Continuous Verification & Validation of Critical Software via DevSecOps

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Definitions (IEEE Std 1012™-2016)

Verification: The process of providing objective evidence that the system and it products

- Conform to requirements (e.g., for correctness, completeness, consistency, and accuracy) for all activities during each life cycle process
- Satisfy standards, practices, and conventions during life cycle processes
- Successfully complete each life cycle activity and satisfy all the criteria for initiating succeeding life cycle activities

Validation: The process of providing evidence that the system and its products

- satisfy requirements at the end of each life cycle activity
- Solve the right problem (e.g., correctly model physical laws, implement business rules, and use the proper system assumptions)
- Satisfy intended use and user needs in the operational environment.

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Builds the product correctly

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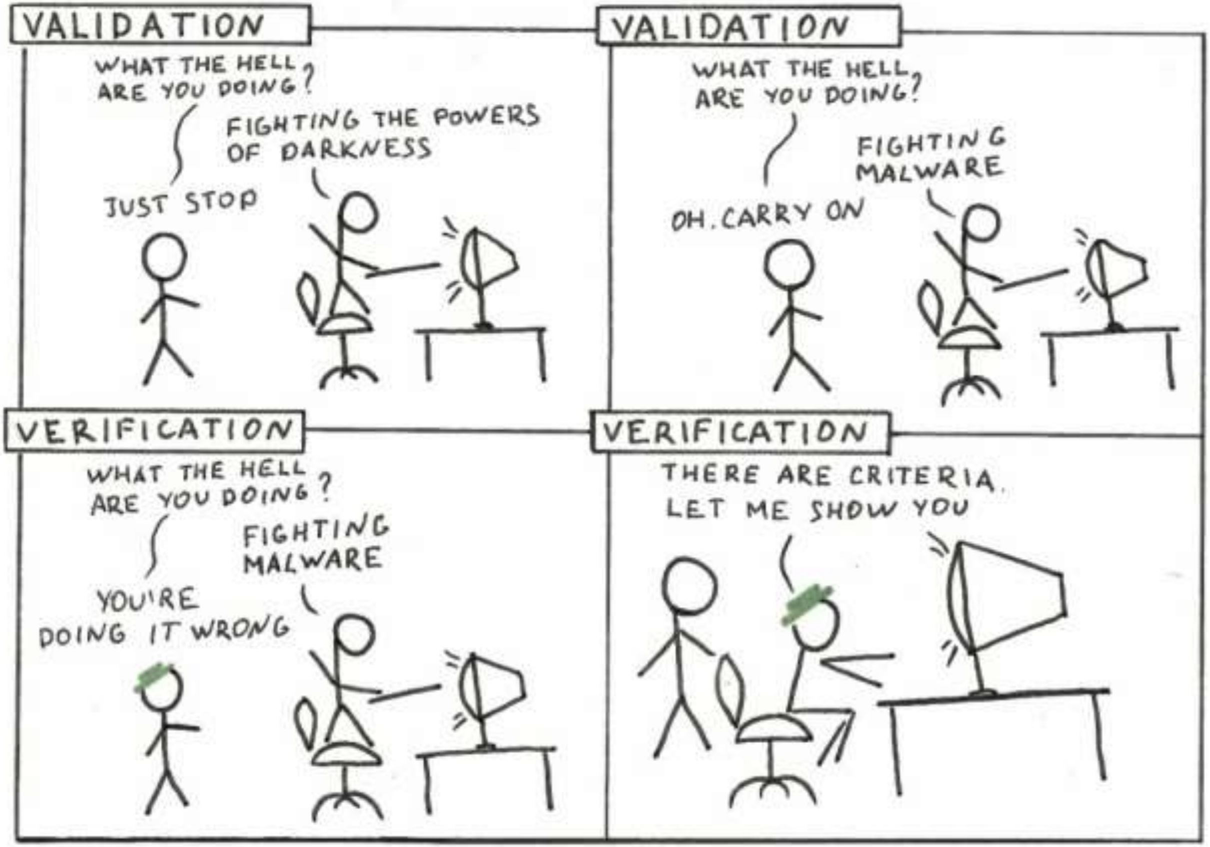
Builds the correct product


VALIDATION
WHAT THE HELL ARE YOU DOING?
FIGHTING THE POWERS OF DARKNESS
JUST STOP
VALIDATION
WHAT THE HELL, ARE YOU DOING?
FIGHTING MALWARE
OH. CARRY ON
VERIFICATION
WHAT THE HELL ARE YOU DOING?
FIGHTING MALWARE
YOU'RE DOING IT WRONG
VERIFICATION
THERE ARE CRITERIA. LET ME SHOW YOU

* https://securelist.com/the-power-of-vv/72615/

Why V&V?

Successful V&V process result

- Capture early detection and correction of any anomalies
- Engage with management insight into system lifecycle process
- Conformance to program performance, schedule and budget
- Early performance assessment
- Objective evidence
- Improve product quality from acquisition to operations
- Improve development and maintenance process

Verification Analysis

- Process:

  Conformance of developing product according to the specification

- Requirement:

  Architecture, Design, Code, SRS(System Requirement Specification), SDD (System Design Document)

- Activities:

  Reviews, Inspections, communication, code review, walkthroughs

- Methods:

  Static Methods of checking documentations and code

Validation Analysis

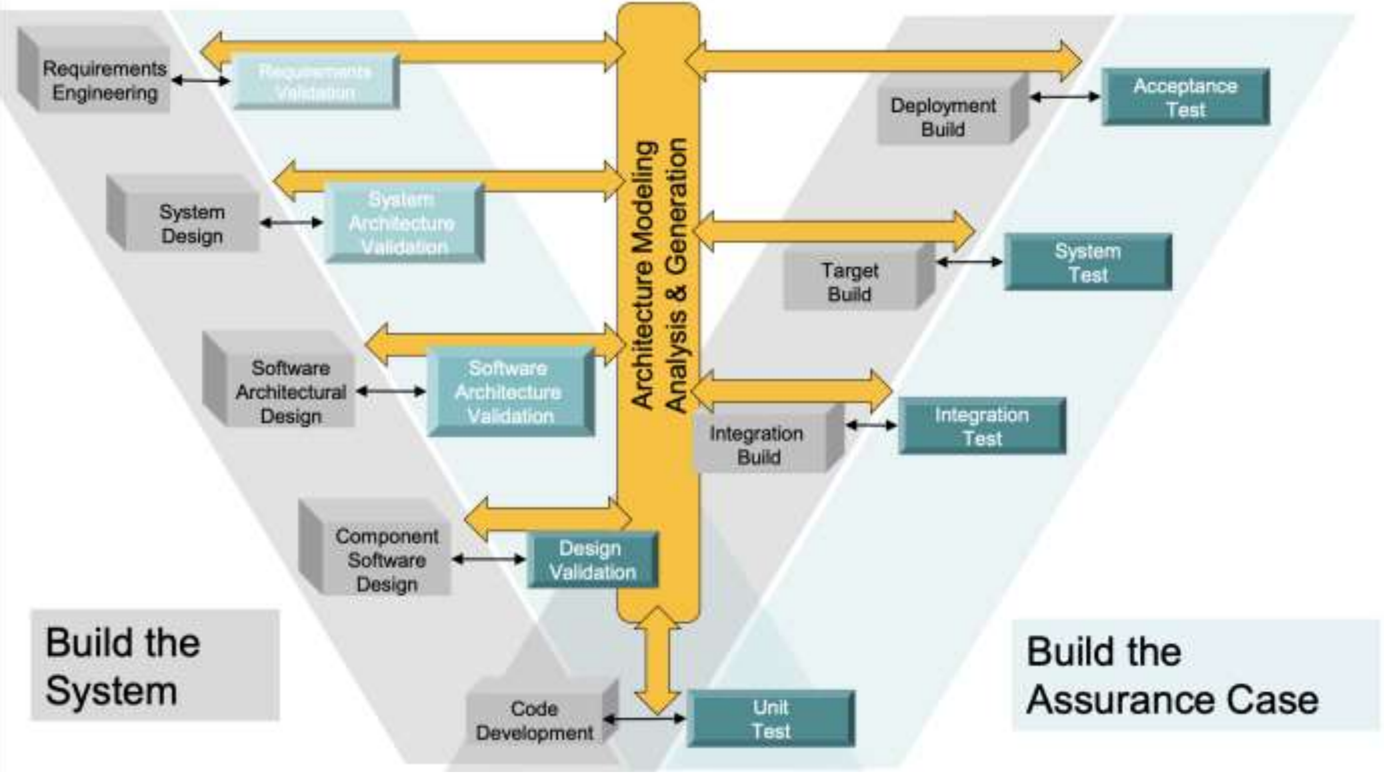
- Process:
  - *Testing and validation of the developed product*

- Requirement:
  - *Actual product*

- Activities:
  - *Various level of testing, (unit, functional/ non-functional, acceptance) – Code execution*

- Methods:
  - *Dynamic process of testing the actual product*

Architecture-centric Validation & Verification



* http://fm.csl.sri.com/LAW/2010/law2010-slides-Lewis.pdf

V&V Activities - 1

- Concept Documentation Evaluation
- Requirements Allocation Analysis
- Requirements Evaluation
- Design Evaluation
- Interface Analysis
- Traceability Analysis
- Criticality Analysis
- Software Component Test and Design Plan V&V
- Software Integration Test and Design Plan V&V
- Hazard Analysis
- Security Analysis
- Software Qualification Test Plan V&V
- Software Acceptance Test Plan V&V

V&V Activities - 2

- Risk Analysis
- Source Code and Source Code Documentation Evaluation
- Software Integration Test Execution V&V
- Software Qualification Test Execution V&V
- Installation Configuration Audit
- Installation Checkout
- Evaluation of New Constraints
- Operating Procedures Evaluation
- VVP Revision
- Anomaly Evaluation
- Migration Assessment
- Retirement Assessment
- Software Disposal Evaluation

Main Activity - Hazard Analysis

- Analyze the potential hazards to and from the conceptual system.
- Identify the potential system hazards.
- Assess the consequences of each hazard.
- Assess the probability of each hazard.
- Identify mitigation strategies for each hazard.

Main Activity - Security Analysis

- Review the system owner's definition

- Analyze the system concept from a security perspective

- Identify potential security risks with respect to CIA triad.

- Include an assessment of the sensitivity of the information/data to be processed.

- Analyze self introduced the security risks

Main Activity - Risk Analysis

- Review and update risk analysis using prior task reports.
  - Previous test results
  - Identify new risks
  - Hazard and Security uses cases

- Provide recommendations to eliminate, reduce, or mitigate the risks.
  - Assess and evaluate hazard driven security analysis
  - Integrate back to early lifecycle

Continuous Verification and Validation of Critical Software

Current SW Development Process

DevOps / Agile

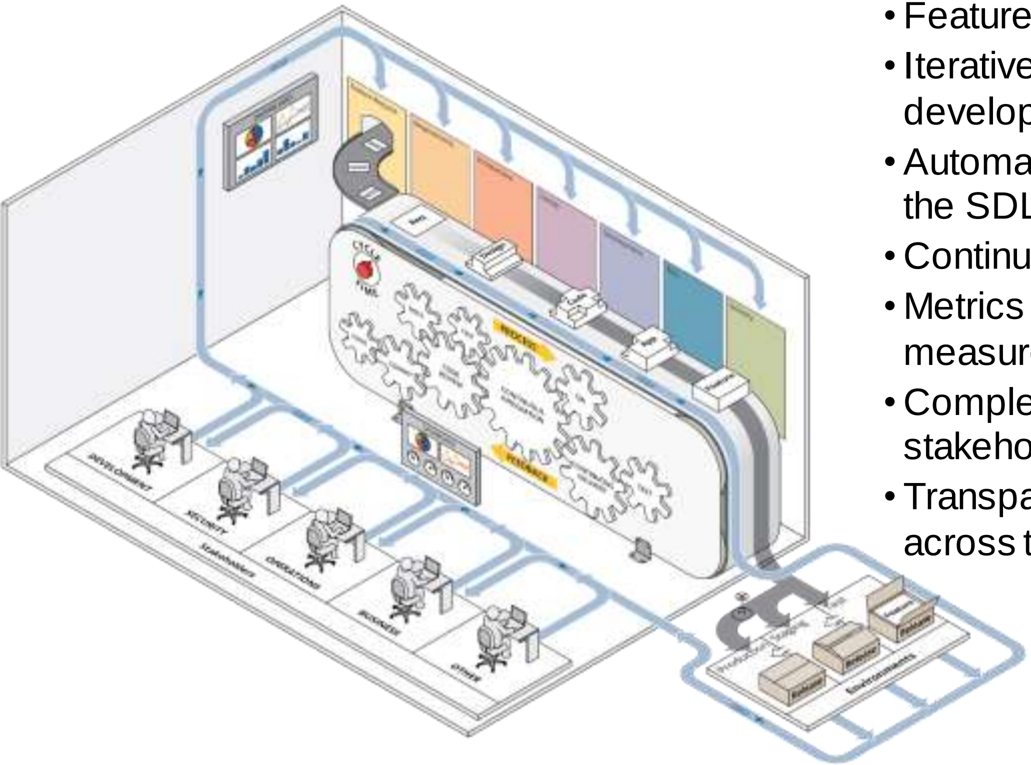
DevOps is a set of principles and practices emphasizing collaboration and communication between software development teams and IT operations staff along with acquirers, suppliers, and other stakeholders in the lifecycle of a software system[1]

Four Fundamental Principles

1. *Collaboration:* between all stakeholders
2. *Infrastructure as code (IaC):* assets are versioned, scripted, and shared
3. *Automation*: deployment, testing, provisioning, any manual or human-error-prone process
4. *Monitoring*: any metric in development or operation that can inform priorities, direction, and policy

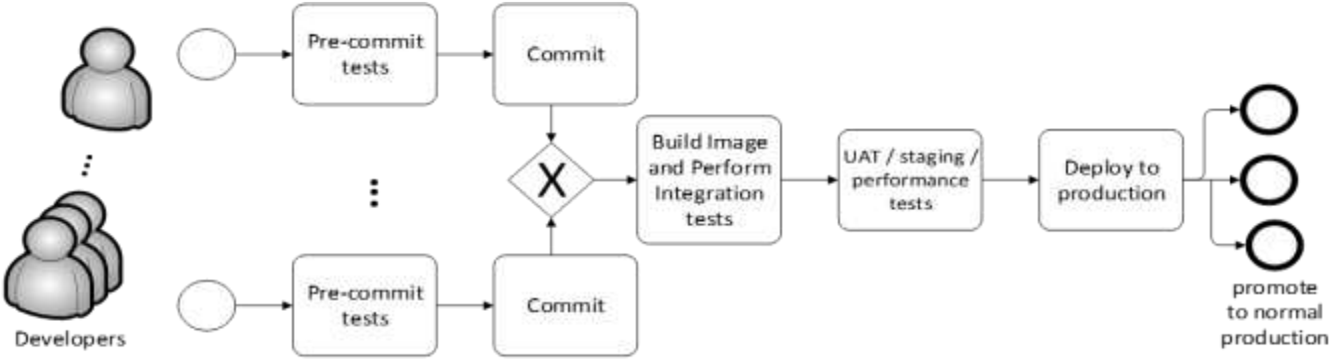
[1] IEEE 2675 DevOps Standard for Building Reliable and Secure Systems Including Application Build, Package and Deployment

DevSecOps Software Factory Concept



- Feature to deployment
- Iterative and incremental development
- Automation in every phase of the SDLC
- Continuous feedback
- Metrics and measurement
- Complete engagement with all stakeholders
- Transparency and traceability across the lifecycle

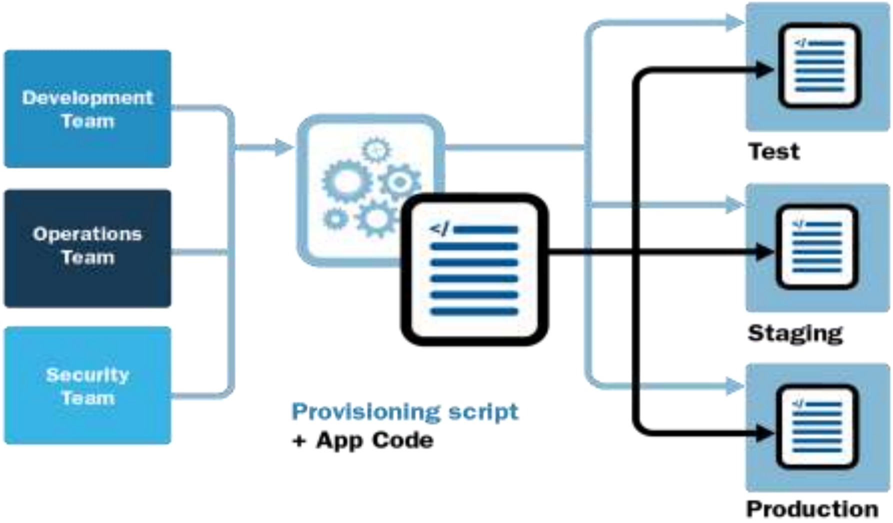
Multiple Environments in SDLC


Developers
Pre-commit tests
Commit
Pre-commit tests
Commit
X
Build Image and Perform Integration tests
UAT / staging / performance tests
Deploy to production
promote to normal production

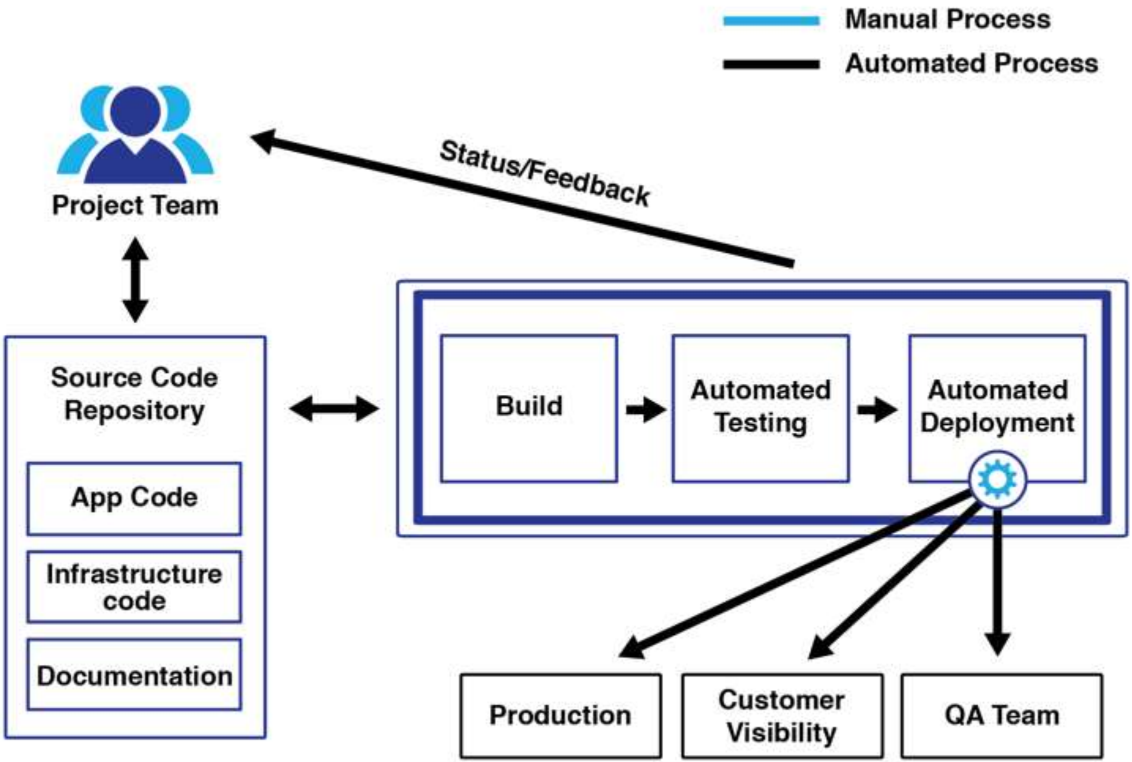
- Development environment
- Integration environment
- Staging environment
- Production environment

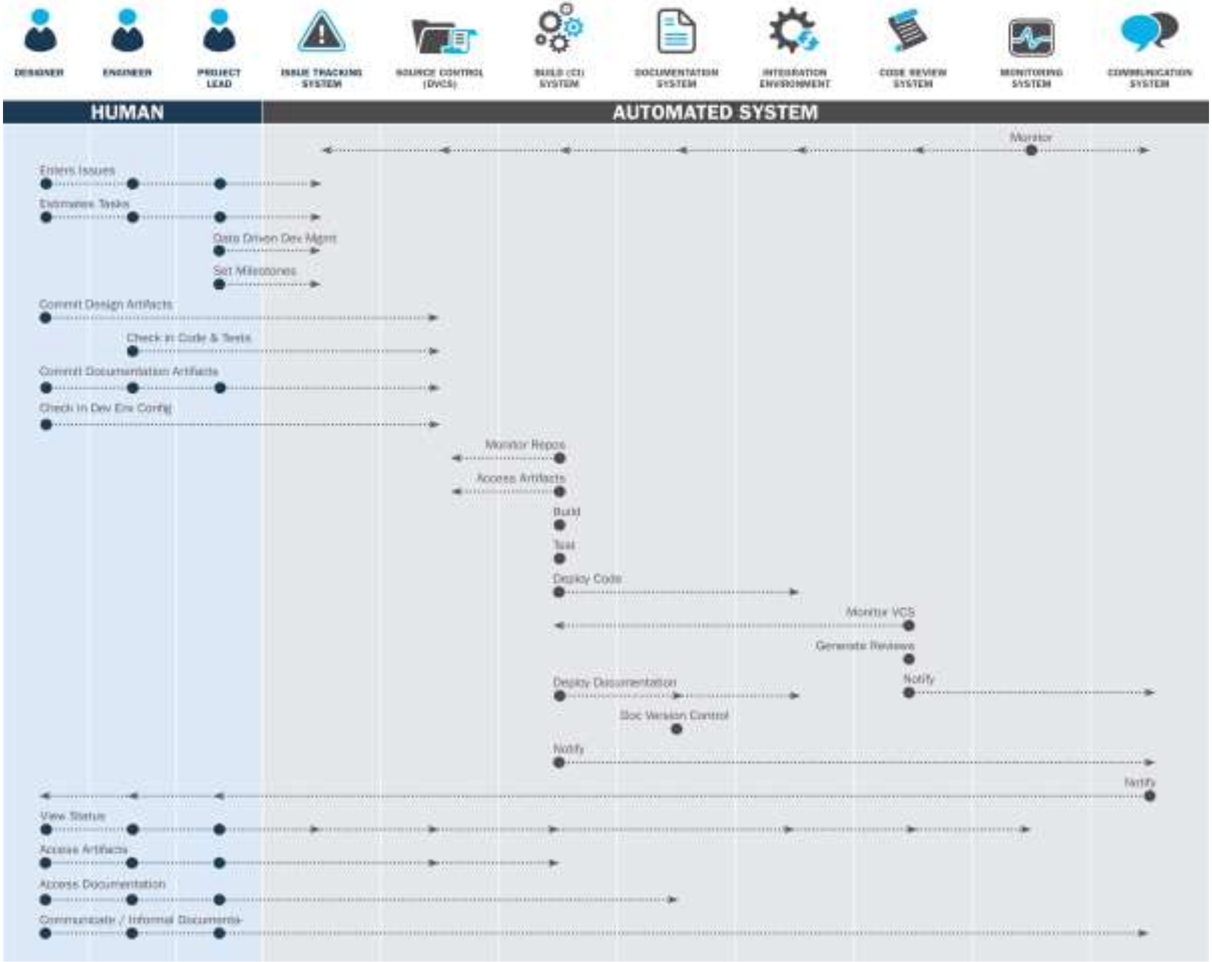
Infrastructure as Code

A program that creates infrastructure



Continuous Integration (CI) Model

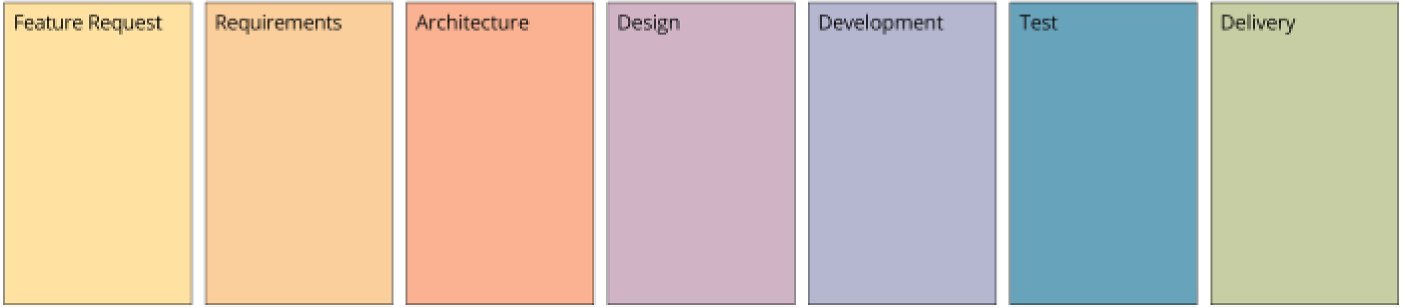



DESIGNER
ENGINEER
PROJECT LEAD
ISSUE TRACKING SYSTEM
SOURCE CONTROL (DVCS)
BUILD (CI) SYSTEM
DOCUMENTATION SYSTEM
INTEGRATION ENVIRONMENT
CODE REVIEW SYSTEM
MONITORING SYSTEM
COMMUNICATION SYSTEM
HUMAN
AUTOMATED SYSTEM
Monitor
Enters Issues
Estimates Tasks
Data Driven Dev Mgmt
Set Milestones
Commit Design Artifacts
Check in Code & Tests
Commit Documentation Artifacts
Check In Dev Env Config
Monitor Repos
Access Artifacts
Build
Test
Deploy Code
Monitor VCS
Generate Reviews
Deploy Documentation
Notify
Doc Version Control
Notify
Notify
View Status
Access Artifacts
Access Documentation
Communicate / Informal Documenta-

Continuous Verification and Validation of Critical Software

V&V Activities Across DevSecOps

Modern Software Development Phases



Feature Request

Requirements

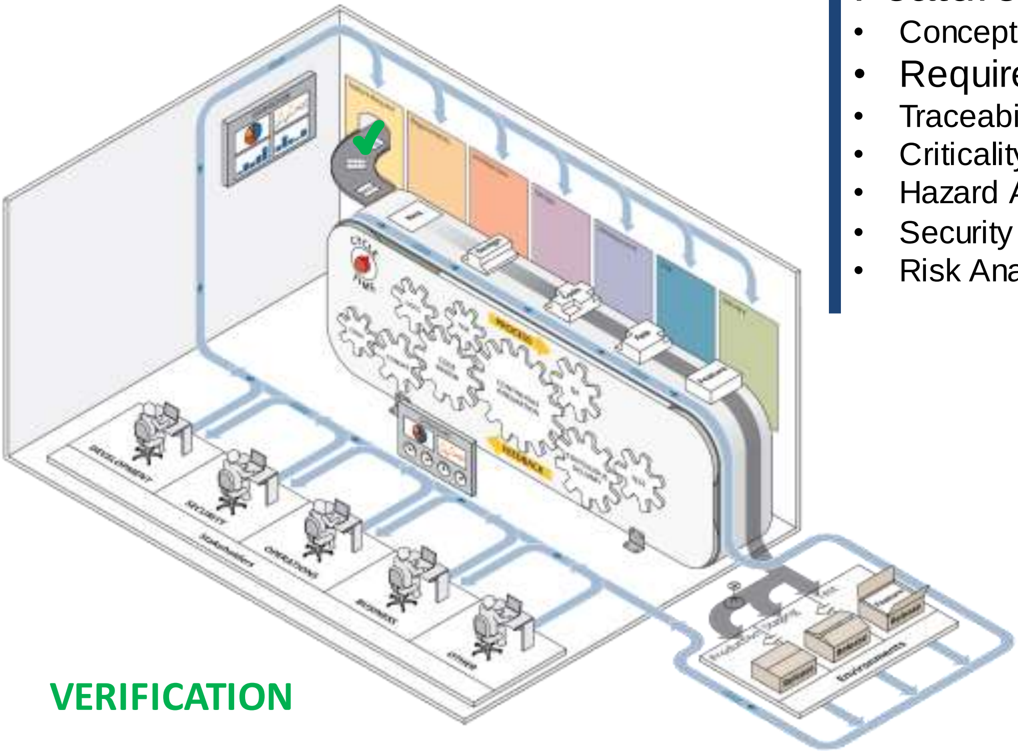
Architecture

Design

Development

Test

Delivery



VERIFICATION

Feature Request/Concept

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- Requirements Allocation Analysis
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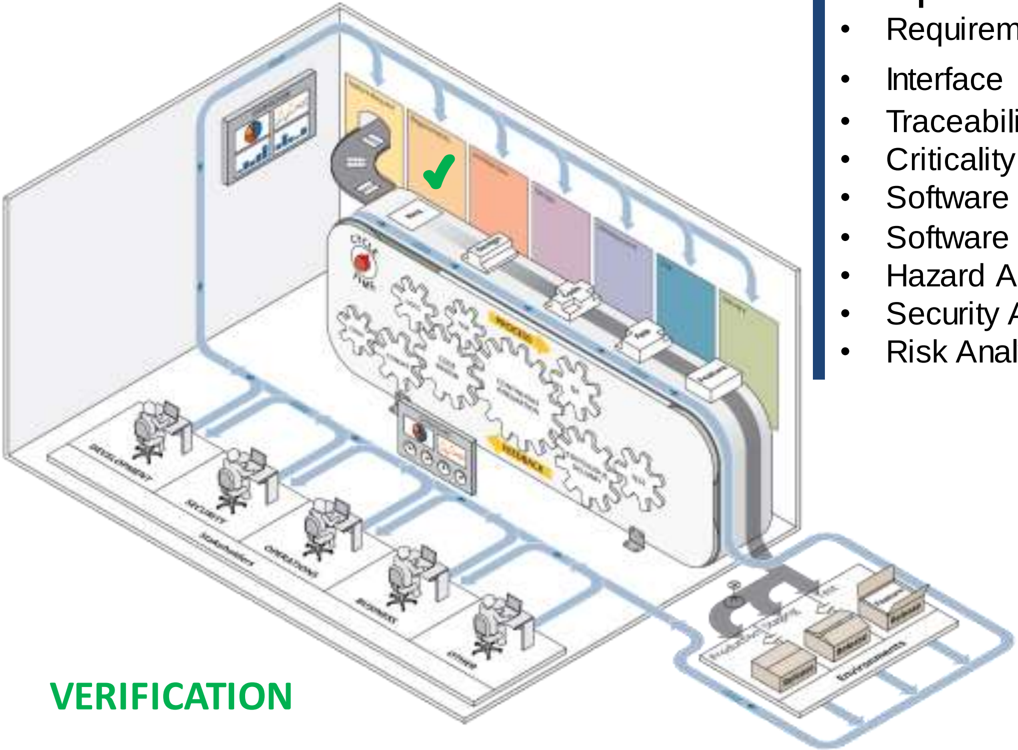
- Security Analysis
- Risk Analysis



VERIFICATION

Requirements

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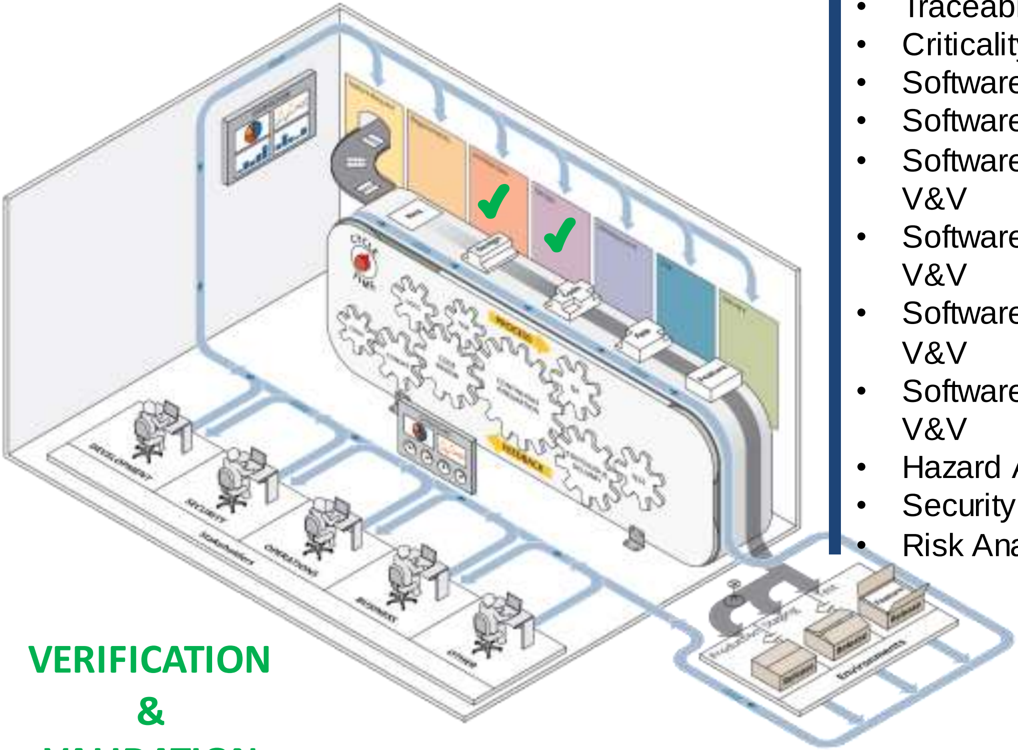
- Risk Analysis



VERIFICATION

&

VALIDATION

Architecture & Design

- Design Evaluation
- Interface Analysis
- Traceability Analysis
- Criticality Analysis
- Software Component Test Plan V&V
- Software Integration Test Plan V&V
- Software Component Test Design V&V
- Software Integration Test Design V&V
- Software Qualification Test Design V&V
- Software Acceptance Test Design V&V
- Hazard Analysis
- Security Analysis
- Risk Analysis

Development

- Source Code and Source Code Documentation Evaluation
- Interface Analysis
- Traceability Analysis
- Criticality Analysis
- Software Component Test Plan V&V
- Software Integration Test Plan V&V
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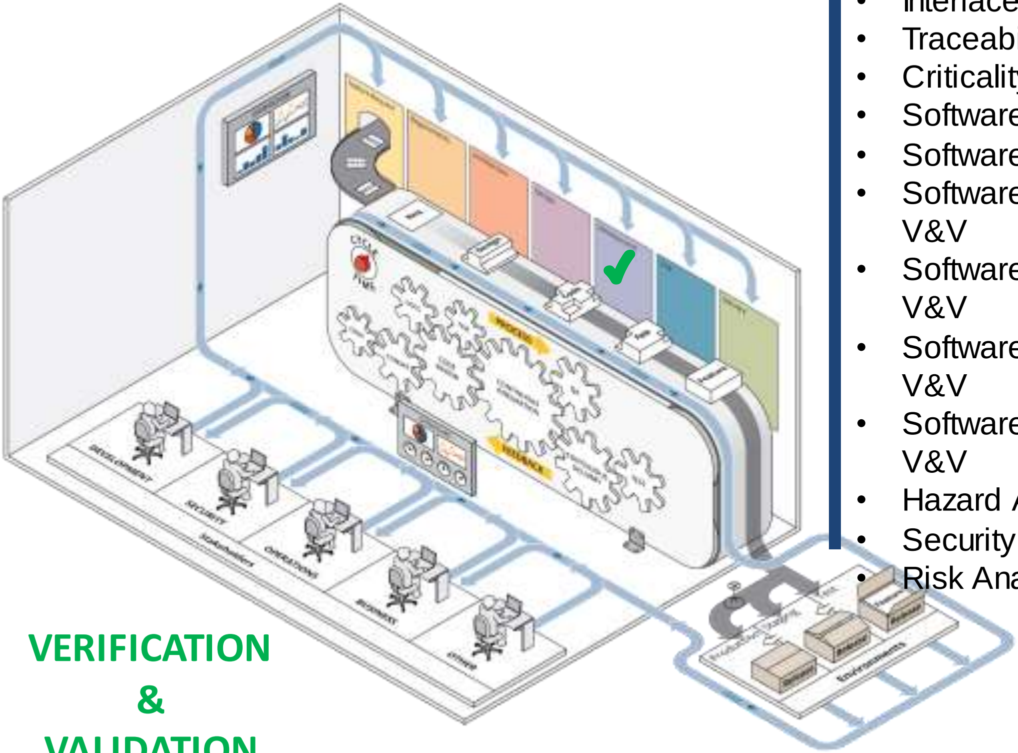
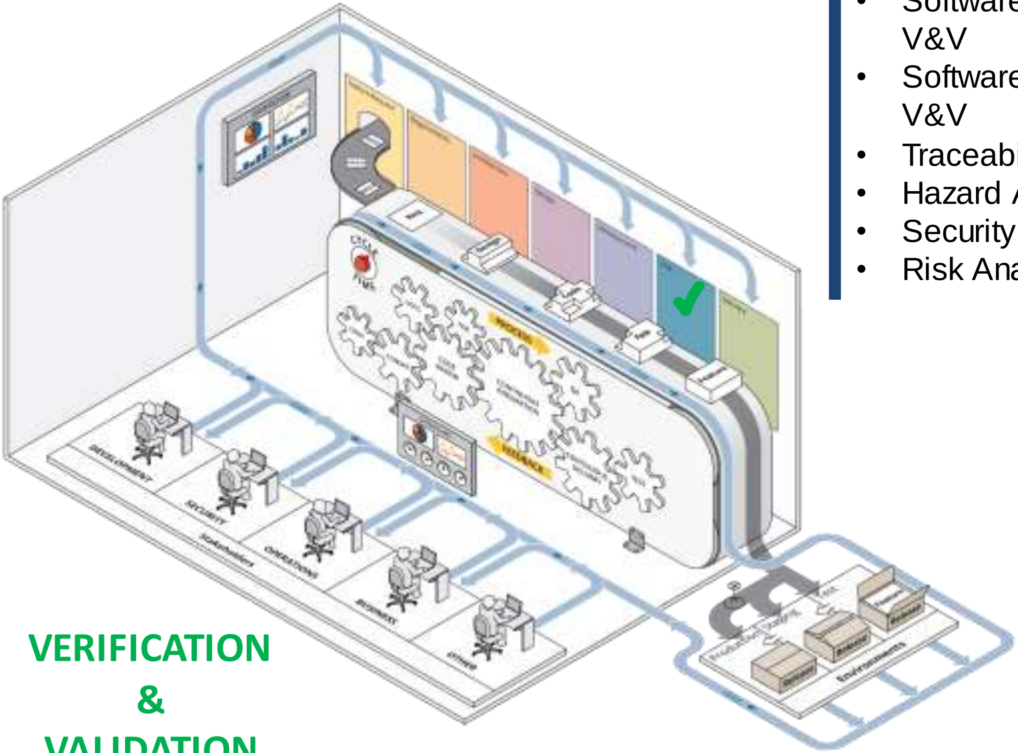


VERIFICATION & VALIDATION

Testing/Integration

- Software Qualification Test Execution V&V
- Software Acceptance Test Design V&V
- Software Integration Test Execution V&V
- Traceability Analysis
- Hazard Analysis
- Security Analysis
- Risk Analysis



VERIFICATION
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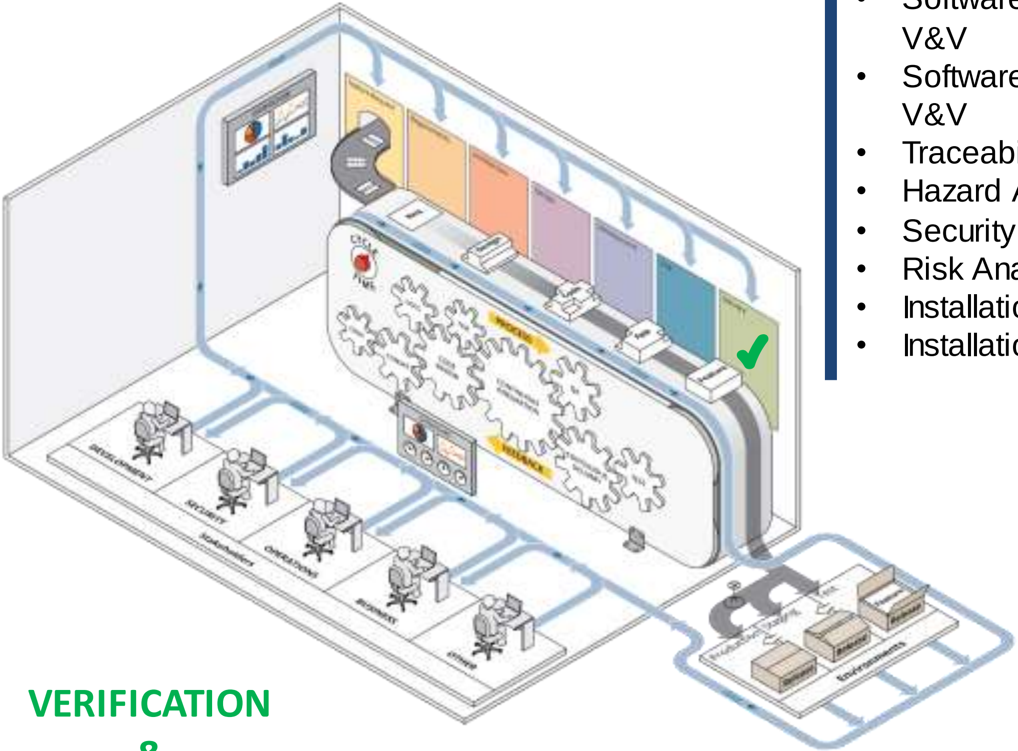
VALIDATION



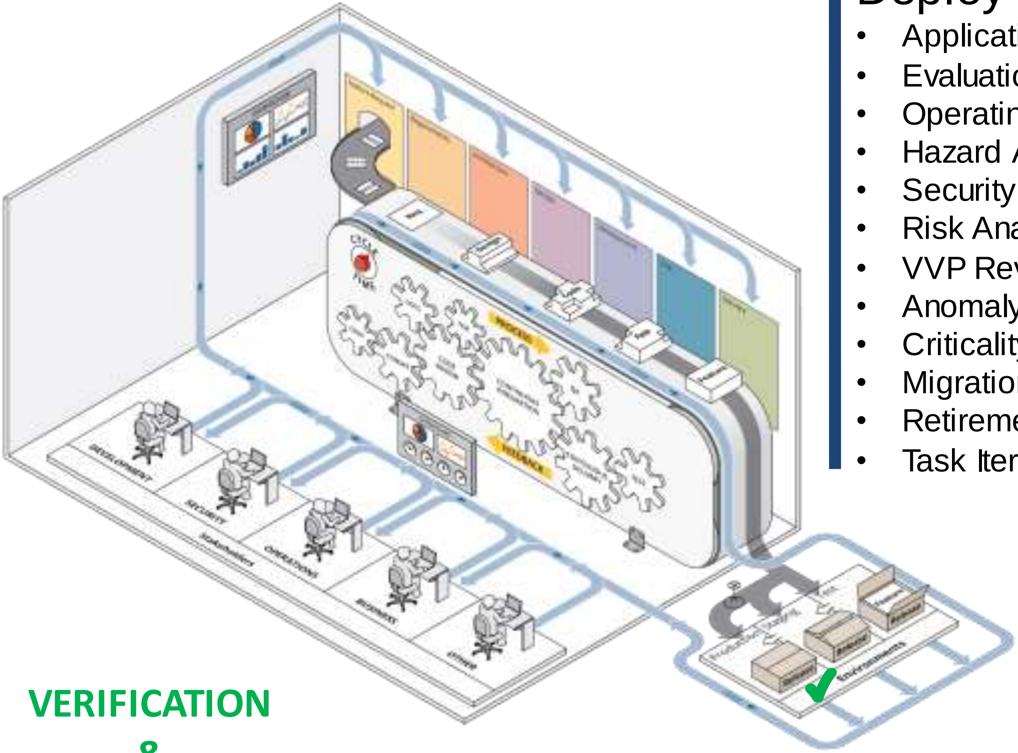
Delivery

- Software Acceptance Test Procedure V&V
- Software Acceptance Test Execution V&V
- Traceability Analysis
- Hazard Analysis
- Security Analysis
- Risk Analysis
- Installation Configuration Audit
- Installation Checkout

VERIFICATION

&

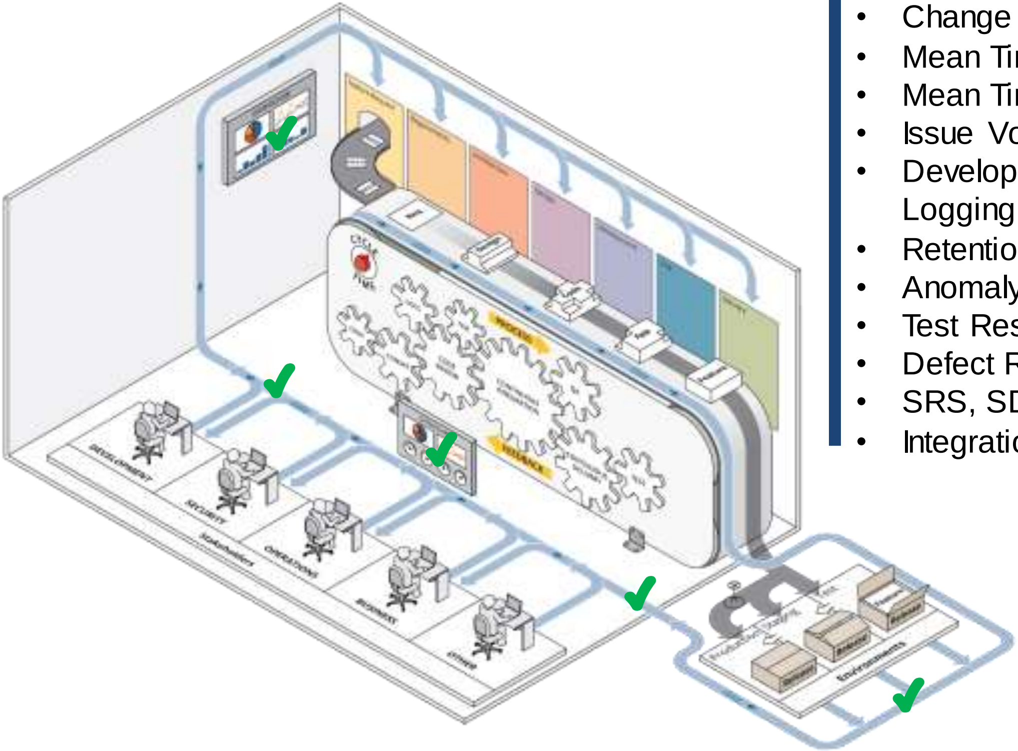
VALIDATION



Deploy

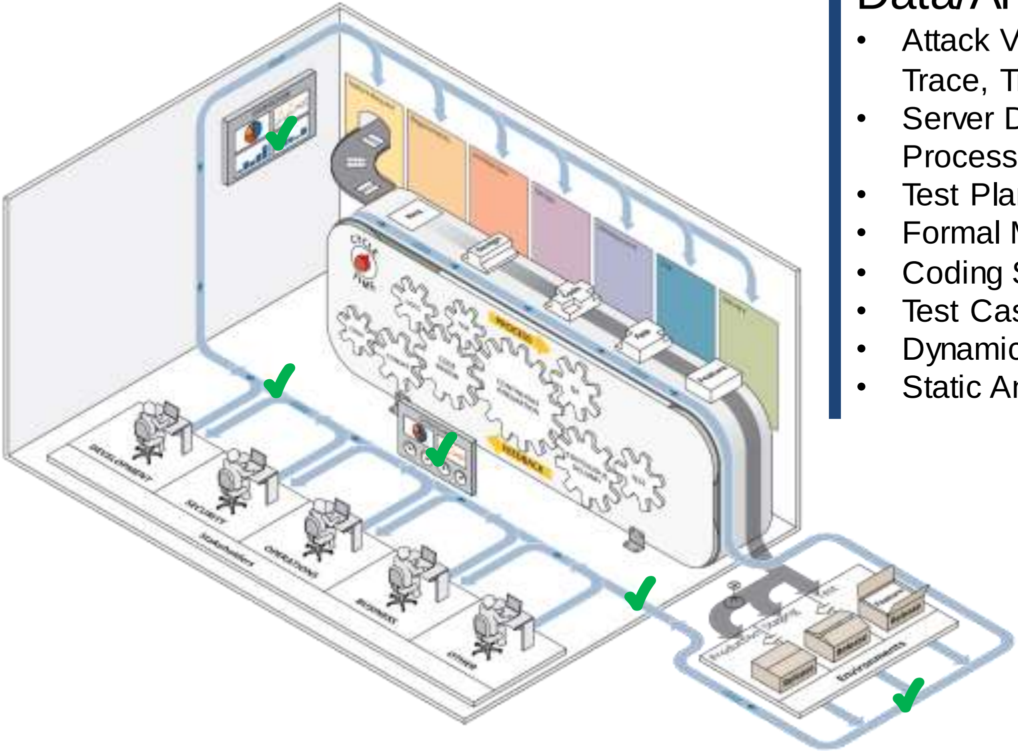
- Application Security Monitoring
- Evaluation of New Constraints
- Operating Procedures Evaluation
- Hazard Analysis
- Security Analysis
- Risk Analysis
- VVP Revision
- Anomaly Evaluation
- Criticality Analysis
- Migration Assessment
- Retirement Assessment
- Task Iteration

VERIFICATION
&
VALIDATION



Data/Artifact

- Change Failure Rate
- Mean Time To Recovery (MTTR)
- Mean Time to Detection (MTTD)
- Issue Volume and Resolution Time
- Development and Application Logging Availability
- Retention Control Compliance
- Anomaly reports
- Test Results
- Defect Rate
- SRS, SDD
- Integration results



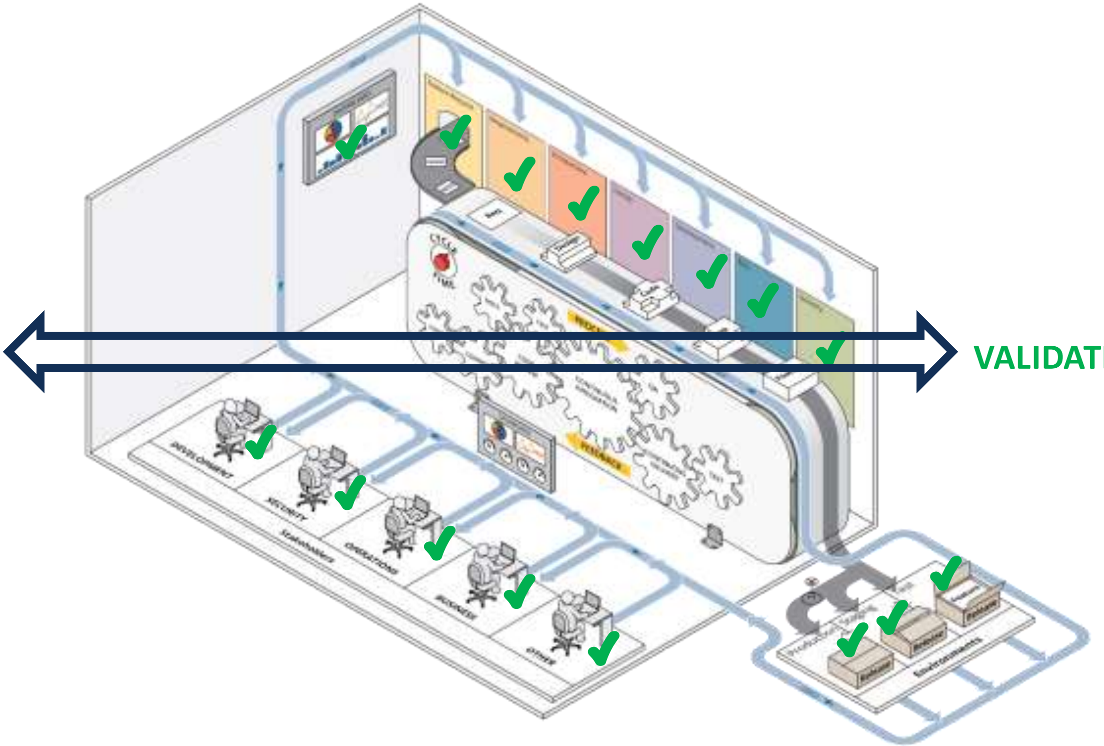
Data/Artifact

- Attack Vector Details (IP, Stack Trace, Time, Rate of Attack, etc)
- Server Disk Space, Load and Process Monitoring
- Test Plan
- Formal Methods
- Coding Standards
- Test Cases
- Dynamic Analysis
- Static Analysis

VERIFY & VALIDATE

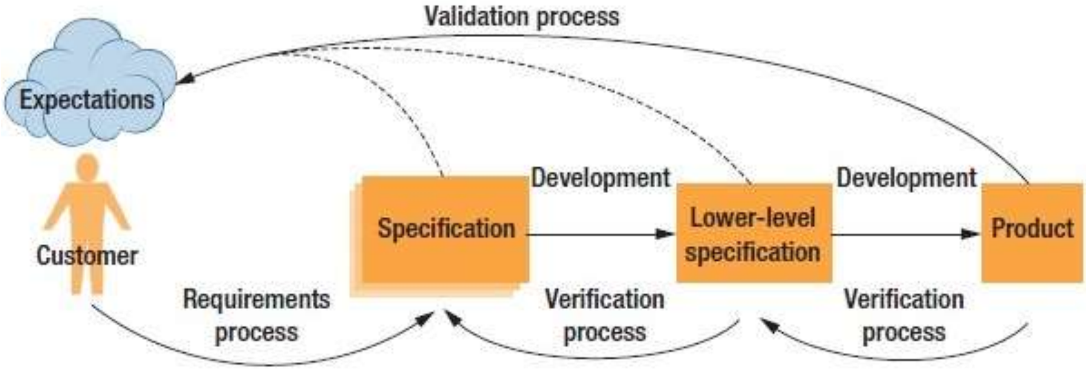
Continuous V&V on every phases of lifecycle

VERIFICATION



VALIDATION

V&V workflow



*https://www.infoq.com/articles/ieee-verification-and-validation-for-software-systems

For more information...

DevOps: https://www.sei.cmu.edu/go/devops

DevOps Blog: https://insights.sei.cmu.edu/devops

Webinar : https://www.sei.cmu.edu/publications/webinars/index.cfm

Podcast : https://www.sei.cmu.edu/publications/podcasts/index.cfm

Thank You

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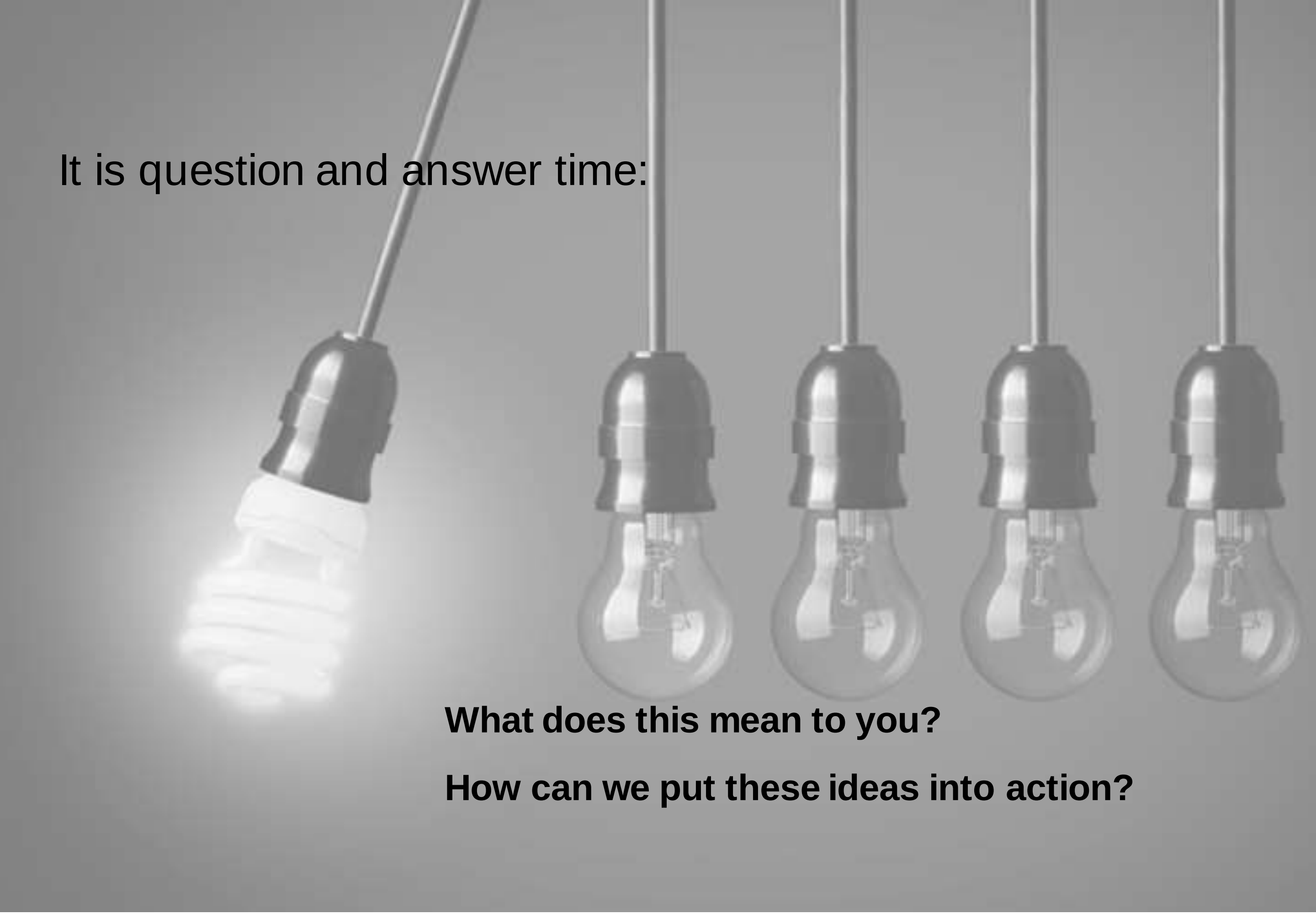

It is question and answer time:

What does this mean to you?

How can we put these ideas into action?