Software Supply Chain Risks to DevSecOps Programs

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Agenda

- Who are we and what are we talking about?
- What is the software supply chain?
- Recent trends and incidents
- Tail risk: Are these sorts of incidents really rare and unpredictable?
- DoD DevSecOps Reference Architecture
- Software supply chain weak points
- What can programs do to protect themselves?
Who are we?

• Aaron Reffett
  • Senior Software Engineer, Security Automation Directorate, CERT
  • Full-Stack Software Engineer
  • 17 years supporting DoD software engineering, 10 years at CERT
  • Directly support DoD programs adopting DevSecOps

• Richard Laughlin
  • Software Engineer, Security Automation Directorate, CERT
  • Research Interests in DevSecOps and Kubernetes.
  • Directly support DoD programs adopting Kubernetes in pursuit of DevSecOps.
DoD DevSecOps is Relatively New

• New model for software engineering and system operations for DoD
  • Still being developed and refined as we speak!
• DevSecOps-based weapons systems have not seen significant use in highly adversarial settings
  • What happens when they face a confluence of adverse events?
• Adoption of open-source software vs COTS/GOTS
• What are the weak points in DevSecOps software supply chain?
• What are the worst-case scenarios if these weak points are exploited?
What is the Software Supply Chain?

- Traditional supply chain focuses on physical rather than logical
- Software Supply Chain is anything and everything that touches or affects your software:
  - Dependencies (configuration, code, binaries, containers, etc.)
  - Build tools (compilers, code analyzers, code repositories, build orchestrators)
  - Operational tools (security, monitoring, logging, alerting, etc.)
  - People, Organizations and Processes (internal and upstream)
  - Underlying platforms and infrastructure (physical or virtual)
- An organization inherits the software supply chain of all components that comprise it’s software
- Average GitHub repository contains 203 open source dependencies
- **Enduring, Continuous and Real-time**
5 Trends in Software Supply Chain Attacks

1. **Deep Impact**: State actors target the software supply chain and do so to great effect.

2. **Abusing Trust**: Code signing is a deeply impactful tactic for compromising software supply chains as it can be used to undermine other related security schemes, including program attestation.

3. **Breaking the Chain**: Hijacked updates are a common and impactful means of compromising supply chains and they recurred throughout the decade despite being a well-recognized attack vector.

4. **Poisoning the Well**: Attacks on OSS are popular, but unnervingly simple in many cases.

5. **Downloading Trouble**: App stores represent a poorly addressed source of risk to mobile device users as they remain popular despite years of evidence of security lapses.

Atlantic Council: Breaking Trust: Shades of Crisis Across an Insecure Software Supply Chain
Recent Examples of Supply Chain Incidents

- Various AWS Outages
  - 2017: us-east-1 S3 outage took down EC2 and other services
  - 2019: Power failure (main and backup) in us-east-1 resulted in data loss
  - 2020: Kinesis outage in us-east-1 disrupted service to many apps and services
- AWS Route 53 BGP Hijack
  - Attackers hijacked IP prefixes for AWS DNS service
  - Re-routed traffic destined for a cryptocurrency site to attacker-controlled servers
- SolarWinds
  - Attack against build process
  - Targeting victims’ operational infrastructures
- Pulse Secure
  - “Normal” vulnerability
  - Pre-auth RCE (SMB, RDP are also recent examples)
Recent Examples of Supply Chain Incidents (2)

- PyPi package name typo squatting
  - urllib vs urllib3
  - crypt vs crypto
  - setup-tools vs setuptools

- event-stream Node.js library
  - New dev imported new unused dependency: flatmap-stream
  - Malicious code injected into flatmap-stream, which users of event-stream transitively inherited
  - Because of transitive indirection, most users of event-stream did not notice the change

- left-pad Node.js library
  - Developer removed the library from npm (Node Package Manager)
  - Downstream dependents failed to build (e.g. React) causing a snowball effect
  - 22 lines of code

- ShadowHammer
  - Targeted ASUS computers by hijacking ASUS’ automated update feature
Tail Risk and the Kurtosis Effect

- Many models of risk assume that the probability events follows a normal distribution
- Fat tails occur when the probability of events outside 2 standard deviations of the mean is greater than that of a normal distribution
- Consequence is that low-probability high-impact events are discounted or ignored completely
- DoD programs should assume that their risks follow a left fat tail distribution
- Simple reason: Don’t assume black swans are random as opposed to orchestrated
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DoD DevSecOps Reference Architecture
High Level View of Abstract System

1. Software-enabled infrastructure
2. Common Platform(s)
3. Software Factory
4. Mission System

Common Platform (e.g. Kubernetes)
Common Infrastructure (e.g. AWS, Azure, GCP)
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Software Supply Chain Weak Points
Cloud Infrastructure

• Software layer over someone else’s compute, network and storage

• Example: S3 went down and crashed half the Internet

• Threat vectors:
  • Attack hardware integration homogeneity
  • Geo-distributed, but global control plane
  • Attack AMIs, Linux kernel, Xen hypervisor

• What happens if the cloud just goes away?
  • BGP hijacking
General Suggestions for **Cloud Infrastructure**

- Do not assume cloud providers are invulnerable.
  - Consider risks due to compromise or unavailability of cloud infrastructure during your risk analysis.

- For critical applications develop a Disaster Recovery / Business Continuity plan and exercise it regularly.

- Monitoring and Telemetry
  - Utilize cloud monitoring, but assume that during an attack the adversary will attempt to blind operators by attacking monitoring infrastructure as well.
Platform

• Platform One/Kubernetes
  • Homogenous, compromise this and many programs are at risk.
  • Based on open-source, adversaries have full visibility into the components and supply chain.

• Includes Application platforms: OSGi, application servers (e.g. Websphere), application stacks (e.g. Struts, Django)
  • Libraries and containers

• Cloud platforms (S3, EC2, RDS, etc.)
  • Can be reconnned in commercial regions to develop attacks against government regions
### General Suggestions for Platform

- Do not assume that vendors or distributions of container orchestrators (e.g. Kubernetes) have got architectural tradeoffs right for your use case.

- Be aware of, and familiar with all components of vendor supplied platforms and remove any components which are not strictly necessary for your environment and use case.
Factory Inputs

- Base container images
- Distro Packages (and dependencies)
- Third-party tools
- Software Libraries/Packages
General Suggestions for **Factory Inputs**

- **Manage Base Images**
  - Look for signed images.
  - Consolidate on a single package ecosystem (when possible).

- Utilize scanning tools to manage the system packages within containers, and to detect and respond to CVEs.

- Carefully consider each software library which is used by your software.
  - Avoid packages with a small user base (when possible).
  - Watch out for typo-squatting
Mission System

• Mission system utilizes many tools to support its operations
  • What happens if the logging and alerting system is subverted?

• Does the mission system integrate with external applications or services (e.g. via API)?

• SolarWinds: Targeted operational infrastructure
• Pulse Secure: Protects access to critical components, control plane

• How do you know your telemetry is good and accurate?
• Treat tools with ITSM stack as critically as software factory tools or mission application components
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Wrapping up
Wrapping Up

• Take inventory of all software, tools, vendors, etc. that make up your supply chain

• Monitoring and Telemetry

• Comprehensive risk analysis

• Control as much of the supply chain as possible

• Be proactive, but be prepared to respond quickly
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Discussion and Questions