



**National Defense Industrial Association**

# **Consensus Measures for Continuous Iterative Development**

**An industry/DoD collaboration**

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**for PSM / NDIA / INCOSE CID Measurement WG**

**NDIA SE Division, December 2019**

# Overview – SW Measurement Framework

## DSB SW

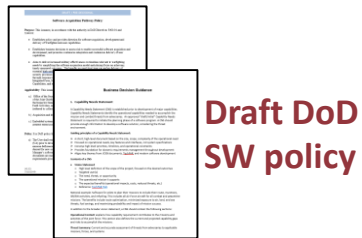


## DIB SWAP

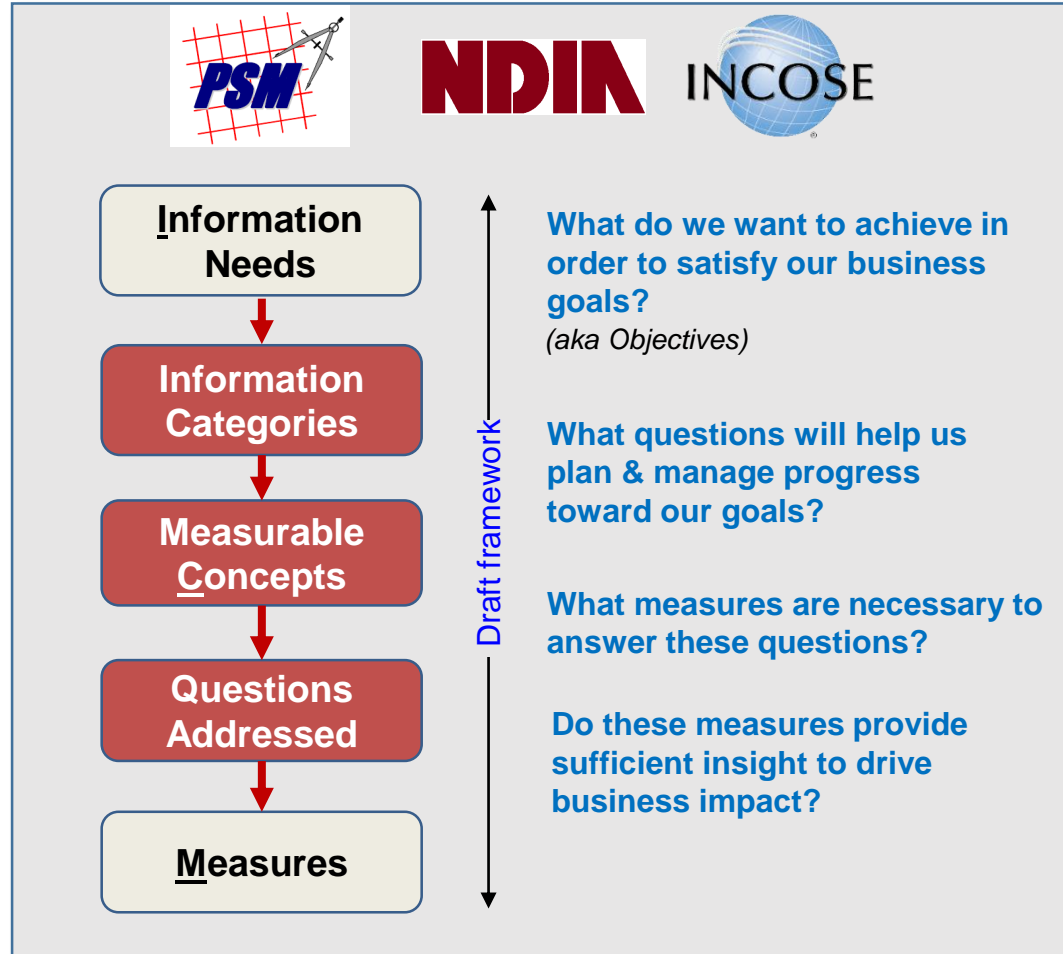


## Info Needs Measures Surveys

- PSM
- NDIA
- INCOSE
- SERC



Draft DoD SW policy

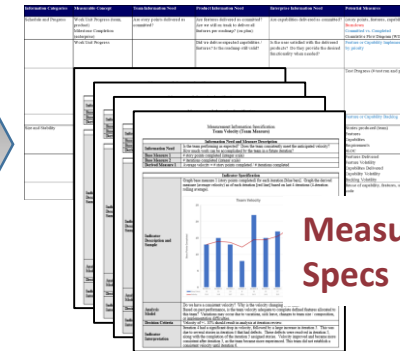


PSM, NDIA, and INCOSE are collaborating on development of a consensus industry measurement framework for agile/CID

<https://www.ndia.org/divisions/systems-engineering/studies-and-publications>

## NDIA WG recommendations: DSB #3 (measures)

Picture of Success (end state)	
Consensus frameworks	• Objectives first - measures aligned and tailored from information needs, goals and constraints, at program and enterprise levels
Modernized measures	• Migration toward consensus alternatives to traditional waterfall and phase-based SW measures (LOC, EVM, milestones, ...) • Derived from SW factory processes, automated by toolchain • Basis for measuring cost and schedule vs. plan
History-based estimates	• Repositories collect performance-based measures (e.g., WBS, staff, cost, productivity) supporting future comparisons, basis of estimates, proposals, and program monitoring



## ICM Table

- Information Categories
- Measurable Concepts
- Information Need (team, product, enterprise)
- Potential measures

## Measurement Specs

- Information Need
- Measures (base, derived)
- Indicator description, sample
- Analysis model
- Decision criteria
- Interpretation, guidance
- Implementation considerations

Acceleration	Automated Test Coverage	Burndown (Sprint/Release)	Defect Containment
Defect Escapes	Defect Resolution	Cycle Time	Lead Time
Release Frequency	Velocity	Committed vs. Completed	...

# PSM CID Measurement Framework



**Practical Software & Systems Measurement**  
Objective Information for Decision Makers

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Welcome to the Official PSM Web Site!

**New - Continuous Iterative Development (Agile) Measurement Framework**

The draft materials on this web site provide recommendations for measurement of continuous iterative developments (CID). The white paper includes an overview, and a series of diagrams and an ontology, to describe the development approaches and terminology used. The paper includes a measurement framework detailing common information needs and measures that are effective for evaluating CID approaches. This is documented in the "Information Category-Measurable Concept-Measures" (ICM) Table. The information needs address the enterprise, product/program, and team perspectives, as described in the ICM table. The framework also identifies an initial set of measures that have been identified as being practical measures to address these information needs. For the highest priority measures, sample measurement specifications have been developed that detail the identified measures. These materials are all draft. This is an initial release that is currently being updated by the working group. An updated release is scheduled for **20 December 2019**.

[Go to the New CID Page](#)

**Practical Software & Systems Measurement**  
Objective Information for Decision Makers

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**Continuous Iterative Development (Agile) Measurement Framework**

The draft materials on this web site provide recommendations for measurement of continuous iterative developments (CID). The white paper includes an overview, and a series of diagrams and an ontology, to describe the development approaches and terminology used. The paper includes a measurement framework detailing common information needs and measures that are effective for evaluating CID approaches. This is documented in the "Information Category-Measurable Concept-Measures" (ICM) Table. The information needs address the enterprise, product/program, and team perspectives, as described in the ICM table. The framework also identifies an initial set of measures that have been identified as being practical measures to address these information needs. For the highest priority measures, sample measurement specifications have been developed that detail the identified measures. These materials are all draft. This is an initial release that is currently being updated by the working group. An updated release is scheduled for **20 December 2019**.

**Background:**

The National Defense Industrial Association (NDIA) Systems Engineering Division formed a working group in conjunction with Practical Software and Systems Measurement (PSM) and International Council on Systems Engineering (INCOSE) to develop measurement recommendations. These operational recommendations address implementation of the strategic Defense Science Board (DSB) and Defense Innovation Board (DIB) recommendations on measurement for continuous iterative development (CID).

The most critical information needs and measures have been prioritized, based on a series of surveys with members of relevant NDIA, PSM, and INCOSE working groups. Additional measures will be specified, and revisions to the information needs will be included, as additional input is provided. We welcome your recommendations and comments.

*Click on the links below to view and download the CID Measurement white paper and associated ICM table and measurement specifications.*

[CID Measurement White Paper](#)  
[Information Category-Measurable Concept-Measures \(ICM\) Table](#)  
[Measurement Specifications](#)

Automated Test Coverage  
Burndown  
Committed vs. Completed  
Cumulative Flow  
Cycle Lead Time  
Defect Detection  
Defect Resolution  
Mean Time to Restore (MTTR)  
Release Frequency  
Velocity

**Work products (v0.5 draft > v1.0 final Dec 2019)**

**Continuous Iterative Development Measurement Framework**

**1. Introduction**

This paper provides recommendations for measurement of continuous iterative developments (CID). It includes a series of diagrams and an ontology to describe the development approaches and terminology used. The paper includes a measurement framework detailing common information needs and measures that are effective for evaluating CID approaches. This is documented in the "Information Category-Measurable Concept-Measures" (ICM) Table. The information needs address the enterprise, product/program, and team perspectives. This is documented in the ICM table described in section 5. The framework also identifies an initial set of measures that have been identified as being practical measures to address these information needs. For the highest priority measures, sample measurement specifications have been developed that detail the identified measures.

A successful measurement program depends on establishing a clear context and operational definitions for the measures to be collected. Definitions can sometimes vary depending on the references and how measures are applied. The diagrams and definitions that follow provide the terminology used in this white paper, in order to establish a common understanding, so that measures can be implemented and used consistently with community consensus.

This paper is intended to be methodology and approach agnostic, and is written so that it may be adapted to organizational needs. Different methodologies and tools may use different terminology than defined in this paper. The ontology in Section 4 provides synonyms for commonly used terms.

**2. Background**

The National Defense Industrial Association (NDIA) Systems Engineering Division formed a working group in conjunction with Practical Software and Systems Measurement (PSM) and International Council on Systems Engineering (INCOSE) to develop measurement recommendations. These operational recommendations address implementation of the strategic Defense Science Board (DSB) and Defense Innovation Board (DIB) recommendations on measurement for continuous iterative development (CID). The most critical information needs and measures have been prioritized, based on a series of surveys with members of relevant NDIA, PSM, and INCOSE working groups. Additional measures will be specified, and revisions to the information needs will be included, as additional input is provided. We welcome your recommendations and comments.

**3. Continuous Iterative Development Measurement Framework**

a. CID Work Decomposition

Figure 1 contains a sample work decomposition approach for continuous iterative development. This terminology will be used throughout this paper and the associated ICM Table and measurement specifications.

**White paper (intro, concepts, terms)**

**Measurement specs (10)**

Measurement Information Specification  
**Team Velocity (Team Measure)**

Measure Introduction	
<b>Description</b>	Velocity is a measure of team performance and the amount of work completed, typically a count of completed story points or equivalent. Velocity is used to estimate the amount of work that can be accomplished by the team in future iterations and when planned deliveries will be completed.
<b>Relevant Terminology</b>	Velocity Acceleration The average amount of work a team completes in a sprint, iteration, or release. Used for planning and measuring team performance in iterative software development. (derived from DSB report) Change in velocity across iterations.

Information Need and Measure Description	
<b>Information Need</b>	Is the team performing as expected? Does the team consistently meet the anticipated velocity?
<b>Base Measure 1</b>	How much work can be accomplished by the team in a future iteration?
<b>Base Measure 2</b>	# story points completed (integer scale)
<b>Derived Measure 1</b>	# iterations completed (integer scale)
<b>Derived Measure 2</b>	Average velocity = # story points completed / # iterations completed
<b>Derived Measure 3</b>	Team Acceleration = (Current iteration velocity - reference comparison increment velocity) / comparison increment velocity
<b>Overall Acceleration</b>	Team Acceleration 1 - Team Acceleration N / N

**Indicator Specification**

Graph base measure 1 (story points completed) for each iteration (blue bars). Graph the derived measure (average velocity) as of each iteration (red line) based on last 4 iterations (4-iteration rolling average).

**Indicator Description and Sample**

Velocity Team Velocity

Sample calculation:  
Velocity for Iteration 4  
Velocity = (1+2+3+4) / 4 = 11.3

Velocity Team Velocity

Sample calculation:  
Velocity for Iteration 4  
Velocity = (1+2+3+4) / 4 = 11.3

Information Categories	Measurable Concept	Team Information Need	Product Information Need	Enterprise Information Need	Potential Measures	Notes
Schedule and Progress	Work Unit Progress (team, product) Milestone Completion (enterprise) Work Backlog	Are story points delivered as committed? Are we still on track to deliver all story points per roadmap? (on plan)	Are features delivered as committed? Are we still on track to deliver all features per roadmap? (on plan)	Are capabilities delivered as committed? Are we still on track to deliver all capabilities per roadmap? (on plan)	<b>Burndown</b> <b>Committed vs. Completed</b> <b>Cumulative Flow Diagram</b> <b>Velocity</b> <b>Cumulative Flow Diagram</b> <b>Feature or Capability Backlog</b>	Story points, features, capabilities Criticality is key
Size and Stability	Functional Size and Stability	How big is our system?	How big is our system?	How big is our system?	<b>Committed vs. Completed</b>	Continue to do SLOC actuals for a transitional period
Performance	Performance	Does functionality work as expected?	Does functionality work as expected?	Does functionality work as expected?	<b>Defect Detection</b> <b>Defect Resolution</b> <b>Stories Accepted</b> <b>Retrospect Stories</b>	Defect resolution, need to be considered. Need to track source or reason for change; CID work, change in mission, defects, etc. Some volatility is expected with reworking.
Product Quality	Functional Correctness	Does functionality work as expected?	Does functionality work as expected?	Is rework identified and managed?	<b>Defect Detection</b> <b>Defect Resolution</b> <b>Stories Accepted</b> <b>Retrospect Stories</b>	Some teams do not track defects as story points or change reports
Operational Readiness	Supportability - Maintainability Dependability - Reliability	What is the reliability and availability of operational service capabilities?	What is the reliability and availability of the development environment (e.g., people, process, infrastructure)?	What is the reliability and availability of the development environment (e.g., people, process, infrastructure)?	<b>Mean Time to Detect (MTD)</b> <b>Mean Time to Restore (MTTR)</b>	For operational environment. May focus on types of defect or failure such as security, priority 1,2, etc.

**ICM Table (Information needs, Concepts, Measures)**

PSM, NDIA, and INCOSE are collaborating on a consensus industry/government measurement framework for continuous iterative development. Final products will be distributed for NDIA approval to publish in December.

# Candidate Measures

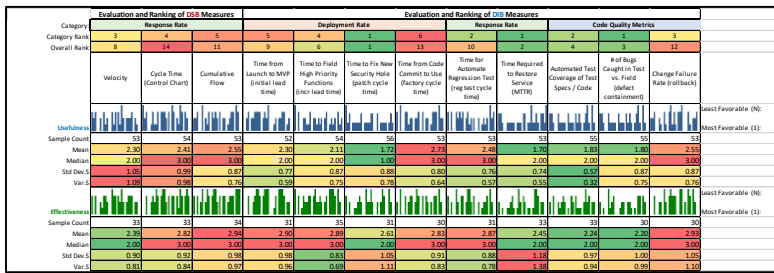
DSB	
Deployment Rate	*Sprint burndown
	*Epic and release burndown
	*Velocity
	*Cycle time (control chart)
	Cumulative flow

DIB SWAP	
Deployment Rate	*Time from launch to MVP (initial lead time)
	*Time to field high priority functions (incremental lead time)
Response Rate	Time to fix new security hole (patch cycle time)
	*Time from code commit to use (factory cycle time)
Code Quality	*Time for automated regression test
	Time required to restore service (MTTR)
	*Automated test coverage
	*# of bugs caught in test vs. field (defect containment)
	*Change failure rate (rollback)

Draft OUSD A&S SW Policy	
Agile Process Metrics	Story points
	*Velocity
	Story completion rate
Agile Quality Metrics	*Sprint burndown chart
	Recidivism rate
	*Defect count
Agile Product Metrics	Number of blockers
	Delivered features
	Delivered value points
DevSecOps Metrics	Level of user satisfaction
	Mean Time to Restore (MTTR)
	*Deployment frequency
Cost Metrics	*Change fail rate – defect counts
	*Total cost estimate
	Burn rate

PSM **Draft**	
Deployment Rate	Burndown (sprint/release)
	Velocity
	Acceleration
Response Rate	Cycle time
	Lead time
	Release frequency
Code Quality	Defect containment
	Defect escapes
	Defect resolution
	Automated test coverage
Core PSM framework:	
<ul style="list-style-type: none"> <li>Cost (est. vs. actual)</li> <li>Schedule (est. vs. actual)</li> <li>Staffing</li> <li>...etc.</li> </ul>	

Industry Survey Feedback (usefulness, effectiveness)



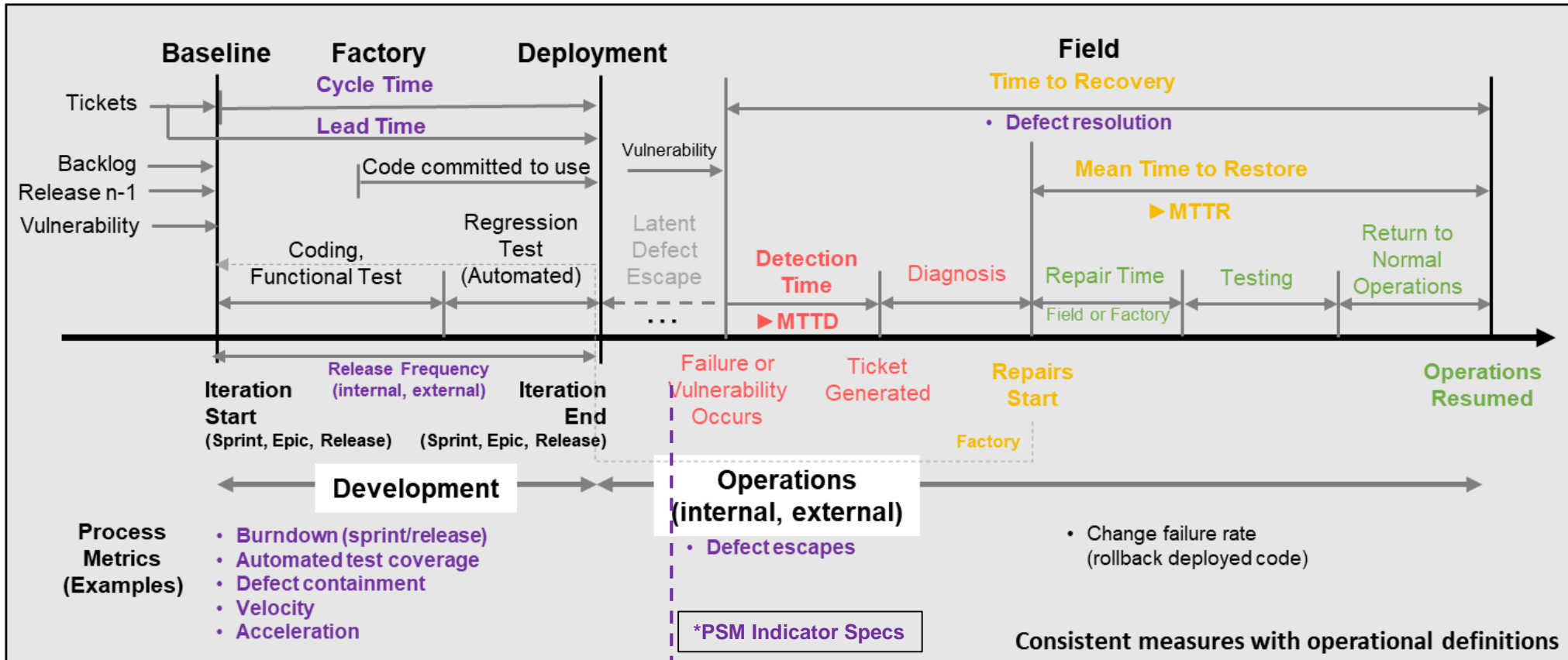
\* = addressed in draft PSM framework

See PSM framework for details.

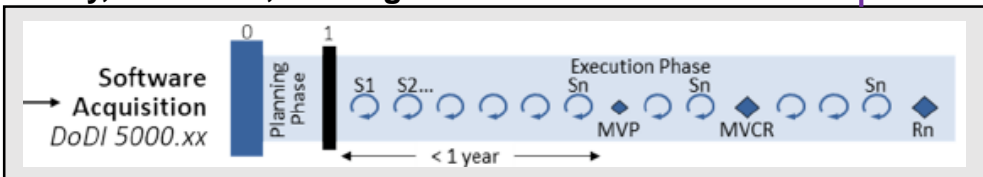
- Information categories
- Measurable concepts
- Information needs
- Cross-reference mappings

Additional candidate measures are defined in draft ICM table but not implemented in first release.

# Aligning the PSM framework and measures with DoD SW policy and enterprise improvement



## Policy, Guidance, Oversight



Measures, goals, and priorities are tailored and aligned based on objectives and information needs

Program ► Product ► Enterprise

**References:**

- Defense Science Board, Design and Acquisition of Software for Defense Systems, Feb 2018
- Defense Innovation Board Metrics for Software Development, version 0.9, 9 Jul 2018
- MTTR, MTBF, or MTTF? A Simple Guide to Failure Metrics. <https://limblecmms.com/blog/mttr-mtbf-mttf-guide-to-failure-metrics/>