
```

- Watering Holes; e.g. Wordpress
- Spoofed software download locations

> Infamous Israeli surveillance firm NSO Group created a web domain that looked as if it belonged to Facebook's security team to entice targets to click on links that would install the company's powerful cell phone hacking technology, according to data analyzed by Motherboard.
>
> It is not uncommon for hackers working for governments to impersonate Facebook, perhaps with a phishing page that displays a Facebook login

https://www.vice.com/en_us/article/qj4p3w/nso-group-hack-fake-facebook-domain

Common Misconceptions

- A verified digitally signed software object is always trustworthy; NOT TRUE
  - Digitally signed software provides a “veil” of trust that may not be justified
  - COMODO Fraudulent Certificates

    Microsoft is aware of nine fraudulent digital certificates issued by Comodo, a certification authority **present in the Trusted Root Certification Authorities Store, on all supported releases of Microsoft Windows**
  - ASUS March 29, 2019

    As *Motherboard* reported, researchers at Kaspersky discovered that malicious hackers had **successfully planted malware posing as an official ASUS security update** onto ASUS’s servers **and signed it with two of the company’s legitimate digital certificates.**
  - Sophos Threat Report 2020

    Attackers may attempt to minimize detection by **digitally code-signing their ransomware with an Authenticode certificate.**

Software Vendors Always Patch Known Vulnerabilities Immediately

- NOT TRUE

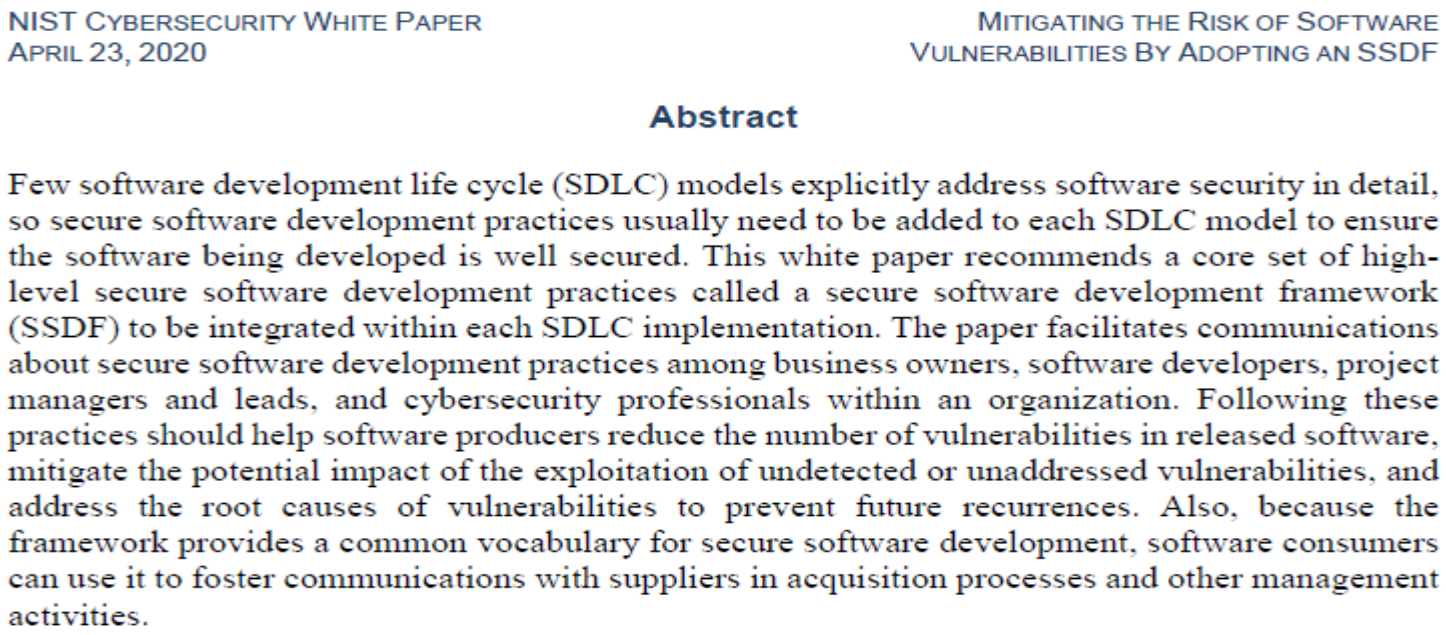
Microsoft fixes vulnerability affecting all Windows versions since 1996

Another vulnerability in the same Windows component was abused by Stuxnet a decade ago

Amer Owaida 15 May 2020 - 03:30PM

All Vendors Follow Secure Coding Standards; NOT TRUE

- https://nvlpubs.nist.gov/nistpubs/CSWP/NIST.CSWP.04232020.pdf



NIST CYBERSECURITY WHITE PAPER
APRIL 23, 2020

MITIGATING THE RISK OF SOFTWARE VULNERABILITIES BY ADOPTING AN SSDF

Abstract

Few software development life cycle (SDLC) models explicitly address software security in detail, so secure software development practices usually need to be added to each SDLC model to ensure the software being developed is well secured. This white paper recommends a core set of high-level secure software development practices called a secure software development framework (SSDF) to be integrated within each SDLC implementation. The paper facilitates communications about secure software development practices among business owners, software developers, project managers and leads, and cybersecurity professionals within an organization. Following these practices should help software producers reduce the number of vulnerabilities in released software, mitigate the potential impact of the exploitation of undetected or unaddressed vulnerabilities, and address the root causes of vulnerabilities to prevent future recurrences. Also, because the framework provides a common vocabulary for secure software development, software consumers can use it to foster communications with suppliers in acquisition processes and other management activities.

You must protect yourself

- You cannot be assured that a vendor is aware of the risks that are inherent in their software or the supply chain used by your Company to acquire their software
- If a breach occurs in your Company, then you will be the one accountable for the damage and costs to recover (not the SW vendor/supplier), along with any non-compliance fines
- You cannot “outsource” all of the cost of a breach, i.e. recovery efforts and the harm to reputation from a successful cyber attack on your Company,
- But you can try to detect risks
- Would you take a free drink from a stranger in a bar? Software should be viewed in the same way!
- Never trust software, always verify and report!™

Ongoing Due Diligence

- Implement software integrity and authenticity controls following the technical guidelines contained in NERC CIP-010-3 augmented by the enhanced best practices provided in the NIST Cybersecurity Framework
- Follow FERC's suggestions:
  - *"Standards do not necessarily require entities to employ best practices"*
  - *"augmenting the current CIP Reliability Standards under FPA section 215 with an incentive-based approach under FPA section 219 that encourages utilities to undertake cybersecurity investments on a voluntary basis. This approach would incentivize a utility to adopt best practices to protect its own transmission system as well as improve the security of the BES"*
- The NIST CSF contains a comprehensive set of guidelines of cybersecurity best practices that are intended to protect the Bulk Electric System, above an beyond NERC CIP-010-3 standards
- Cybersecurity is a cat and mouse game that requires constant vigilance
- Security risks don't stand still and neither should your software cybersecurity risk controls, in order to remain effective
- FERC Order 850, Mandatory Supply Chain Standards, are scheduled to go into effect on 10/1/2020 (18 CFR 40); it can take several months to setup effective risk management controls to satisfy NERC compliance requirements and apply effective best practices following the NIST CSF

Summary

- Software Supply Chain breaches are costly to recover from and can adversely effect Company finances and reputation (and your own career)
- Apply prudent risk management controls following NIST CSF best practices and NERC CIP-010-3 to detect risks and threats to the Bulk Electric System, and meet NERC compliance requirements
- No risk management control is guaranteed to protect you from harm, but some are useful
- Software supply chain risk assessments should include both vendor centric (CIP-013) and software centric risk (CIP-010-3) analysis
- You cannot rely on vendors to protect you from harm; you alone are accountable for your own security!

When Reality Sets In

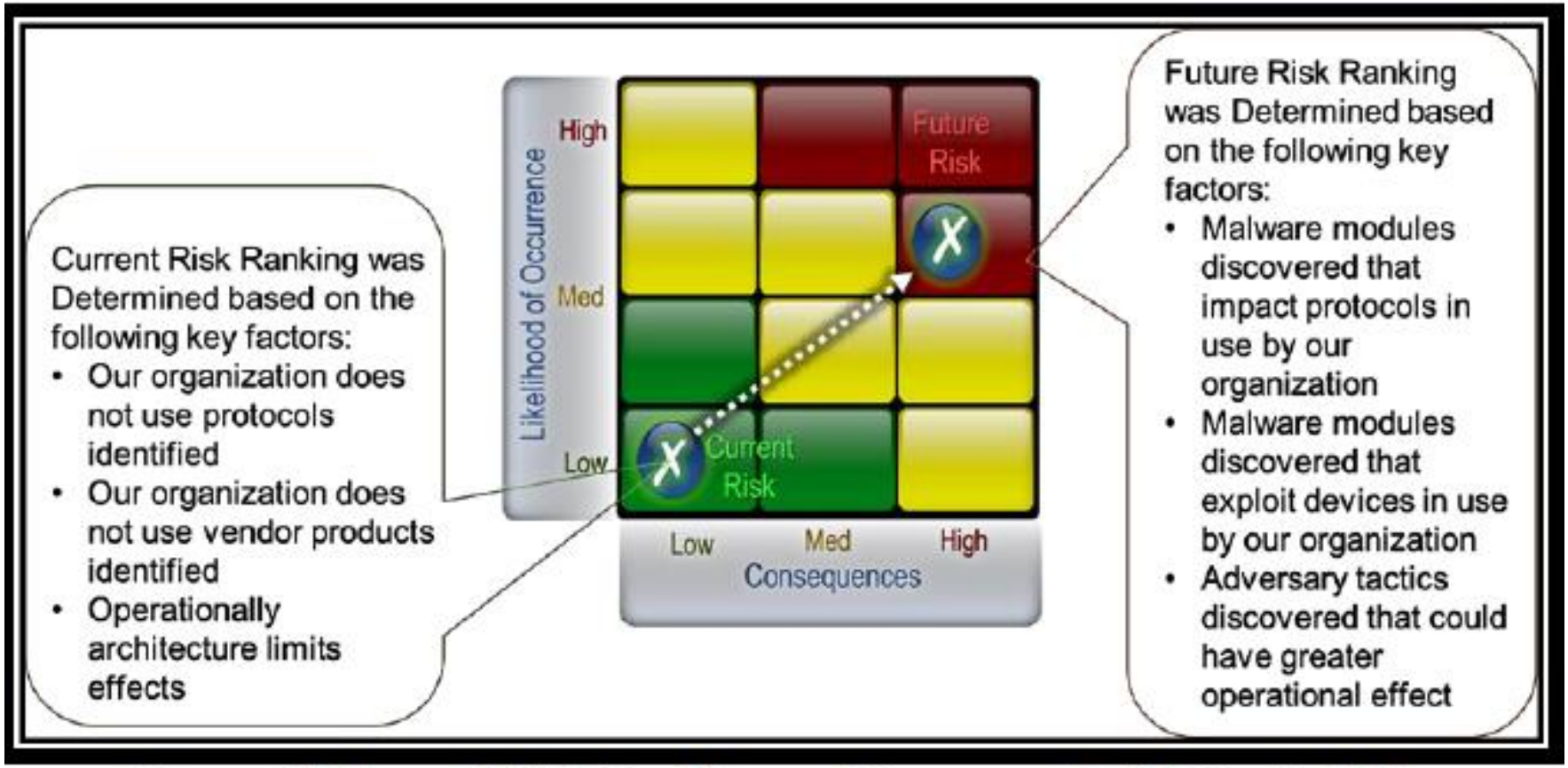


Figure 15: Current Risk Ranking and Assessment of Potential Risk

https://ics.sans.org/media/E-ISAC_SANS_Ukraine_DUC_6.pdf

Questions?

Dick Brooks
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Acknowledgements

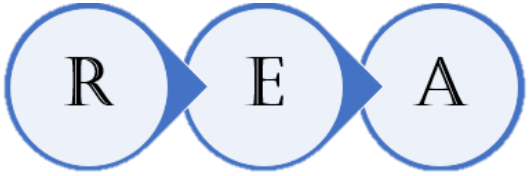
- Many thanks to Tom Alrich for providing valuable insights on NERC CIP-013-1.
- I highly recommend following his NERC CIP blog postings here: http://tomalrichblog.blogspot.com/

Reliable Energy Analytics LLC

- Established December 2018
- Developer of patent pending Software Assurance Guardian™ (SAG) Methodologies and Technologies
- Provider of Software Risk Management controls to meet NERC CIP-010-3 and FERC Order 850 regulations on 10/1/2020; SAG Point Man software (SAG-PM™)
- Extensive Energy industry experience, since 1990, delivering secure, mission critical software solutions
- 14 years with ISO New England responsible for enterprise architecture, Advanced Data Analytic solutions, NAESB PKI standards and implementation
- Active member of the North American Energy Standards Board (NAESB), serving as Vice Chairman on the Wholesale Electric Quadrant (WEQ) Executive Committee
- Never trust software, always verify and report!™

Contact Information

Dick Brooks



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