APT
Advanced Product Transitions

Product Maturity Metrics (PMMs)

— a concise and effective way to assess and communicate program risks —

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4 June 2012

Why Product Maturity Metrics™ (PMMs)?

- Over the last ten years various GAO audits and reports, Nunn-McCurdy breaches (high cost, delayed programs) and test/field failures all point to a DOD acquisition process that needs improvement. Highlights of the GAO findings are:
  - There is little incentive for DOD program managers to capture knowledge early in the development process
  - In 2008 the cumulative cost growth of 96 major defense acquisition programs was $296 billion
  - The total acquisition costs for these programs increased 25% from first estimates
  - The average delay in delivery to the war-fighter was 22 months
  - DOD needs to do a better job ensuring acquisitions begin with realistic plans and baselines prior to the start of development

- The April 2009 GAO report further delineates a clear set of prerequisites that must be met by each program's acquisition strategy before a measurement of the program's health will be of real value
  - Establishing an evolutionary, knowledge-based business case for each acquisition
  - Separating technology development from product development
  - Limiting time and requirements for product development to manageable levels
  - Employing systems engineering early on in the process to arrive at realistic cost and schedule estimates

PMM Background

- In 2002 Engineering Manufacturing Readiness Levels (EMRLs) were developed for the Missile Defense Agency as a standardized methodology to assess risk during product development and production utilizing:
  - DoD and Industry Best Practices
  - Willoughby Templates
  - GAO recommendations
- EMRLs have proven to be effective as a streamlined, objective measure of product maturity and risk identification at key milestones in programs such as:
  - Aegis BMD and THAAD
  - H1 Helicopter, ARH-70A Helicopter, P-8A Aircraft, JSF, and F135 Engine
- EMRLs incorporate and streamline both Manufacturing Readiness Levels (MRLs) and Technology Readiness Levels (TRLs), in addition to incorporating the broader programmatic risks
  - MRLs focus on in depth evaluation of manufacturing
  - TRLs focus on in depth evaluation of technology
- PMM criteria and metrics, refined and enhanced to improve their utility, were developed to provide differentiation from MRLs and TRLs while maintaining the EMRL concept of an easy-to-use tool to assess product maturity during development and production

PMM Benefits

- PMMs provide the product manager (PM), integrated product teams (IPTs), and independent reviewers with an easy to use, resource friendly means to:
  - Assure systems engineering is employed early on in the development process
  - Assure realistic plans and baselines are in place at the start of development
  - Measure technology and design maturity before entering product development
  - Limit time and requirements for product development to manageable levels
  - Capture knowledge early in the development process and reduce the risks of cost, schedule and performance problems
- PMMs provide the PM and others the ability to quickly assess product development high risks as part of scheduled product status reviews in addition to major milestones or gate reviews
- PMMs provide PMs with 20 criteria and associated metrics, enabling them to concisely and effectively assess product development status and risks at the product level, as well as lower levels in the supply chain

PMM Description

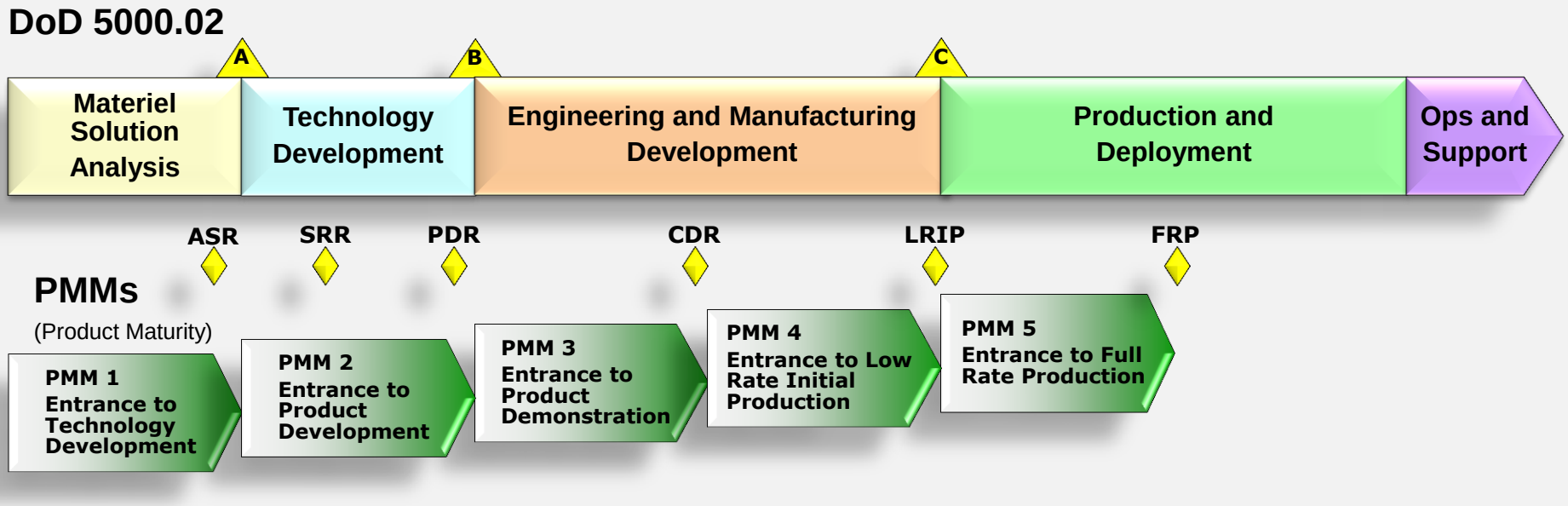
Product Maturity Metrics™ are a means of concisely and effectively assessing and communicating the degree to which a product is designed to be producible, reliable, sustainable, and affordable.

PMMs:

- Measure product maturity during all phases of design, development, and production
- Establish a level of risk at each product development milestone
- Capture knowledge required to successfully transition with minimal risk
- Measure time certain development and delivery of a product during design, development, and production
- Are composed of five gates matched to an established product development milestone with twenty consistent criteria and corresponding metrics

PMMs provide concise and easy to use measures of product maturity and risk

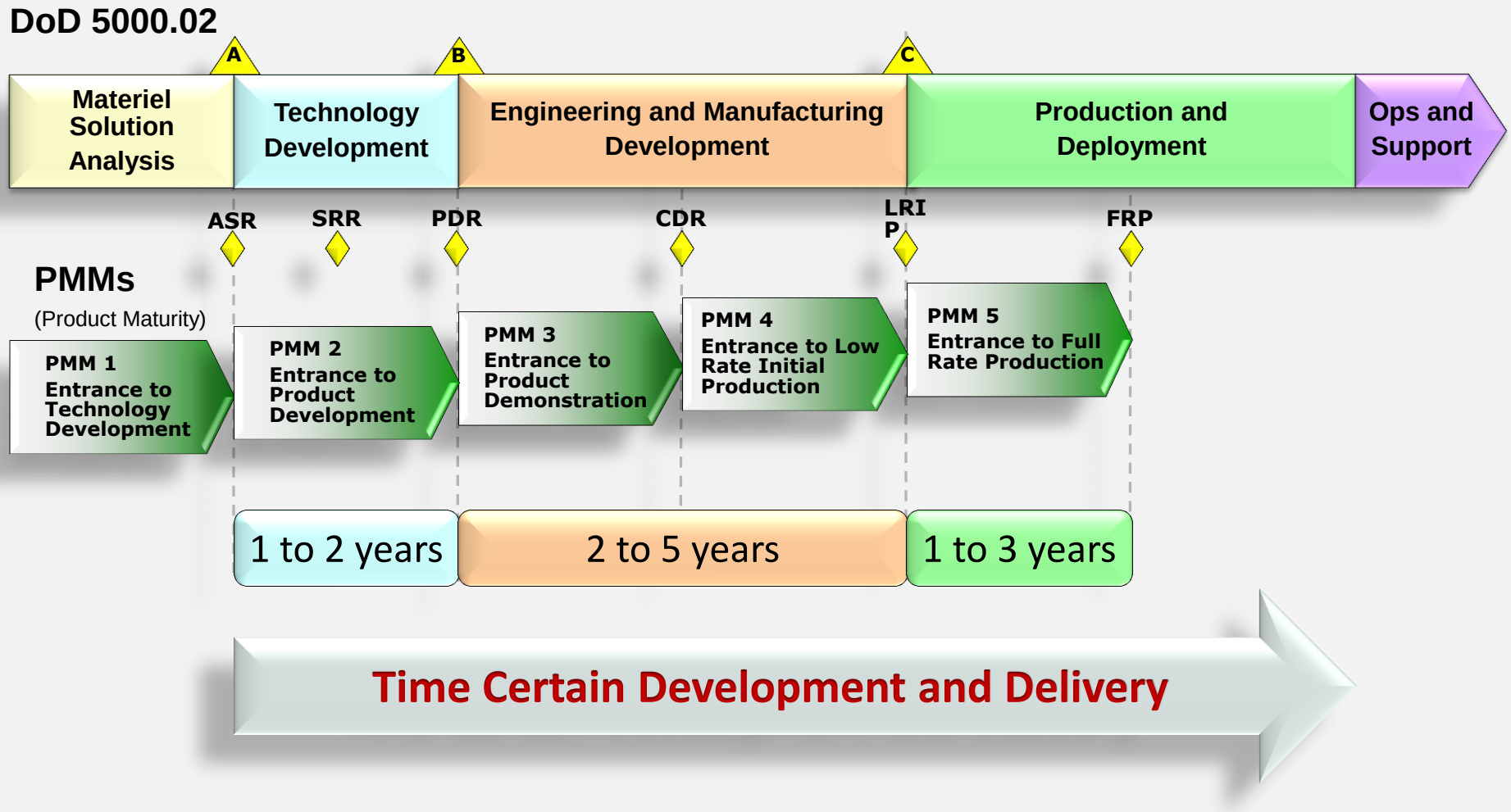
PMM Best Practices



- PMM 1 – ASR complete before Milestone A decision
- PMM 2 – PDR complete before Milestone B decision
- PMM 3 – CDR complete and design stability demonstrated

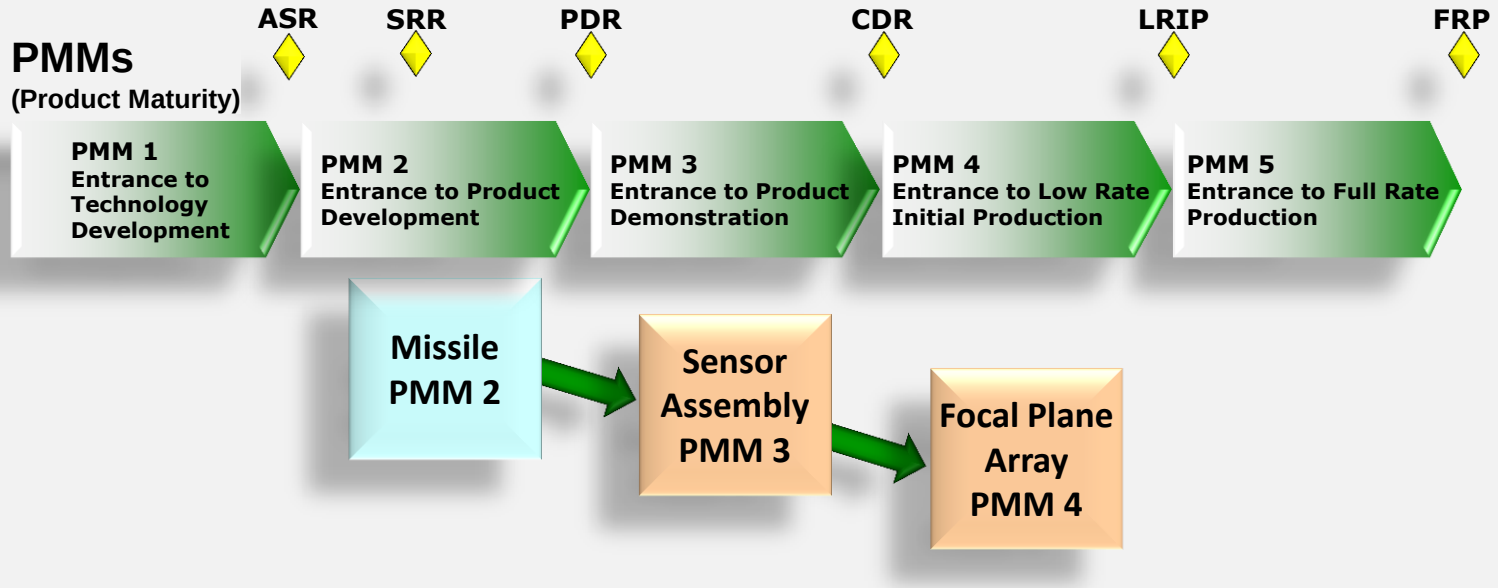
Note: An analysis of current ASR, PDR, and CDR guidance and checklists shows a lack of consistency and completeness from one review to the next across the Acquisition Lifecycle Framework.

Product Maturity Gates

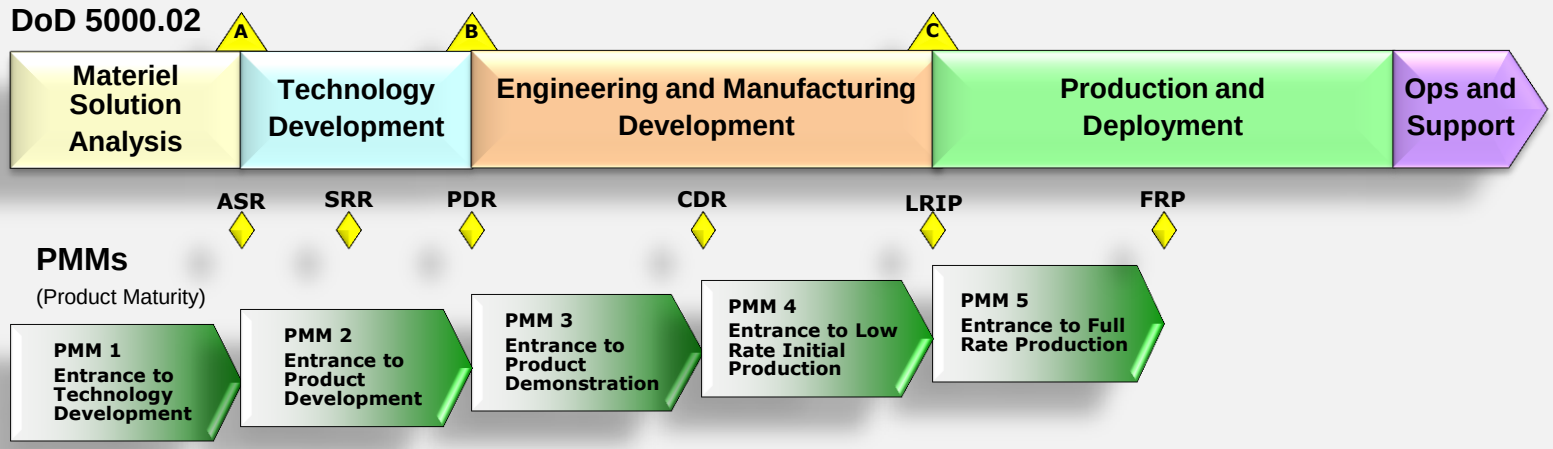


Phased Maturity

- To minimize product development risks, products lower in the supply chain should be more mature in development (at a higher PMM gate) than the next higher level product
- As example, an infrared heat-seeking missile:
  - Missile has met the entrance criteria for the Product Development Phase (Milestone B/PDR)
  - Sensor Assembly has met the entrance criteria for product demonstration (CDR)
  - Focal Plane Array should be at or near Low Rate Initial Production (LRIP)

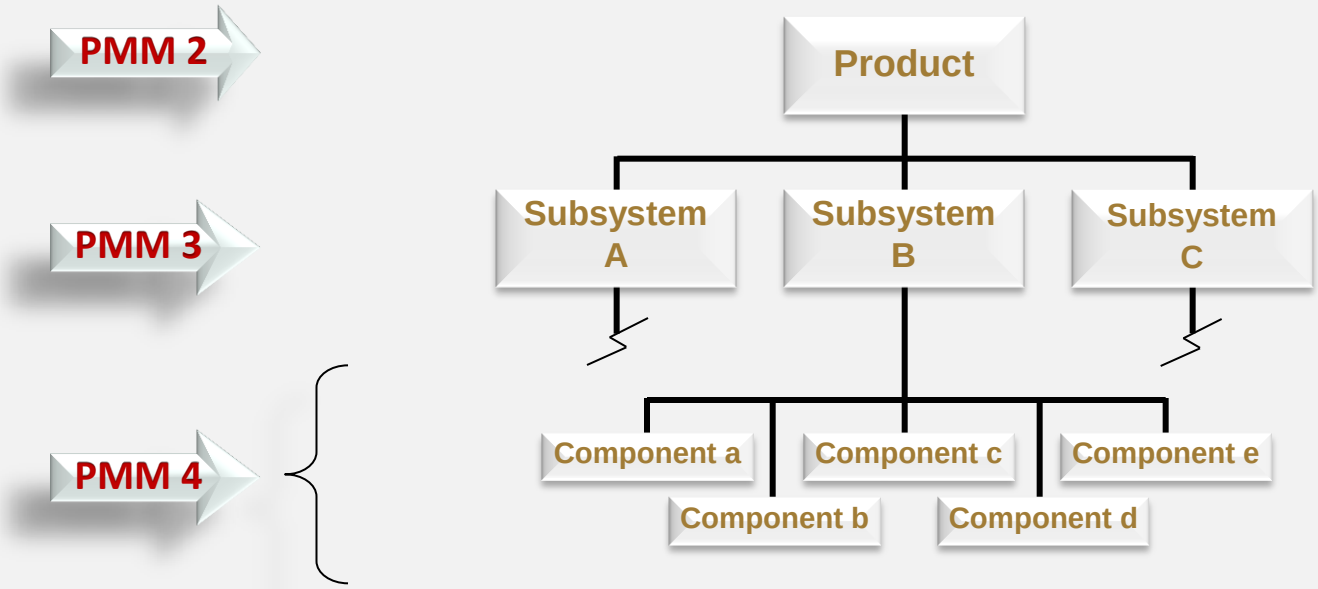


Performing an Assessment



- To implement a PMM assessment for a product, the PM must first determine where the product, subsystems, and components are in the development cycle based on the scheduled reviews and milestones
  - This will establish the maturity gate against which the product and lower level products in the supply chain should be assessed
  - PMM assessments should be performed from Materiel Solution Analysis until the product is transitioned from production
- To transition from one phase of development to the next with minimal risk, all of the entrance criteria for a particular gate or milestone should be met

WBS Assessment Level



- Product Manager determines at what level in the WBS structure to initiate assessments
  - Assessments are conducted using either a top-down or a bottom-up approach
  - Product should be decomposed at least one or two levels down to begin an assessment at the product level
  - Effective initial assessments can be made with one or two levels of detail from the subsystem level and/or the component level, and then at the product level

PMM Templates

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PMM 2 2011
Product Maturity Metrics™
Assessment

Detailed Evaluation Criteria for use during the Technology Development Phase Entrance Criteria for Product Development (Milestone B)			
Program: MISSILE SYSTEM SAMPLE			
Date: 15 JAN 2011			
Instructions: Working from a computer: Use the other sheet (detail). The sheets are hyperlinked by criteria. Type the appropriate character (R, Y, G or NA) in the status space to the right of each criteria (risk characters are not case sensitive). The total number of each character will be displayed in the summary status at the top of this sheet. • Green means you have met the criteria and are within cost and schedule. • Yellow means that the program does not meet the assessment criteria, but the requirements will be met without impact to cost and/or schedule. • Red means that the program does not meet the PMM criteria and will not be able to do so without an impact to cost and/or schedule.	Totals:		
	R	Red	8
	Y	Yellow	11
	G	Green	1
	N/A	Not App	

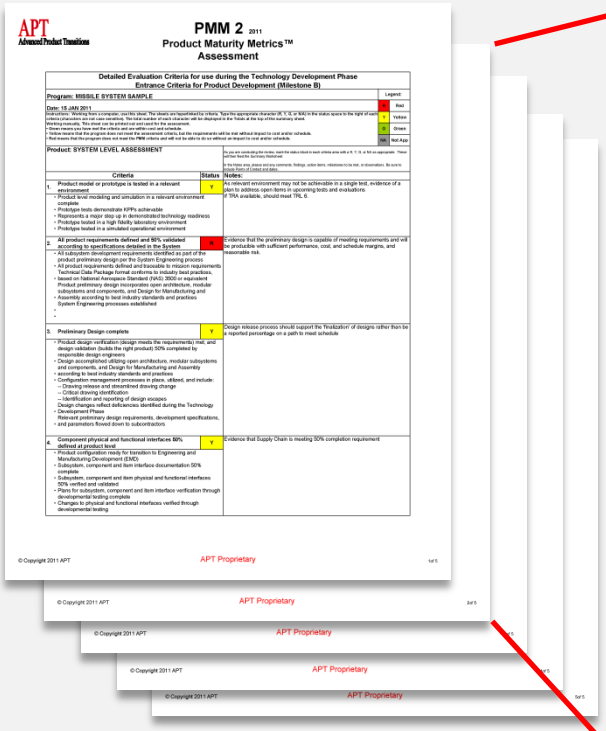
	Criteria	Status
1.	Product model or prototype is tested in a relevant environment	Y
2.	All product requirements defined and 50% validated according to specifications detailed in the System Engineering Plan (SEP)	R
3.	Preliminary Design complete	Y
4.	Component physical and functional interfaces 50% defined at product level	Y
5.	Capability to produce a product level prototype in a production relevant environment	Y
6.	Product level manufacturing processes and product integration demonstrated	R
7.	Product level software architecture developed and functional interface requirements specified	G
8.	Quality and reliability levels identified and established for 50% of the product	Y
9.	90% product Key Performance Parameters (KPPs) verified	R
10.	Acquisition Strategy and Preliminary Design Review (PDR) complete at product level	Y
11.	75% of the product major subsystems (representing 80% of cost) meet requirements of PMM 3 and Critical Design Review (CDR) complete	Y
12.	90% of the components and items for the product and major subsystems are proven designs or in production and are at PMM 4	R
13.	Developmental test plans complete for 75% of major subsystems	R
14.	Developmental Test & Evaluation (DT&E) ongoing and Initial Operational T&E (IOT&E) plans initiated at the product level	Y
15.	Acquisition and Integrated Logistics Support (ILS) plans initiated at product level	R
16.	Safety Assessment, Mission Assurance, and Environmental Safety and Occupational Health (ESOH) plans complete	Y
17.	Product Management Team in place for Engineering and Manufacturing Development	R
18.	Funding and contracts in place for the integrated product to proceed to PMM 3 (CDR)	Y
19.	Schedule, contracts and funding profile reflects achievement of PMM 3 (CDR) in 1 to 3 years	Y
20.	Product cost goals established	R

The assessment template consists of two worksheets

- The detail worksheet
  - Lists several sub-factors or guidance for each criterion
  - Has area for capturing evidence and notes
  - Automatically updates the summary worksheet
- The summary worksheet
  - Shows the 20 entrance criteria
  - Shows the one page score summary
  - Is useful for reporting purposes

The assessment is conducted using the detail sheets

PMM Detail Sheets



- Rate the risk of 20 criteria and metrics
- Sub-factors for guidance only
- Capture evidence and notes

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Product Maturity Metrics™
Assessment

5.	**Capability to produce a product level prototype in a production relevant environment**	Y	The 'as is/to be' inventory documentation of current manufacturing capabilities includes those of the Supply Chain. If MRA available, should meet MRL 6.
	• Manufacturing processes and equipment at product level demonstrated in a production relevant environment • Modeling and Simulation of product level manufacturing processes complete • Long lead items identified • ManTech solutions developed in a relevant environment • Industrial base capability assessment complete		
6.	**Product level manufacturing processes and product integration demonstrated**	R	Emphasis should be on newly developed processes and aspects of the manufacturing operation
	• Process controls defined for most manufacturing processes • Manufacturing processes identified and 75% defined at the product level • Environmental Stress Screening (ESS) standard practice for all electronic hardware and ESS 50% completed for subsystems and 90% completed for components and items • Plans for tooling complete • Plans for use of Special Test Equipment (STE) complete		
7.	**Product level software architecture developed and functional interface requirements specified**	G	How functions were selected and allocated should be presented as integral and supportive of overall design progress.
	• Software architecture/design document complete and software re-use established • Final key functional and key algorithm approaches to be selected through modeling • Project-specific division of functions completed • Human Machine Interface (HMI) concepts have been developed and reviewed • Measures of Effectiveness (MOEs), Measures of Performance (MOPs), and Technical Performance Measures (TPMs) established Procedures for software test identified		
8.	**Quality and reliability levels identified and established for 50% of the product**	Y	Evidence of specific examples of the MRB, engineering review process, and defect control system were employed in the ongoing design process
	• Nonconforming materials system and Material Review Board establishment underway • A defect control program will be established at the subsystem, component and item levels • Failure modes, effects and criticality analysis (FMECA) required and underway for all WBS levels • 50% or more of subsystem qualification tests complete • All selected subsystems, components and items meet established quality and reliability levels		

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Risk Rating Criteria Metrics by Color

The PMM assessment uses a Green, Yellow, and Red color scheme to rate the maturity and risk for each of the twenty entrance criteria listed. Each color is defined as follows:

Green – Product meets the entrance criterion or requirement for the gate assessed and is within cost and schedule

Yellow – Product does not meet the entrance criterion or requirement for the gate assessed; however, the entrance criterion or requirement will be met without impact to cost or schedule

Red – Product does not satisfy the entrance criterion or requirement for the gate assessed and meeting the criterion will impact cost, schedule, or both

N/A – "Not applicable" should be avoided; use only if the criterion does not apply at the gate of product being assessed

PMM Assessment – Block Report

Assessment Date:		12/15/10		11/30/10	11/15/10	12/1/10	12/2/10	12/3/10	11/27/10	11/28/10	11/29/10	11/30/10
Criteria Number		PMM 2		PMM 3					PMM 4			
		Missile		Missile Structure	Sensor Assy	Booster Motor	Comm Sub-system	Ordinance Sub-system	Telescope	Electronics	Integrated Dewar	Focal Plane Array
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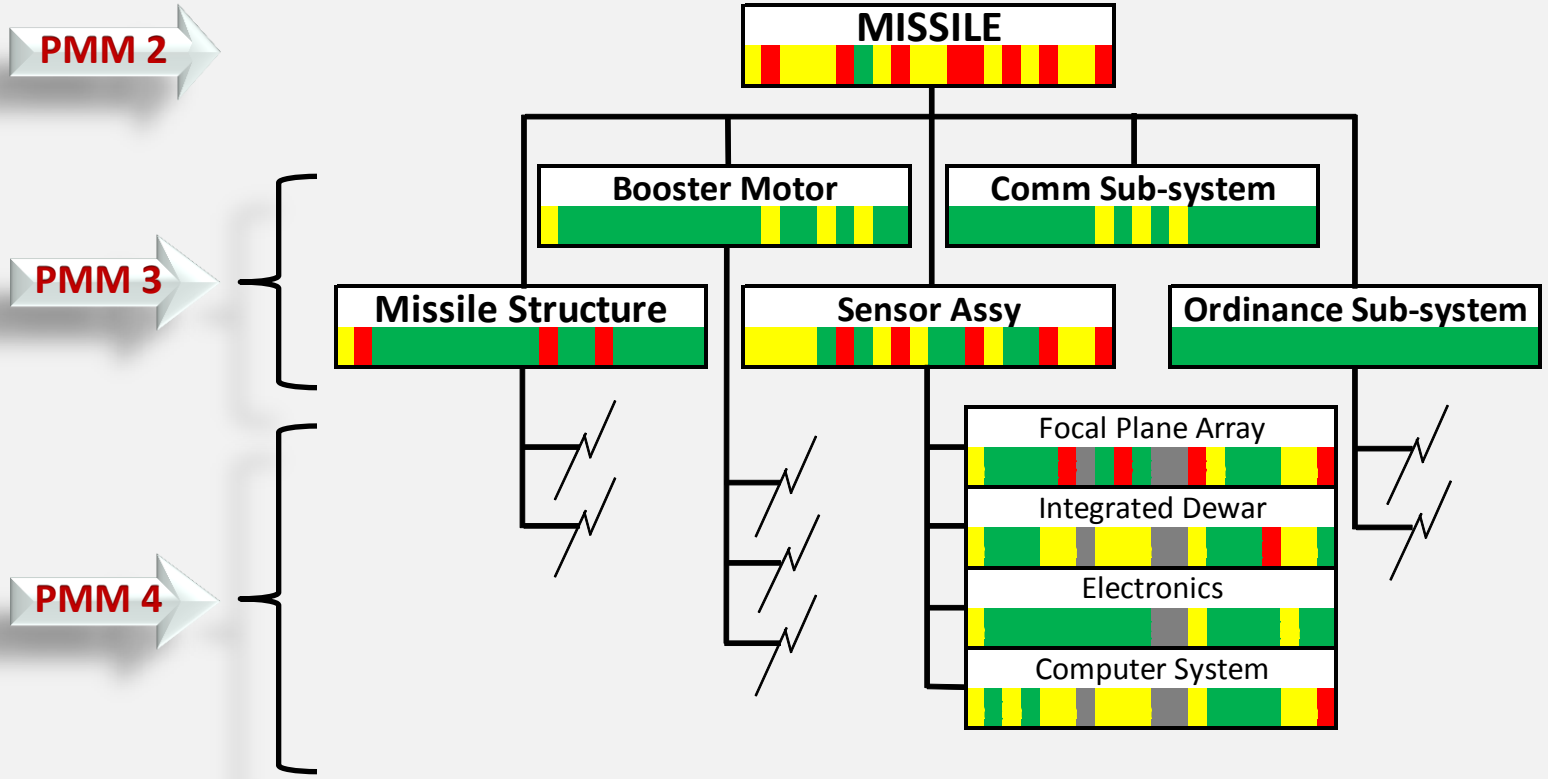
- A WBS overview display can be constructed based on PMM assessments performed
- Display shows high risks at all WBS levels assessed

PMM Assessment – Flag Report



Display shows high risks at all WBS levels assessed

Summary

- PMMs provide the product manager, product support teams, and independent reviewers with an easy to use, resource friendly means to:
  - Assure systems engineering is employed early on in the development process
  - Assure realistic plans and baselines are in place at the start of development
  - Measure technology and design maturity before entering product development
  - Limit time and requirements for product development to manageable levels
- PMMs enable the product manager to capture knowledge early in the development process and reduce the risks of cost, schedule and performance problems
- PMMs provide the product manager and others the ability to concisely and effectively assess product development risks as part of scheduled product status reviews, in addition to major milestones or gate reviews
- PMMs provide product managers with the criteria and metrics to assess product development status and risks at the product level, as well as lower WBS levels (lower levels in the supply chain)