Integrating the Risk Management Framework (RMF) with DevOps

March 2018

Timothy A. Chick
Security Automation Systems Technical Manager

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213
Distribution Statements

Copyright 2018 Carnegie Mellon University. All Rights Reserved.

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

The view, opinions, and/or findings contained in this material are those of the author(s) and should not be construed as an official Government position, policy, or decision, unless designated by other documentation.

References herein to any specific commercial product, process, or service by trade name, trade mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by Carnegie Mellon University or its Software Engineering Institute.

NO WARRANTY. THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

[DISTRIBUTION STATEMENT A] This material has been approved for public release and unlimited distribution. Please see Copyright notice for non-US Government use and distribution.

This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

CERT® is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

DM17-0727
Topics

What is DevOps
What is RMF
Security in an Agile World
Achieving Ongoing Authorization Decisions
DevOps Strategies

What are the core strategies of the DevOps paradigm?

Design flexible software architecture encompassing simple, independent components

Implement frequent, incremental changes

Integrate innovative, customizable tools that can automate maintenance processes to include communications, testing, deployment, cyber security . . .
DevOps is an Extension of Agile Thinking

Agile

Embrace Constant Change

Embed Customer in team to internalize expertise on domain and requirements

DevOps

Embrace Continuous Integration, Testing, Delivery

Embed Operations in team to internalize expertise on delivery and maintenance
DevOps Phases

DEVELOPMENT

OPERATIONS

- BUILD
- CODE
- PLAN
- TEST

- RELEASE
- DEPLOY
- OPERATE
- MONITOR
Topics

What is DevOps
What is RMF
Security in an Agile World
Achieving Ongoing Authorization Decisions
What is the Risk Management Framework (RMF)?

In 2014, the DoD started transitioning from the DoD Information Assurance Certification and Accreditation Process (DIACAP) to the Risk Management Framework for the DoD IT (RMF).


The Risk Management Framework (RMF) provides a disciplined and structured process that integrates information security and risk management activities into the system development lifecycle.
What is the RMF?

Step 1 CATEGORIZE System
- Categorize the system in accordance with the CNSSI 1253
- Initiate the Security Plan
- Register system with DoD Component Cybersecurity Program
- Assign qualified personnel to RMF roles

Step 2 SELECT Security Controls
- Common Control Identification
- Select security controls
- Develop system-level continuous monitoring strategy
- Review and approve the security plan and continuous monitoring strategy
- Apply overlays and tailor

Step 3 IMPLEMENT Security Controls
- Implement control solutions consistent with DoD Component Cybersecurity architectures
- Document security control implementation in the security plan

Step 4 ASSESS Security Controls
- Develop and approve Security Assessment Plan
- Assess security controls
- SCA prepares Security Assessment Report (SAR)
- Conduct initial remediation actions

Step 5 AUTHORIZE System
- Prepare the POA&M
- Submit Security Authorization Package (security plan, SAR and POA&M) to AO
- AO conducts final risk determination
- AO makes authorization decision

Step 6 MONITOR Security Controls
- Determine impact of changes to the system and environment
- Assess selected controls annually
- Conduct needed remediation
- Update security plan, SAR and POA&M
- Report security status to AO
- AO reviews reported status
- Implement system decommissioning strategy
The RMF/ATO Problem

Every system has **inherent risks** associated with it.

Program Manager (PM) is **graded** against the system’s **KPP** and their compliance with all **regulations**, along with **cost** and **schedule** parameters.

PM makes **trades** between cost, schedule, quality, and functionality. With each trade **residual risks** occur.

Someone must **accept ALL residual risk** associated with the system before placing it into operations.

The Authorizing Official (AO) is responsible to **accepting information security risks**, which is done through the RMF process.

An ATO is usually good for 3 years, but **assumes no major changes** to the system’s cybersecurity posture will be made during that time.

When **changes** do occur the AO may require a **reassessment** and **reauthorization**, which impacts the PM’s cost and schedule and is **contrary to being Agile**.
RMF’s Solution to Problem

RMF encourages an alternative approach to the traditional 3 year ATO process through ongoing authorization decisions or continuous reauthorization.

RMF assumes these systems have “been evaluated as having sufficiently robust system-level continuous monitoring programs”
Topics

What is DevOps
What is RMF
Security in an Agile World
Achieving Ongoing Authorization Decisions
Security in an Agile World - 1

Security is often focused on testing, and security activities are often conducted outside and apart from the software development process.

As a result, the outcomes of security activities are presented in documents and outputs that do not naturally fit any of the software development activities.
Security in an Agile World - 2

The goal is to guide the development of new activities and make adjustments to existing activities to make it natural and efficient to build security into an agile process.

DevSecOps Manifesto (http://www.devsecops.org)

    Leaning in over Always Saying “No”
    Data & Security Science over Fear, Uncertainty and Doubt
    Open Contribution & Collaboration over Security-Only Requirements
    Consumable Security Services with APIs over Mandated Security Controls & Paperwork
    Business Driven Security Scores over Rubber Stamp Security
    Red & Blue Team Exploit Testing over Relying on Scans & Theoretical Vulnerabilities
    24x7 Proactive Security Monitoring over Reacting after being Informed of an Incident
    Shared Threat Intelligence over Keeping Info to Ourselves
    Compliance Operations over Clipboards & Checklists

“By developing security as code, we will strive to create awesome products and services, provide insights directly to developers, and generally favor iteration over trying to always come up with the best answer before a deployment.”
DoD SDLC, RMF, and DevOps

RMF’s Continuous Reauthorization concept directly aligns with DevOps

CYBER SECURITY

Security Must be Integrated in order to be Effective

The Application Layer is the new perimeter

Security must be Engineered into the Lifecycle of Applications

2017 less than 5% of DevOps initiatives have achieved the level of security automation required to be considered fully DevSecOps.³

1. Clark, Tim, Most cyber Attacks Occur from this Common Vulnerability, Forbes. 03-10-2015
2. Feiman, Joseph, Maverick Research: Stop Protecting Your Apps; It’s Time for Apps to Protect Themselves, Gartner. 09-25-2014. G00269825
Topics

What is DevOps
What is RMF
Security in an Agile World
Achieving Ongoing Authorization Decisions
DevOps Has Four Primary Focus Areas

Collaboration between project team roles

Infrastructure as Code: Scripted Infrastructure Configuration

Automation of Tasks / Processes / Workflows

Monitoring Applications and Infrastructure
DevOps Uses Automation to facilitate Communication

- Define Problem Domain
- Capture, Analyze, Track, and Communicate changes
- Collaborate Across Cross-Functional Team
- Used in support controls such as:
  - CA-7(1) Continuous Monitoring
  - CM-2 Baseline Configuration
  - CM-3 Configuration Change Control
  - CM-4 Security Impact Analysis
  - IR-4 Incident Handling
  - MA-6 Timely Maintenance
The SDLC is Full of Decision Points

Without Ops knowledge, developers continually make uninformed decisions, causing eventual *risk* or *inefficiency*.
The SDLC contains many Decision Points with Security Implications

What OS?
What ports?
VMs or containers?
Entry points?

What kind of user authentication?
REST vs SOAP?
How to architect for scalability?
Infrastructure as Code
What is IaC?

A program that creates infrastructure

* A concretely defined description of the environment is good material for conversation between team members.
IaC Apparent Benefits

Because the environment and application are versioned together, tagging code is that much more meaningful.
IaC Provides a Solution – Scenario #1

Scenario #1

A vulnerability is being exploited in production that cannot be reproduced in development. Even rolling back development code to the production version doesn’t allow it to manifest. It may be an issue with updated packages or OS in development.

Examples of related RMF Controls:

• IR-3 Incident Response Testing
• IR-10 Integrated Information Security Analysis Team
• SA-10 Developer Configuration Management

Versioned Environment
IaC Provides a Solution – Scenario #2

Scenario #2

The operations team is following recovery instructions for the production environment based on documentation. It turns out there is a dependency problem because an incorrect version of a package was cited.

Examples of related RMF Controls:

- CP-2 Contingency Plan
- CP-6 Alternative Storage Site
- CP-7 Alternative Processing Site
- CP-10 Information System Recovery and Reconstitution

Scripted Environment
IaC Provides a Solution – Scenario #3

Scenario #3

Security features that worked perfectly during testing fails when deployed to the production infrastructure.

Examples of related RMF Controls:

- CA-8 Penetration Testing
- CM-2 Baseline Configuration
- CM-3 Configuration Change Control
- CM-4(2) Security Impact Analysis | Verification of Security Functionality
- CM-6 Configuration Settings

Environment Parity
Common Tools

Shell scripts – scripting platform-specific commands

Vagrant - assists in managing virtual machines and provisioning

Chef or Puppet - wrappers around your shell
  provide hooks and convenience methods
  layer of indirection between script and OS-specifics
  provides portability

Docker – deployable Linux containers
  runs on Linux only (for now)
  whole environments can be easily shared
Automation of Tasks, Processes, and Workflows

(SA-15 Development Process, Standards, and Tools)
Software projects consist of many artifacts
Integration can be challenging

![Diagram showing different software artifacts and a merge conflict]

- Code
  - Developer
- Code
  - Developer
- Images
  - Designer
- Environment Configuring Scripts
  - Operations

Merge Conflict!
This is often a manual process
Continuous Integration (CI) Model
Fail the Build When Software isn’t Good Enough

Don’t just configure failure for compile/build errors!

- Does the changes include a know weak coding practices (CWE)?
  - Automatically run changes against a static code analysis tool and fail the build if a new CWE is found
- Do any of the current or new libraries have known vulnerabilities (CVE)?
- Did any Functional Security Tests Fail?
- Example Security Controls:
  - SA-11 Developer Security Testing and Evaluation
  - SA-12 Supply Chain Protection
  - CM-4 Security Impact Analysis
  - RA-3 Risk Assessment

CI is your best tool to enforce security standards
Functional Security Tests

Automated unit, integration and acceptance testing tools can be used to verify security controls.

A large proportion of security tests are essentially checks that known weaknesses have not been introduced.

The following security controls are examples of controls that can be monitored/tested using existing acceptance testing browser automation tools like Selenium:

- AC-2(4) Account Management | Automated Audit Actions
- AC-2(5) Account Management | Inactivity Logout
- AC-2(11) Account Management | Usage Conditions
- AC-6 Least Privilege
- AC-12(1) Session Termination | User-Initiated Logouts/Message Displays
- AC-7 Unsuccessful Login Attempts
- CM-2 Least Functionality
- IA-2 Identification and Authentication (multi-factor)
Continuous Integration Systems
Monitoring Applications and Infrastructure
Clarifying Terms

Continuous Deployment

Changes are deployed ASAP into production

Continuous Delivery

Changes are deployed immediately into a *production-like environment*, to ensure that they *could* be deployed into production
Shift Left Operational Concerns

Benefits of Continuous Delivery

- Speed time to market
- Reduce cost
- Reduce risk
- Scale
Gold-standard deployment

• Environment Parity
• Process Parity
• Automate
• Perform incremental changes
• Appropriate Testing
Continuous Delivery Is REALLY About Rigorous Testing

Certainty requires rigorous testing before and after deployment.
Test Enough That You Are Sure You Could Deploy Successfully

How much is enough?

What factors are important to you and your organization?

**Security?** Automate a large number of security-focused unit/integration tests

Design your CI/CD success criteria to enforce your goals
DevOps Operate Phase

- Continuous Monitoring
- Performance Measurement
- Incident Management
- System Security
- Auditing
DevOps and RMF Integration

There are several RMF process steps that can be executed throughout the DevOps deployment pipeline including:

• Develop Security Assessment Plan
  • DevOps team provides details/scripts regarding the implementation and configuration of automated testing tools

• Assess security controls
  • DevOps practices improve this process by automatically providing outputs from team code reviews, application scanning and regression tests

• Prepare Security Assessment Report
  • Automated test tool output can be generated into a suitable format for inclusion as input
  • These reports are generated as part of the Continuous Testing cycle (not just annually), so assessment data is fresh and reports can be compared for differences

• Conduct initial remediation actions
Continue Automated Testing in Production

Example Security Controls:
- AC-2(3) Account Management | Disable Inactive Accounts
- AU-2 Audit Events
- AU-5 Response to Audit Processing Failures
- AU-9 Protection of Audit Information
- AU-11Audit Record Retention
- SI-7 Software Firmware, and Information Integrity
- SI-11 Error Handling
DevOps Operate Phase: Integrate the Necessary Tools

- Nagios
- Elasticsearch
- PagerDuty
- Docker
- Logstash
- Ansible
- Prometheus
- Kibana
- Nessus
- MONIT
- Splunk
- Snort
DevOps Operate Phase: Performance Measurement
DevOps Operate Phase: Incident Management

Before the advent of DevOps strategies and associated tools, handling production incidents (application errors, performance hiccups, security breaches) was a tedious and time-consuming process.

Integrating DevOps tools (e.g. PagerDuty) can automate the process of incident monitoring, handling and reporting (IR-4, IR-5, IR-6, SI-4 Security Controls).

- Fatal Errors
- Performance Hits
- Security Breach

- Warnings are logged

- cat, awk, tail
- Hours/days searching through tons of log data
DevOps Operate Phase: Incident Management
DevOps Operate Phase: System Security

DevOps strategies and tools greatly enhance the tedium of implementing and managing application security (SI-4, SI-5, SI-6 Security Controls).

IaC tools such as Puppet can be used to configure, deploy and manage tools like Nessus and Snort.

Nessus scans systems and applications for weaknesses and vulnerabilities (RA-5). Reports are automatically generated and sent to necessary members of cross-functional team.

Snort can be deployed to automate intrusion detection (SC-38).
Benefits of DevOps

When security is fully integrated into the full Software Development, Maintenance, and Operational lifecycle a sufficiently robust system-level continuous monitoring program can be demonstrated in order to achieve a continuous reauthorization (ATO)
Contact Information

Presenter / Point of Contact
Tim Chick
Telephone: +1 412.268.1473
Email: tchick@sei.cmu.edu
Security Controls

AC – Access Control
AT – Awareness and Training
AU – Audit and Accountability
CA – Security Assessment and Authorization
CM – Configuration Management
CP – Contingency Planning
IA – Identification and Authentication
IR – Incident Response

MA – Maintenance
MP – Media Protection
PE – Physical and Environmental Protection
PL – Planning
PS – Personnel Security
RA – Risk Assessment
SA – System and Services Acquisition
SC – System and Communications Protection
SI – System and Information Integrity