



LOCKHEED MARTIN



Measurement Challenges of Higher Levels for SE Capability Models

Garry Roedler

**Principal Systems Engineer
Chair, Systems Integration
Process Review Board**

**Lockheed Martin
Management and Data Systems**

Sarah Sheard

**Deputy Manager, Systems Engineering
Software Productivity Consortium**



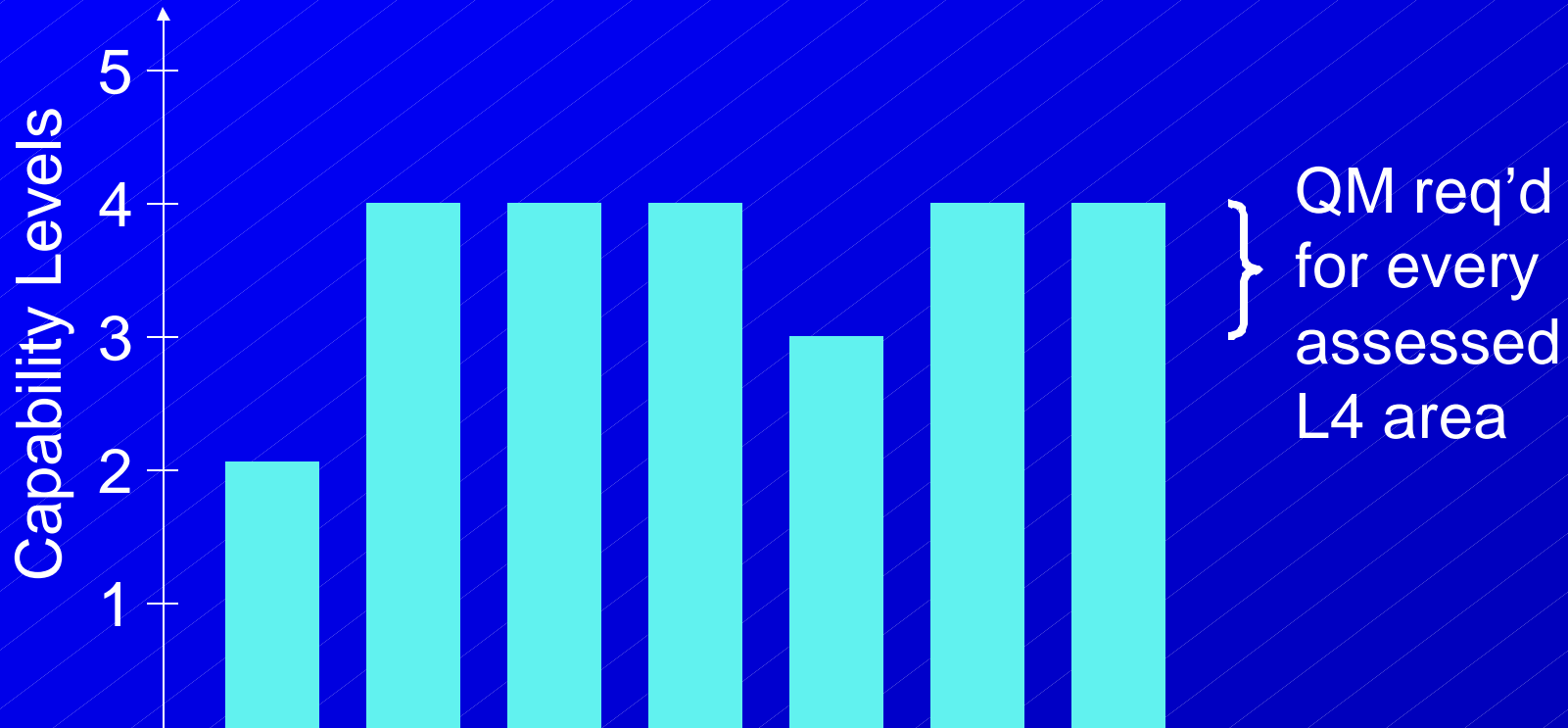


AGENDA

- ✦ *Continuous and Staged Views*
- ✦ *Higher Level Measurement Requirements*
- ✦ *Overview of Level 4 & 5 Challenges*
- ✦ *Approach to Address These Challenges*
- ✦ *Summary*

Continuous View Models

LOCKHEED MARTIN



Process Areas (SE-CMM and CMMI)
or Focus Areas (EIA/IS 731)



Measurement at Level 4

Staged view

- ✦ Measurements for key processes for your organization (based on business needs)
- ✦ Organization implements and institutionalizes quantitative measurement program

Continuous view

- ✦ Measurements for every process/focus area you wish to mature to Level 4 capability
- ✦ Can result in 18-19 times as many measurements (measures for each PA/FA)
- ✦ Presents additional challenges



Level 4: Quantitatively Controlled or Measured

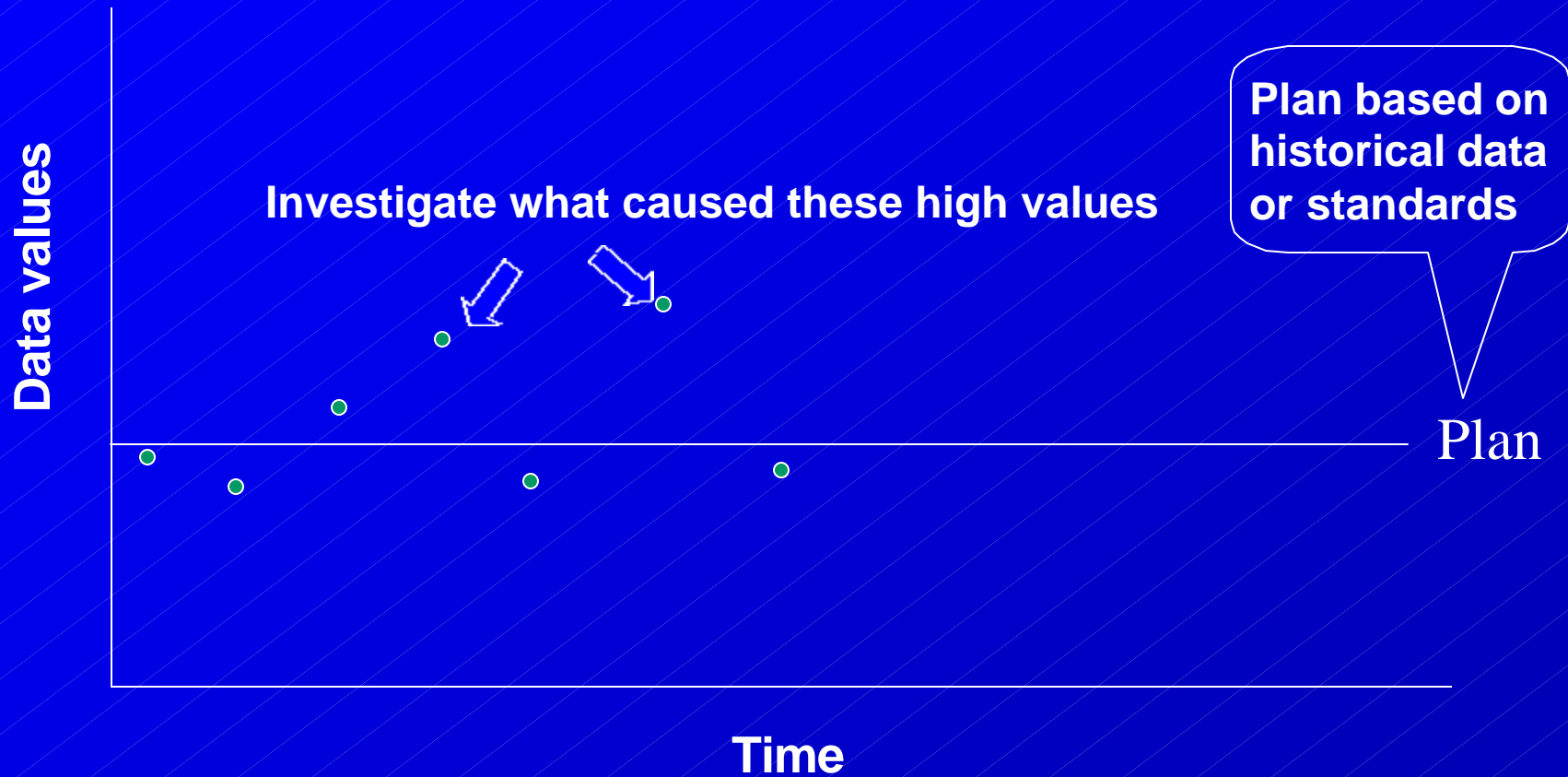
- ◆ **Use quantitative techniques to manage process performance on projects**
 - Stable process
 - Measure process performance and product quality
 - Feed project measurements to organization
 - Process capability known (average, range, thresholds)
 - Project goals for process performance & product quality
 - Address special causes of variation
 - Control projects against goals
 - ◆ Bring the process performance within its natural bounds
 - ◆ Focus on project control



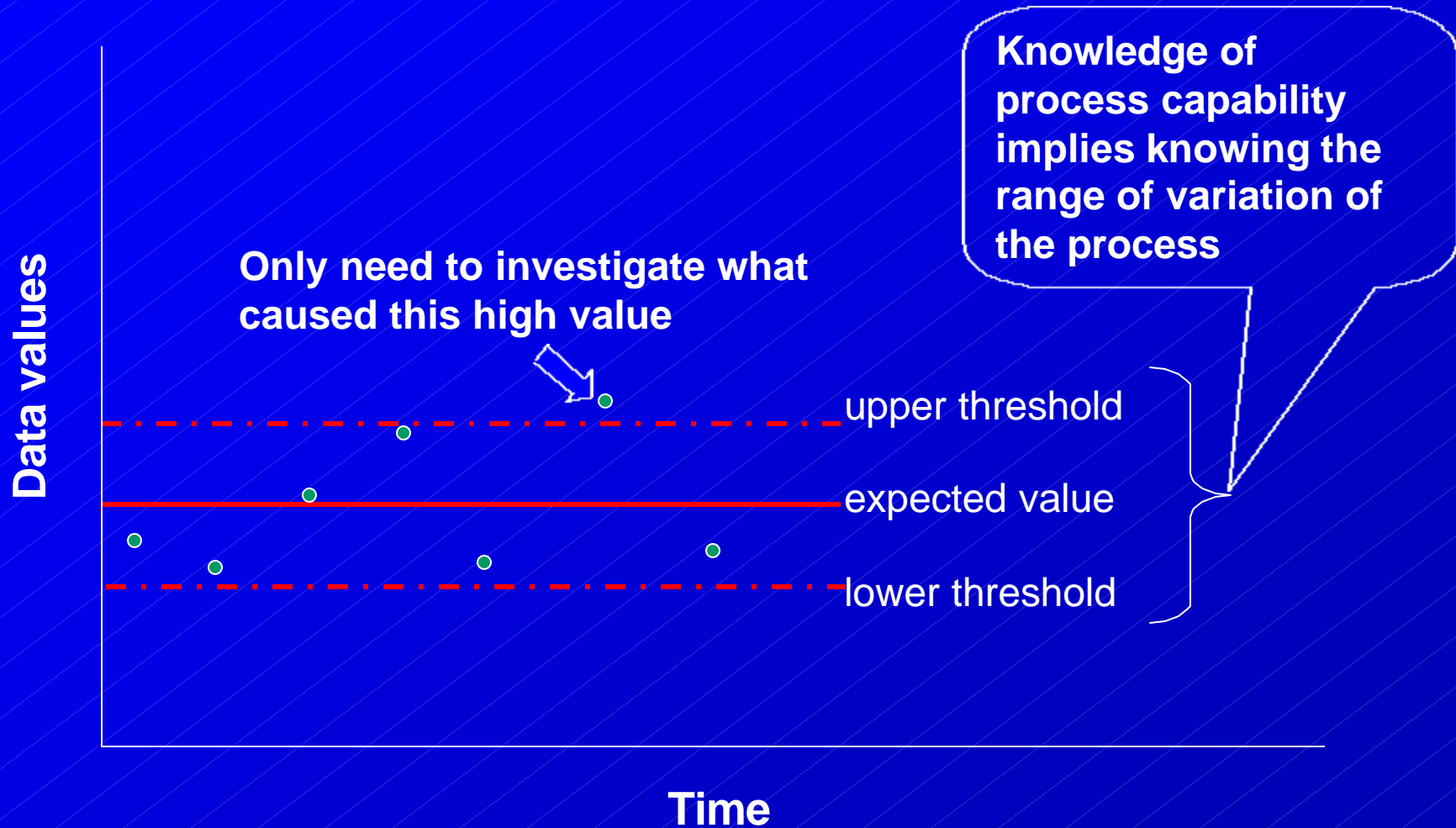
Level 4: Quantitatively Controlled or Measured

- ✦ **Ingrained within organization**
- ✦ **Measurements incorporated into organizational repository**
- ✦ **Take corrective action when determine objectives will not be satisfied**
 - Fix special causes of variation
 - Change objectives
 - Stakeholder agreement to performance shortfall
 - Common cause fixes to meet objectives not required for Level 4

Level 3 Analysis



Level 4 Analysis



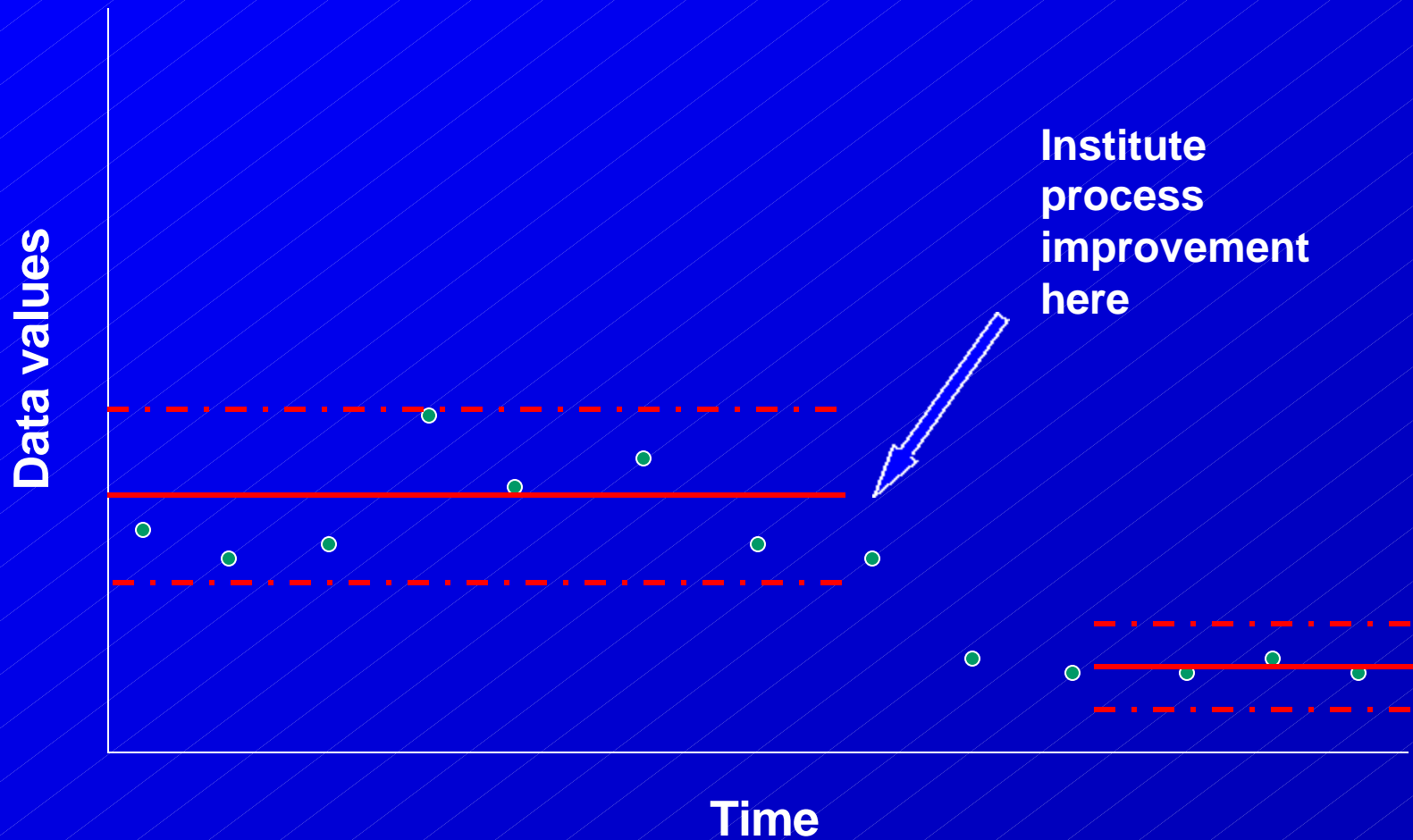


Level 5: Continuously Improving or Optimizing

- ✦ **Level 5 requires measurements be used to:**
 - identify organizational process improvement opportunities
 - establish quantitative process improvement goals for the organization
 - quantify process improvement accomplishments
 - “reduce common causes of variation”



Level 5 Analysis





Level 4 & 5 Challenges

- **Amount of measurement required**
 - previously discussed
- **Meaning of “Maturity Level” in staged and continuous models**



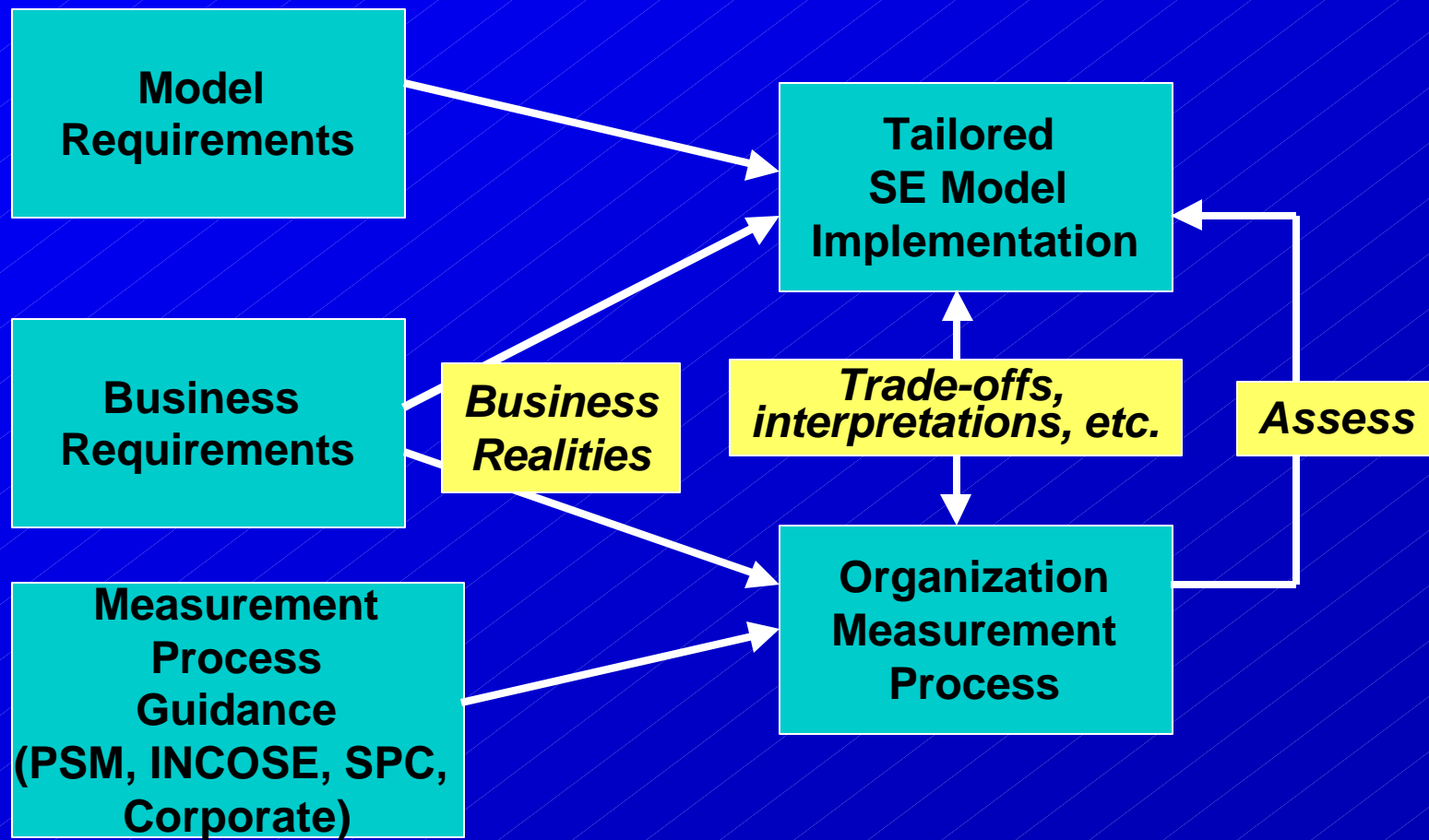
Meaning of “Maturity Level” in Continuous Model

- ✦ Not defined by models
- ✦ Often assumed to mean “Achieve that level in all focus areas”
- ✦ But, is this what we really want
 - See “Interpreting Continuous-View Capability Models for Higher Levels of Maturity” by Sarah A. Sheard and Garry J. Roedler, *Systems Engineering*, 2(1), 1999
 - Available from Consortium web site, www.software.org
- ✦ CMMI draft includes “Equivalent Staging”
 - Comparable to Sheard/Roedler approach

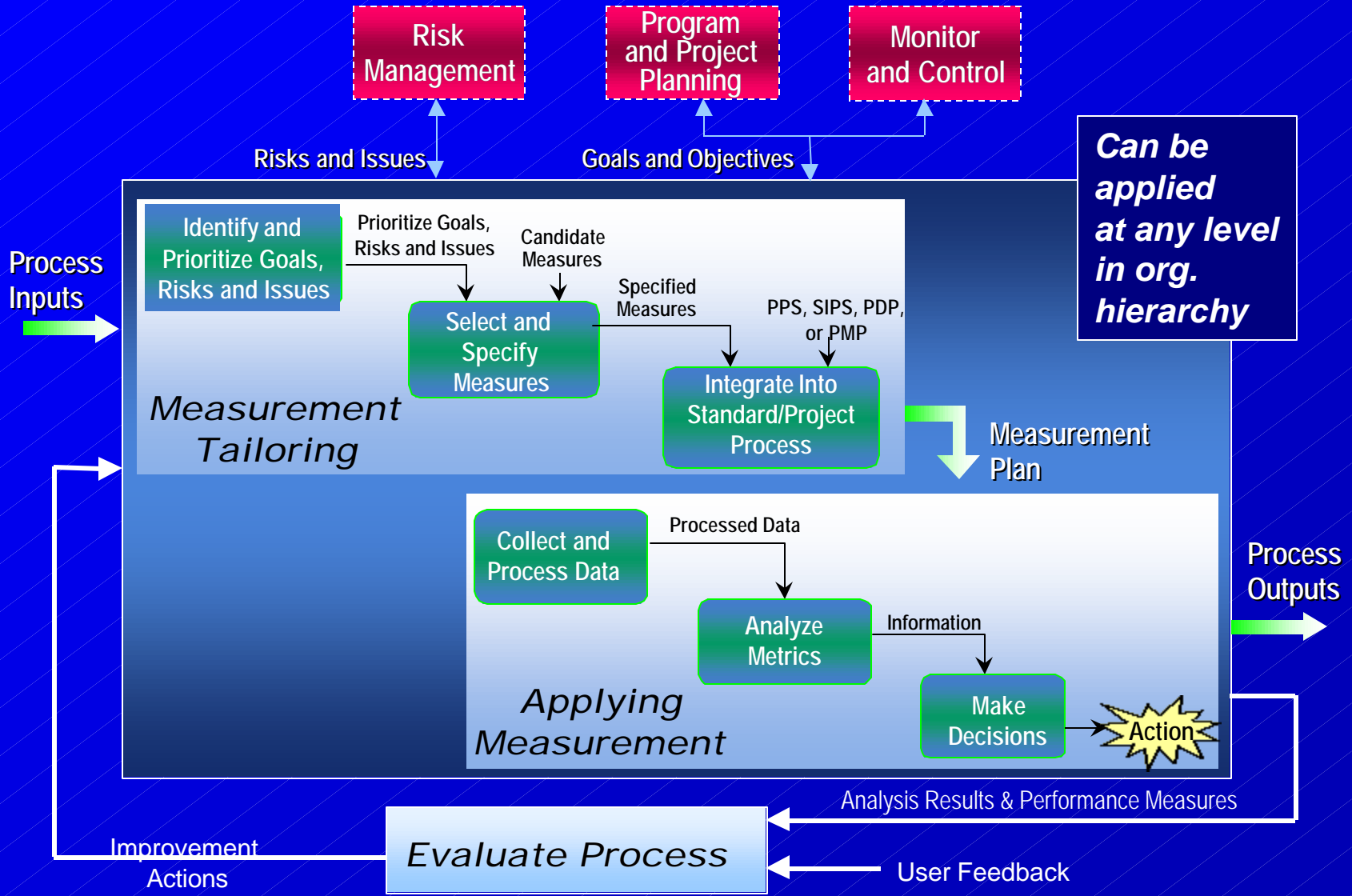


Addressing the Challenge

Aligning Measurement to Meet Both Model & Business Requirements



SI Measurement Process





Measurement Tailoring (Selection)

- ✦ **Key to achieving a manageable set of measures**
- ✦ **Based on issues/objectives at appropriate level**
 - **Company/Line of Business/Functional Org. Measures**
 - ◆ **Focus on:**
 - issues common to most projects
 - information needed to manage the business
 - evaluation of standard process effectiveness
 - evaluation of product quality
 - establishment of process capability
 - **Project-Specific Measures**
 - ◆ **Focus on:**
 - issues specific to the individual project
 - customer-related or required information needs

Integrated Approach that Considers:

- **Product / Process / Project**
- **Cost / Schedule / Quality / Performance**
- **Whole Life Cycle (Concept through O&M)**
- **Organization hierarchy and external data requirements**
- **Minimizing number of measures**



Measurement Tailoring (Selection)

- ★ **Quantity of measures and data availability are major considerations**
 - Identify data available in conduct of processes
 - Identify metrics that provide insight into multiple processes
 - ◆ Select measures based on SI processes, not PAs
 - ◆ Processes mapped back to PAs for traceability
 - ◆ Realized that product performance provides insight into process performance
 - Separate measures are not always necessary
 - E.g., Approval rates provide insight into product quality, but also provide insight into effectiveness of in-process reviews
 - Consider analysis and usage during selection and specification
 - Trade-offs to get most process coverage and insight with least number of measures
- ★ **Document in Measurement Plans**

PA's Included in Assessment

Engineering	Project	Organization
<p><u>Analyze Candidate Solutions</u></p> <p><u>Derive and Allocate Requirements</u></p> <p><u>Evolve System Architecture</u></p> <p><u>Integrate Disciplines</u></p> <p><u>Integrate System</u></p> <p><u>Understand Customer Needs and Expectations</u></p> <p><u>Verify and Validate System</u></p>	<p><u>Ensure Quality</u></p> <p>Manage Configurations *</p> <p><u>Manage Risk</u></p> <p><u>Monitor and control Technical Effort</u></p> <p><u>Plan Technical Effort</u></p> <p><small>* Received Level 4 Rating in 1998</small></p>	<p><u>Define Organization's Systems Engineering Process</u></p> <p><u>Improve Organization's Systems Engineering Process</u></p> <p>Manage Product Line Evolution</p> <p>Manage Systems Engineering Support Environment</p> <p>Provide Ongoing Skills and Knowledge</p> <p>Coordinate with Suppliers</p>

Number of Potential Measures:

- 13 Process Areas
- 1 Process Measure per PA
- 1 Product Measure per PA



26 Measures

Organizational Standard Measures

LOCKHEED MARTIN



Issue	Category	Measure
Customer Satisfaction	Customer Feedback	Award Fee Percent
Process Performance	Process Compliance	Award Fee Comments Program/Process Tailoring Self-Audit Findings
	Process Effectiveness	Rework Effort Percent
	Process Efficiency	Cycle Time Variance System Engineering Productivity
Product Quality	Functional Correctness	Approval Rates
Product Size and Stability	Functional Size and Stability	TBD/TBR (Percent Overdue)
Resources and Cost	Financial Performance	Cost Variance
	Personnel	Effort (Data Only)
Schedule and Progress	Work Unit Progress	Requirements Verification (Percent Overdue) Self-Audit Progress TBD/TBR (Percent Overdue)

13 measures defined and used. However, 4 measures provided insight
across set of processes and products



Applying Measurement

✦ Data Collection

- Collect data as process is being performed
- Use tools to assist, where possible

✦ Measurement Analysis

- Establish product quality goals and process capability thresholds
 - ◆ Establish “loose” thresholds/goals based on available data (if any) and engineering judgment
 - ◆ Measure, analyze, and review trends ⇒ adjust thresholds/goals
 - ◆ Organizational goals must be consistent with organizational capability and business strategic plan
 - ◆ Project goals must be driven by important project issues and integrate organizational goals to the degree appropriate
- Analyze data collected against goals and thresholds



Decision Support & Evaluating Measurement

◆ Decision Support

- Use results of analysis to initiate investigation of outliers and trends
- Take appropriate action, as warranted by investigation (i.e., quantitatively manage)
- Document actions & decisions resulting from each measure
 - ◆ Get all levels of management involved in decisions
- Periodically, use analysis results to refine values

◆ Evaluating Measurement

- Periodically review utility of each measure and retire or modify those of low utility or inconsistent



References & Summary

References & Resources

LOCKHEED MARTIN



Reference

- ✦ Sheard, Sarah A. and Garry J. Roedler, “Interpreting Continuous-View Capability Models for Higher Levels of Maturity”, INCOSE Systems Engineering Journal, Volume 2, Issue 1

Points of Contact

- ✦ Sarah Sheard, 703-742-7106
sheard@software.org
- ✦ Garry Roedler, 610-531-7845
garry.j.roedler@lmco.com



Summary

- ✦ **Continuous view models can drive much more measurement at Level 4**
- ✦ **Quantitative management: product quality and process performance are**
 - understood in statistical terms
 - managed throughout the life of the process
- ✦ **Quantitative objectives based on stakeholder needs**
- ✦ **A structured approach to select and apply measurement is necessary**
- ✦ **Quantitative understanding and focus lead to identifying and evaluating opportunities for process improvement**