CMMI® Version 1.2 and Beyond

CMMI Technology Conference
November 12, 2007

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Software Engineering Institute
Carnegie Mellon University

With thanks to Denise Cattan, Sandra Cepeda, Pascal Rabbath, and Gary Wolf for contributions.

CMMI

CMMI Today

n Status
As reported to the SEI as of 10-31-07

Training

Introduction to CMMI ï 76,794

Intermediate CMMI ï 2,622

Understanding CMMI High Maturity Practices ï 243

Authorized

Introduction to CMMI V1.2 Instructors ï 433

SCAMPI V1.2 Lead Appraisers ï 455

SCAMPI B&C V1.2Team Leads ï 21

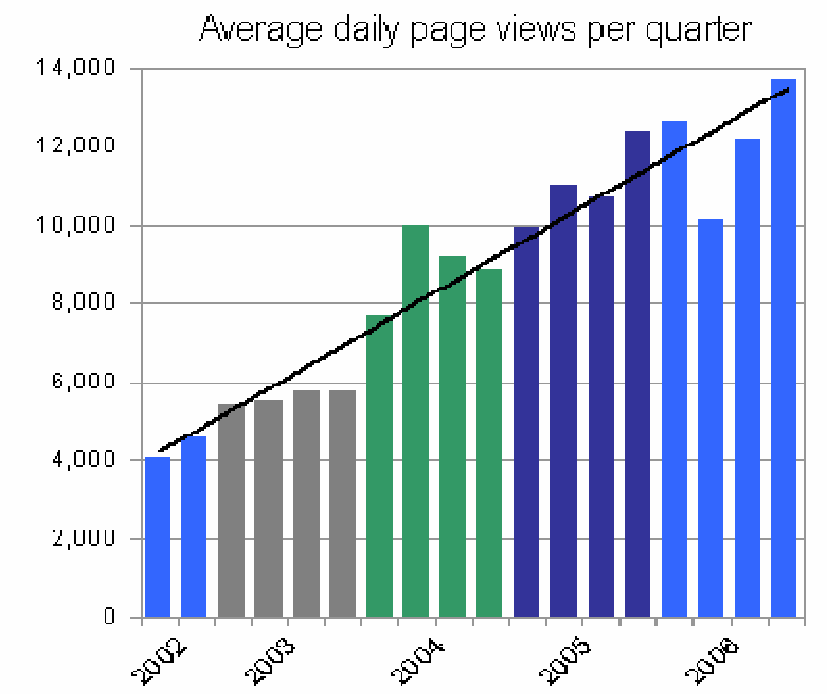
SCAMPI High Maturity Lead Appraisers -- 127

n, Web Views

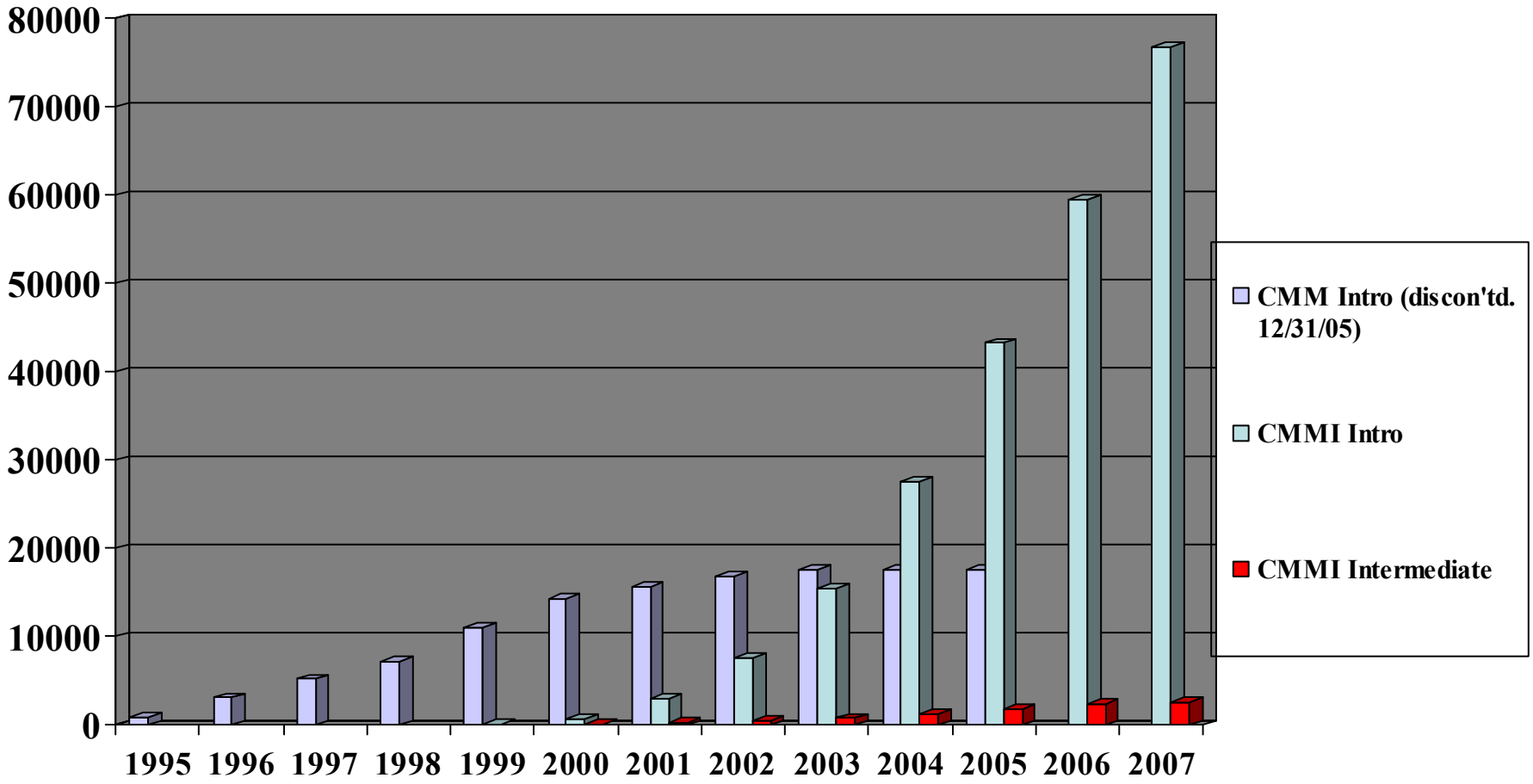
421K views/month in Q4 2006; over 24K views on 27 Sep 2006

Most downloaded files in Q4 2006

- CMMI-DEV, V1.2
- CMMI V1.2 Overview Presentation
- ñExtreme Programming (XP), Six Sigma, & CMMI: How They Can Work Togetherò
- ñCMMI V1.2 Model Changesò Presentation



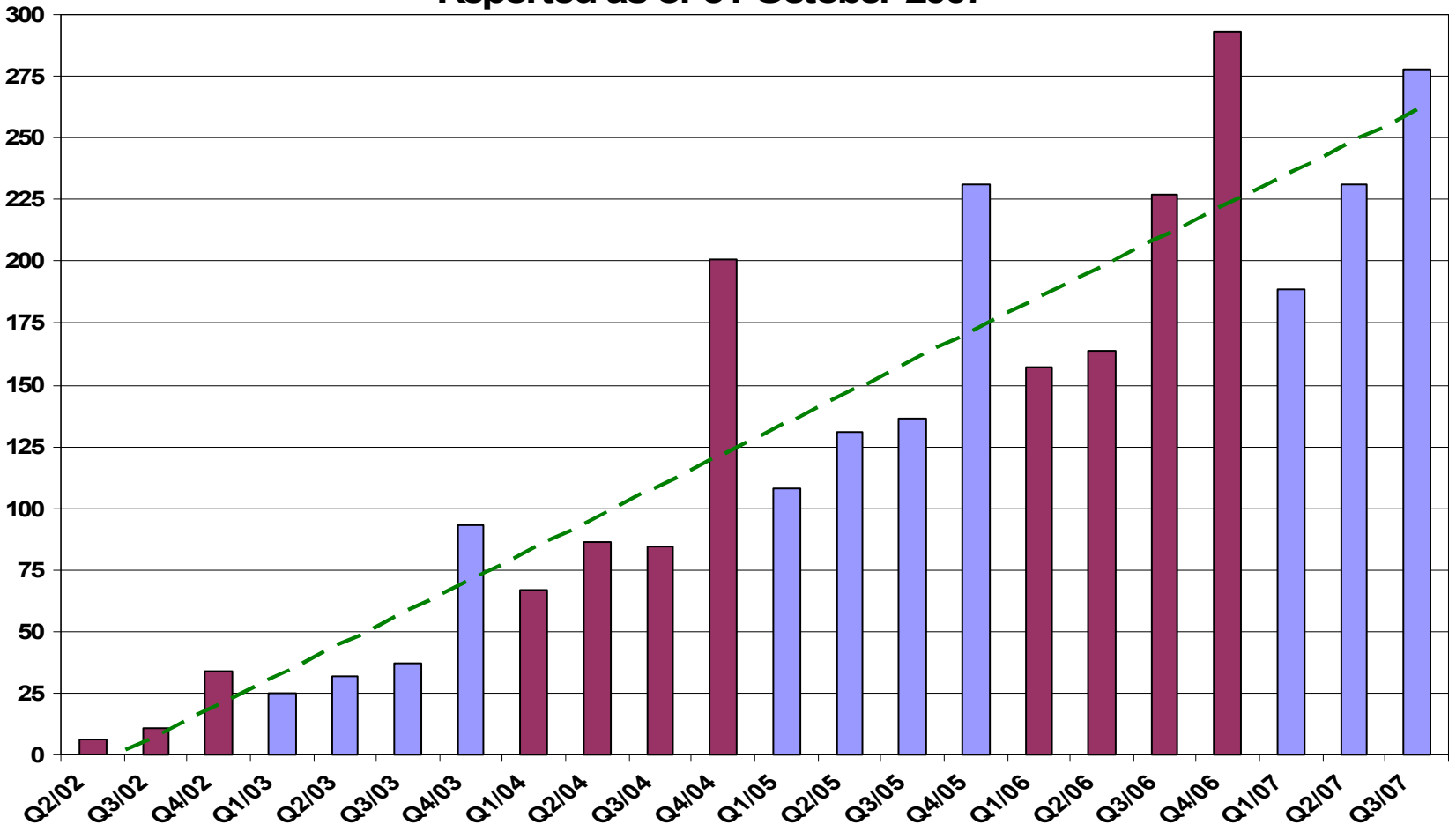
the CMM and CMMI Attendees (Cumulative)



10-31-07

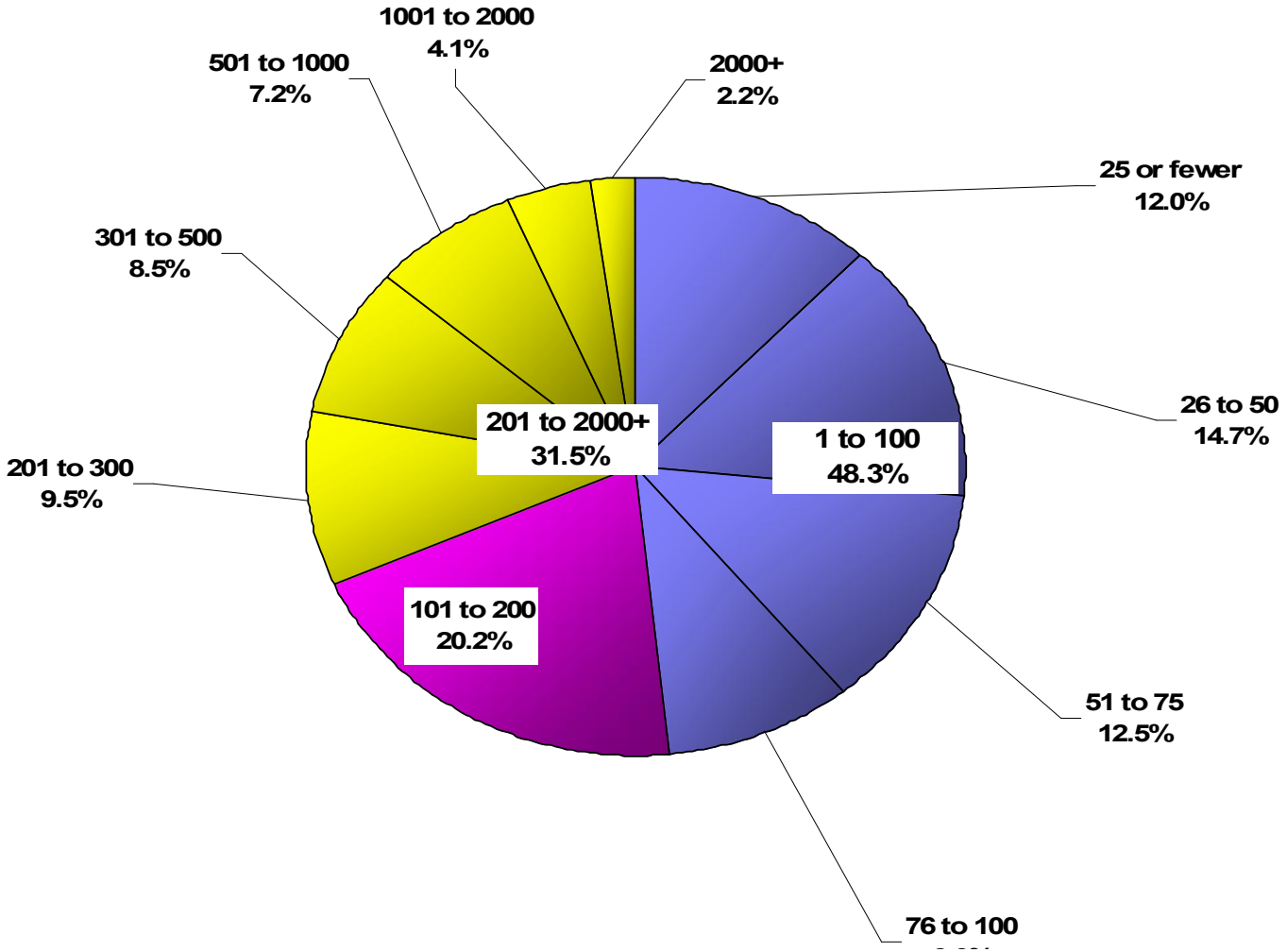
CMMI

Number of SCAMPI v1.1/v1.2 Class A Appraisals Conducted by Quarter Reported as of 31 October 2007

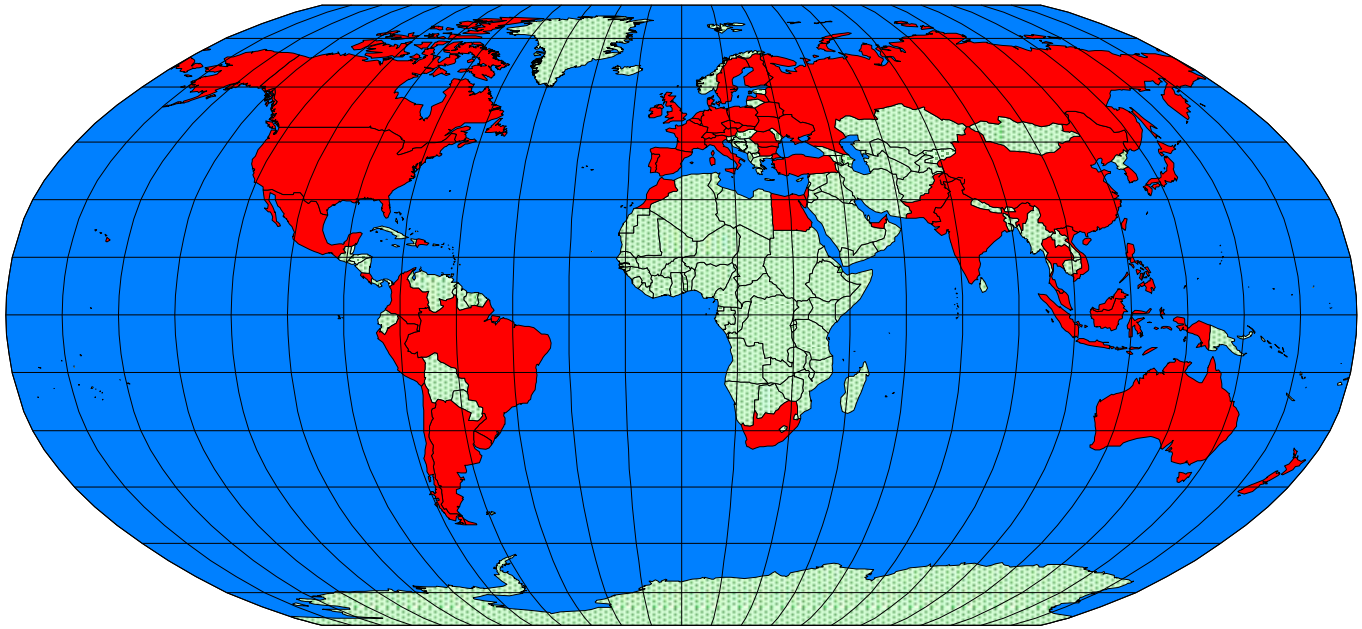


n Size

Based on the total number of employees within the area of the organization that was appraised



re Appraisals have been Performed and Reported to the SEI

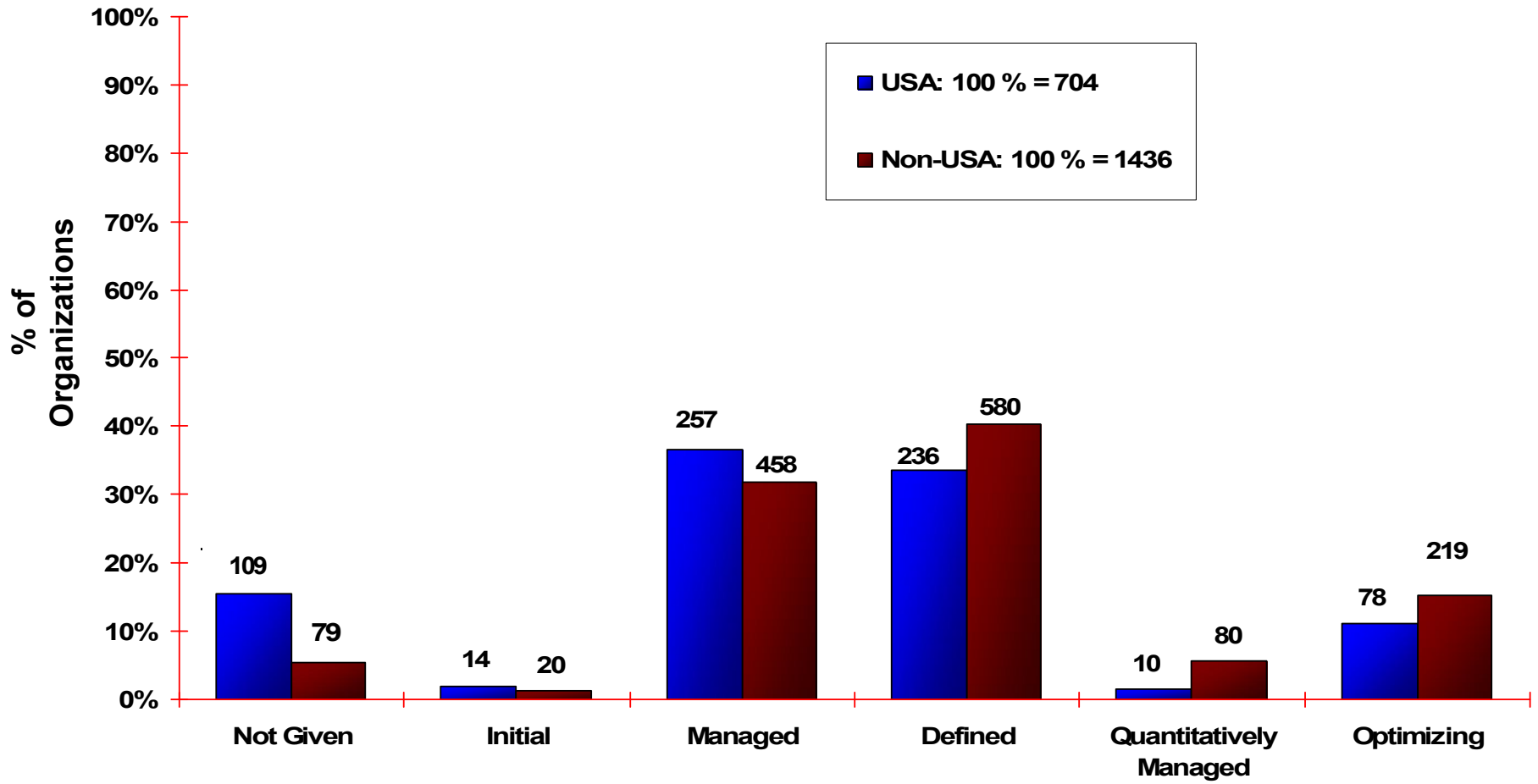


Argentina	Australia	Austria	Bahrain	Belarus	Belgium	Brazil	Bulgaria
Canada	Chile	China	Colombia	Costa Rica	Czech Republic	Denmark	Dominican Republic
Egypt	Finland	France	Germany	Hong Kong	India	Indonesia	Ireland
Israel	Italy	Japan	Korea, Republic Of	Latvia	Malaysia	Mauritius	Mexico
Morocco	Netherlands	New Zealand	Pakistan	Peru	Philippines	Poland	Portugal
Romania	Russia	Singapore	Slovakia	South Africa	Spain	Sweden	Switzerland
Taiwan	Thailand	Turkey	United Kingdom	Ukraine	United Arab Emirates	United States	Uruguay

isals and Maturity Levels
EI by Country

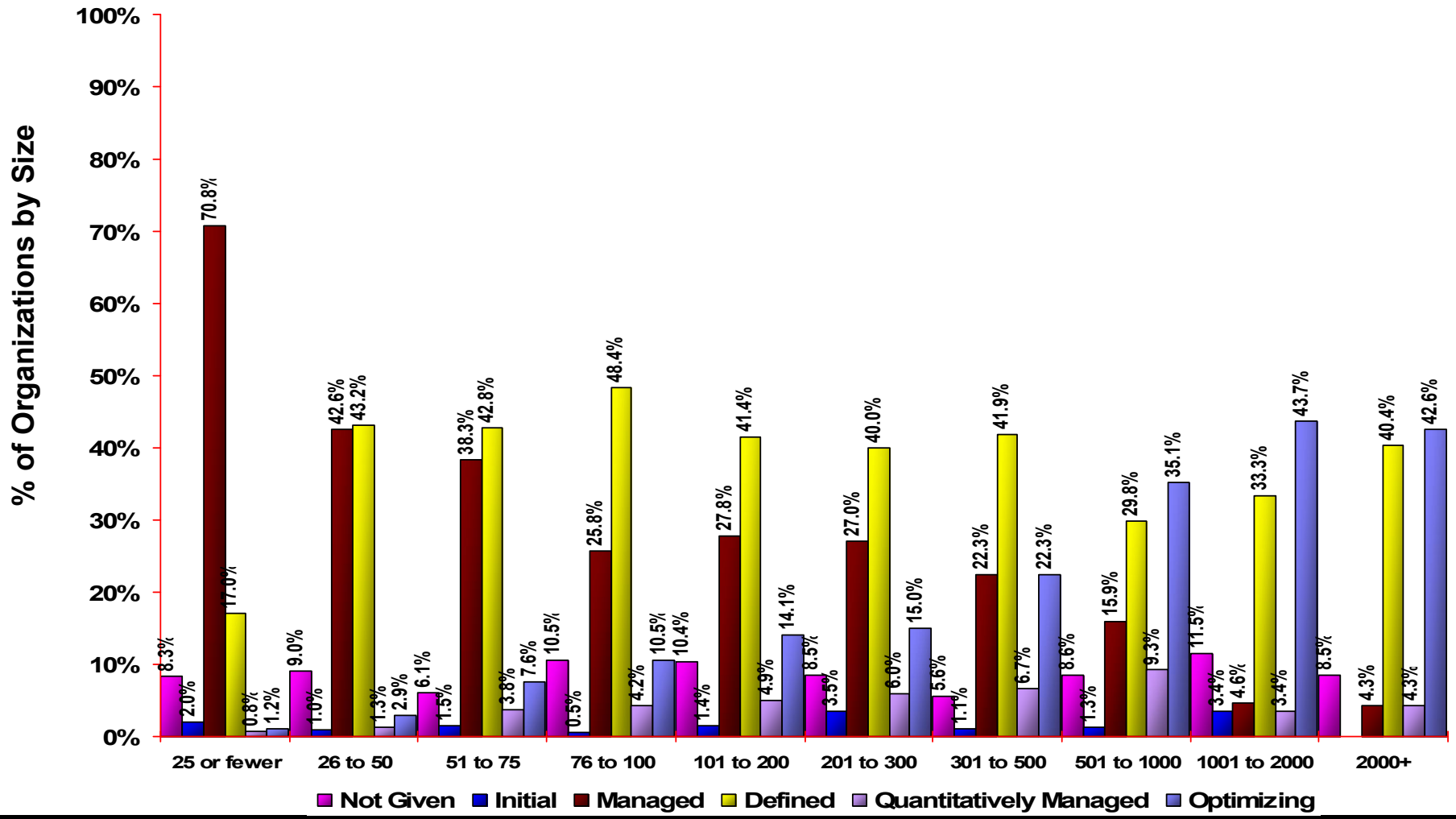
Country	Number of Appraisals	Maturity Level 1 Reported	Maturity Level 2 Reported	Maturity Level 3 Reported	Maturity Level 4 Reported	Maturity Level 5 Reported	Country	Number of Appraisals	Maturity Level 1 Reported	Maturity Level 2 Reported	Maturity Level 3 Reported	Maturity Level 4 Reported	Maturity Level 5 Reported
Argentina	26	No	Yes	Yes	Yes	Yes	Malaysia	29	No	Yes	Yes	No	Yes
Australia	26	Yes	Yes	Yes	Yes	Yes	Mauritius	10 or fewer					
Austria	10 or fewer						Mexico	29	Yes	Yes	Yes	Yes	Yes
Bahrain	10 or fewer						Morocco	10 or fewer					
Belarus	10 or fewer						Netherlands	10 or fewer					
Belgium	10 or fewer						New Zealand	10 or fewer					
Brazil	58	No	Yes	Yes	Yes	Yes	Pakistan	10 or fewer					
Bulgaria	10 or fewer						Peru	10 or fewer					
Canada	38	No	Yes	Yes	Yes	Yes	Philippines	17	No	Yes	Yes	No	Yes
Chile	17	No	Yes	Yes	No	Yes	Poland	10 or fewer					
China	321	Yes	Yes	Yes	Yes	Yes	Portugal	10 or fewer					
Colombia	16	No	Yes	Yes	Yes	Yes	Romania	10 or fewer					
Costa Rica	10 or fewer						Russia	10 or fewer					
Czech Republic	10 or fewer						Singapore	10					
Denmark	10 or fewer						Slovakia	10 or fewer					
Dominican Republic	10 or fewer						South Africa	10 or fewer					
Egypt	25	No	Yes	Yes	Yes	Yes	Spain	55	No	Yes	Yes	Yes	Yes
Finland	10 or fewer						Sweden	10 or fewer					
France	94	Yes	Yes	Yes	Yes	Yes	Switzerland	10 or fewer					
Germany	41	Yes	Yes	Yes	Yes	Yes	Taiwan	71	No	Yes	Yes	No	Yes
Hong Kong	10						Thailand	10 or fewer					
India	256	No	Yes	Yes	Yes	Yes	Turkey	10 or fewer					
Indonesia	10 or fewer						Ukraine	10 or fewer					
Ireland	10 or fewer						United Arab Emi	10 or fewer					
Israel	12	No	Yes	Yes	No	Yes	United Kingdom	57	Yes	Yes	Yes	Yes	Yes
Italy	12	No	Yes	Yes	No	No	United States	859	Yes	Yes	Yes	Yes	Yes
Japan	197	Yes	Yes	Yes	Yes	Yes	Uruguay	10 or fewer					
Korea, Republic Of	87	Yes	Yes	Yes	Yes	Yes	Viet Nam	10 or fewer					
Latvia	10 or fewer												

file by All Reporting USA and Non-USA Organizations

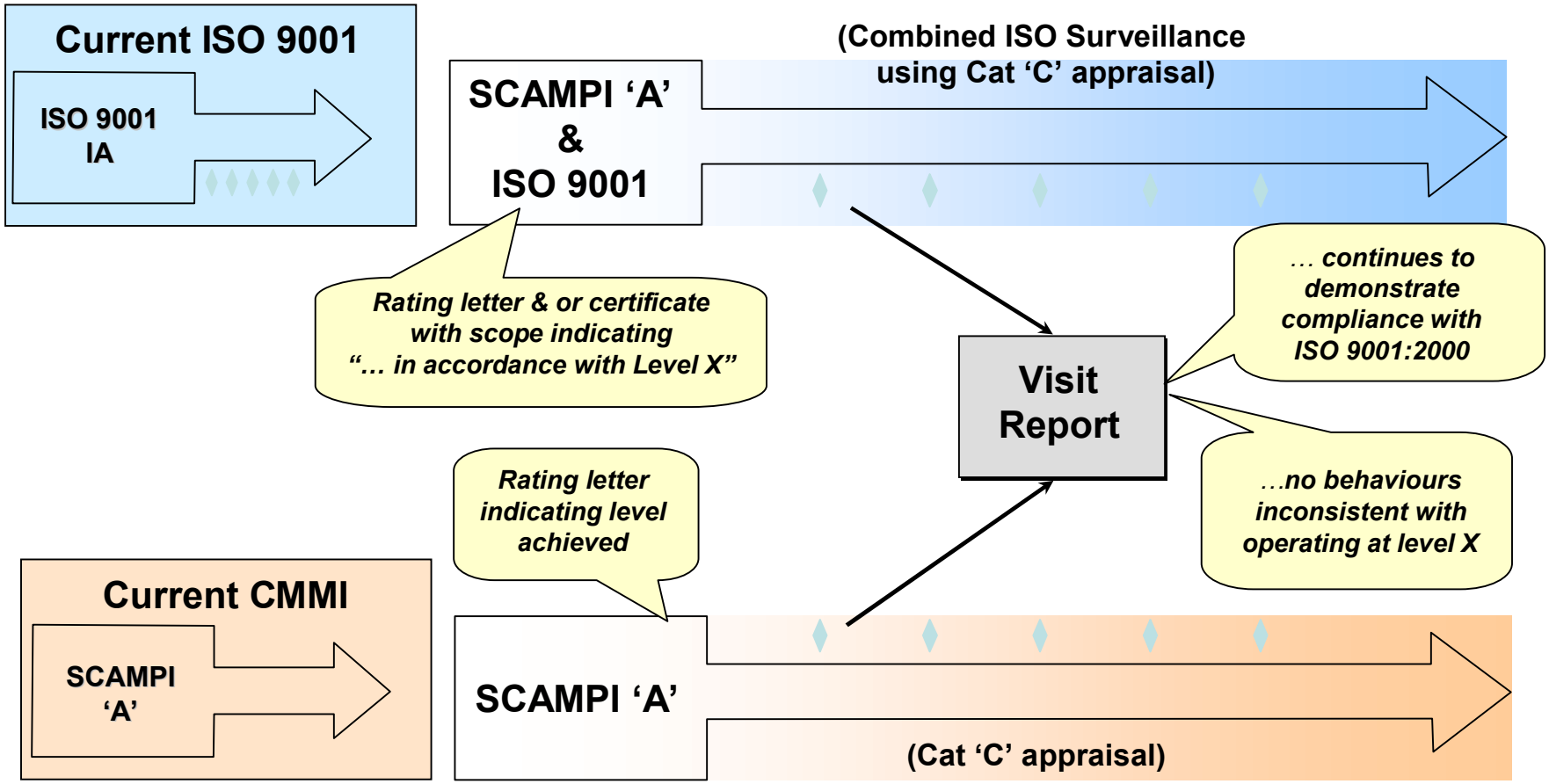


e by Organization Size

ees within the area of the organization that was appraised



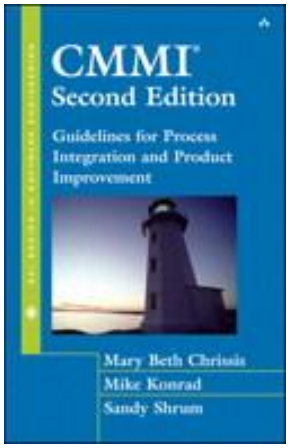
raisal Opportunities



The possible options for assessment and surveillance

t Else Is Happening?

The Addison-Wesley SEI Series Book and



- A Guide to the CMMI
- CMMI: A Frameworké
- CMMI Assessments
- CMMI Distilled: Second Edition
- CMMI SCAMPI Distilled
- CMMI Survival Guide
- CMMI: Un Itinéraire Fléché
- De kleine CMMI
- Interpreting the CMMI
- Making Process Improvement Work
- Practical Insight into CMMI
- Real Process Improvement Using the CMMI
- Systematic Process Improvement Using ISO 9001:2000 and CMMI
- Balancing Agility and Discipline

Publications?

Technical notes and special reports

- Using CMMI-DEV for sourcing
- Interpreting CMMI:
  - for Operational Organizations
  - for COTS Based Systems
  - for Service Organizations
  - for Marketing
- Using CMMI with:
  - TSP/PSP
  - Earned Value Management
  - Product Line Practices
  - Lean Six Sigma
- Supplementing CMMI for Safety Critical Development
- Demonstrating the Impact and Benefits of CMMI (and Web pages ï www.sei.cmu.edu/cmmi/results)

esults Summary

Improvements	Median	# of data points	Low	High
Cost	34%	29	3%	87%
Schedule	50%	22	2%	95%
Productivity	61%	20	11%	329%
Quality	48%	34	2%	132%
Customer Satisfaction	14%	7	-4%	55%
Return on Investment	4.0 : 1	22	1.7 : 1	27.7 : 1

- N = 30, as of August 2006
- Organizations with results expressed as change over time

Version 1.1 CMMI Product Suite was released January 2002.

- CMMI Web site visits average over 20,000/day
- Over 75,000 people have been trained
- Over 2500 ñclass Aòappraisals have been reported to the SEI

Now we want to continuously improveé

CMMI

CMMI V1.2 and Beyond

for V1.2

Reduce complexity & size

Increase coverage

Increase confidence in appraisal results

l Complexity & Size

Eliminated the concepts of advanced practices and common features

Incorporated ISM into SAM; eliminated Supplier Sourcing (SS) addition

Consolidated and simplified the IPPD material

All definitions consolidated in the glossary

Adopted a single book approach (i.e., will no longer provide separate development models)

Report size reduced 15% from either predecessor; PAs reduced 12%

el Coverage

Added hardware amplifications

Added two work environment practices (i.e., one in OPD and one in IPM)

Added goal and two practices in OPF to emphasize importance of project startup

Updated notes (including examples) where appropriate so that they also address service development and acquisition of critical elements

Updated name to CMMI for Development (CMMI-DEV) to reflect the expanded coverage

s - Other

Improved the Overview section (Part One)

Improved clarity of how GPs are used

- Moved generic goals and practices to Part Two
- Added explanation of how process areas support the implementation of GPs
- Added GP elaborations for GP 3.2

Improved the glossary (e.g., higher level management, bidirectional traceability, subprocess)

Limited the process areas that can be considered ñnot applicableòto SAM.

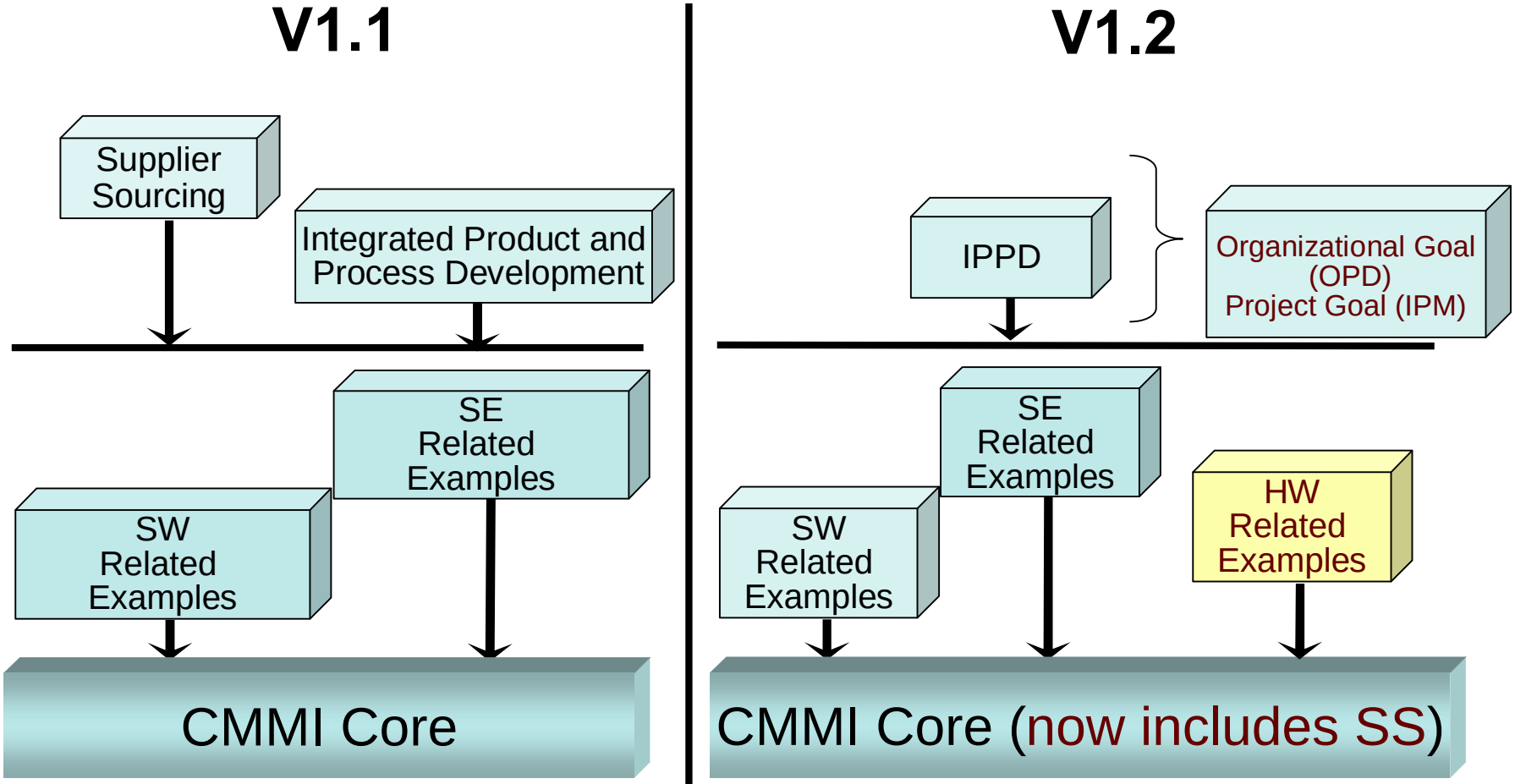
Clarified material throughout the model based on over 1000 change requests

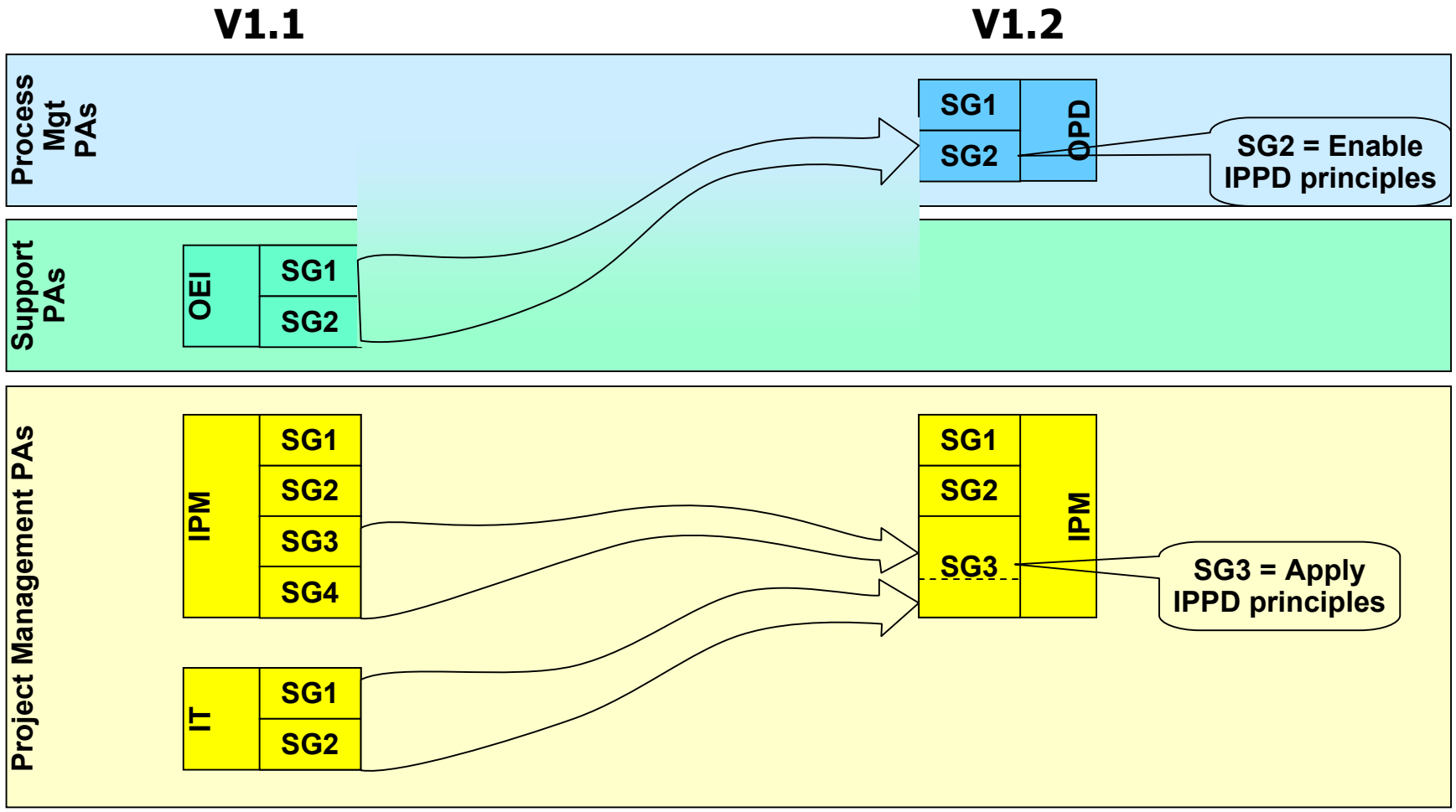
duct and Process Development (IPPD) Changes

IPPD material is being revised significantly.

- Organization Environment for Integration PA removed and material moved to Organizational Process Definition (OPD) PA.
- Integrated Teaming PA removed and material moved to Integrated Project Management (IPM) PA.
- IPPD goals have been consolidated.
  - ñEnable IPPD Managementòin OPD
  - ñApply IPPD Principlesòin IPM
- Overall material condensed and revised to be more consistent with other PAs.

ombinations





ment Management

Specific Goal	Specific Practice
Establish Supplier Agreements	**1.1 – Determine Acquisition Type** **1.2 – Select Suppliers** **1.3 – Establish Supplier Agreements**
Satisfy Supplier Agreements	**2.1 – Execute the Supplier Agreement** **2.2 – Monitor Selected Supplier Processes** **2.3 – Evaluate Selected Supplier Work Products** **2.4 – Accept the Acquired Product** **2.5 – Transition Products**

V1.1 SP2.1 ñReview COTS Products,òwas eliminated. ñIdentify candidate COTS products that satisfy requirementsòis a new subpractice under the Technical Solutions Process Area SP1.1, ñDevelop Alternative Solutions and Selection Criteria.ò

ocess Focus

CMMI

V1.1

SG 1 – Determine Process Improvement Opportunities

1.1 – Establish Organizational Process Needs

1.2 – Appraise the Organization's Processes

1.3 – Identify the Organization's Process Improvements

SG 2 – Plan and Implement Process Improvement Activities

2.1 – Establish Process Action Plans

2.2 – Implement Process Action Plans

2.3 – Deploy Organizational Process Assets

2.4 – Incorporate Process-Related Experiences into the Organizational Process Assets

V1.2

SG 1 – Determine Process Improvement Opportunities

1.1 – Establish Organizational Process Needs

1.2 – Appraise the Organization's Processes

1.3 – Identify the Organization's Process Improvements

SG 2 – Plan and Implement Process Improvement

2.1 – Establish Process Action Plans

New

2.2 – Implement Process Action Plans

SG 3 – Deploy Organizational Process Assets and Incorporate Lessons Learned

3.1 – Deploy Organizational Process Assets

3.2 – Deploy Standard Processes

3.3 – Monitor Implementation

3.4 – Incorporate Process Related Experiences into the Organizational Process Assets

nges for V1.2

Method implementation clarifications

- interviews in ñvirtualò organizations
- practice characterization rules
- organizational unit sampling options

Appraisal Disclosure Statement (ADS) improvements

- reduce redundancy with other appraisal documents
- improve usability for sponsor and government
- Level 4,5 mapping to business objectives
- require sponsorôs signature on the ADS
- require all team members to show agreement on findings
- Both V1,1 and V1.2 ADS reflect these today

Appraisal team will have responsibility for determination of ñapplicabilityò for SAM

Maturity level and capability level validity period ï 3 years, given 1 year of V1.2 availability

raisal Results

Carnegie Mellon Software Engineering Institute

List of Published SCAMPI Appraisal Results

ORGANIZATION NAME:	Satyam Computer Services Ltd.
SPONSOR NAME:	Nagaraj Chevour
LEAD APPRAISER NAME:	Raghavan Nandyal
SEI PARTNER:	SITARA Technologies Pvt. Ltd.
APPRAISAL END DATE:	4/3/2004
MATURITY LEVEL ASSIGNED:	5
APPRAISED ORGANIZATIONAL UNIT:	
Entity Name:	SRU GE-GDC
Location(s):	Secunderabad, AP, India
CMMI MODEL USED:	CMMI-SW/IPPD, V1.1, Continuous
APPRAISAL METHOD USED:	SCAMPI v1.1

MODEL SCOPE & CAPABILITY RATINGS ASSIGNED:

Process Management		Project Management		Engineering		Support	
OPF	Capability Level 3	PP	Capability Level 4	REQM	Capability Level 3	CM	Capability Level 3
OPD	Capability Level 3	PMC	Capability Level 4	RD	Capability Level 4	PPQA	Capability Level 3
OT	Capability Level 3	SAM	Not Applicable	TS	Capability Level 5	MA	Capability Level 3
OPP	Capability Level 3	IPM	Capability Level 3	PI	Capability Level 3	DAR	Capability Level 3
OID	Capability Level 3	RSKM	Capability Level 4	VER	Capability Level 5	OEI	Capability Level 3
		IT	Capability Level 3	VAL	Capability Level 3	CAR	Capability Level 3
		ISM	Not Rated				
		QPM	Capability Level 3				

Major Themes

Reduce complexity and ambiguity

Provide additional guidance where needed

Strengthen appraisal planning and conduct

Strengthen appraisal reporting

Define appraisal validity period

Strengthen lead appraiser requirements

exity -1

The requirement for instruments (e.g., questionnaires) was removed.

Only two types of objective evidence are now required:

- documents
- interviews

The following sections in MDD were revised:

- switched 2.2 Verify and Validate Objective Evidence and 2.3 Document Objective Evidence so that the order of tasks reflects the natural order of conducting an appraisal
- separated Verify Objective Evidence and Validate Preliminary Findings to better describe each process

exity -2

The use of the term instantiation was changed:

- Instantiation is now defined as ñthe implementation of a model practice used in the appropriate context within the boundaries of an organizational unit.ò
- The word ñinstantiationòfor project and organizational-wide entities was replaced with ñprojectòor ñsupport group.ò

uity

The rating Not Rated was clarified:

- Process areas outside of the model scope are rated as Out of Scope. For example, for a maturity level 3 appraisal, maturity level 4 and 5 process areas are rated as Out of Scope.
- For process areas that have insufficient data to be rated, the rating is Not Rated.
- Process areas in the model scope, but outside the organizational scope are rated as Not Applicable. The only process area that can be Not Applicable is SAM (as determined by the appraisal team).

The practice characterization tables were revised:

- clarified the use of virtual versus live interviews
- changed ñface-to-face interviewsòto ñoral interviewsò

onal Guidance

Guidance for readiness reviews was revised to include team and logistical readiness.

Additional guidance was provided for using virtual methods (e.g., for interviews and briefings).

Additional guidance was provided for using alternative practices (i.e., Appendix C: Alternative Practice Identification and Characterization Guidance).

praisal Planning and Conduct

Organizational unit sampling was revised to*

- strengthen parameters and limits for organizational sampling (e.g., identifying a minimum number of focus projects)
- include additional criteria for reporting sampling decisions

The Conduct Appraisal Phase must now be complete within 90 days.

Appraisal team members are now required to sign final findings.

*Changes to address sampling were extensive. Refer to the MDD for details.

praisal Reporting

The Appraisal Disclosure Statement (ADS) now requires the following information.

Organizational sampling criteria and decisions (e.g., projects included, projects excluded, percentage of organization represented)

Basis for maturity/capability level 4 and 5 appraisal results

- subprocesses statistically managed
- mapping of these subprocesses to quality and process-performance objectives

Signatures of both the lead appraiser and sponsor

- The lead appraiser affirms that the appraisal scope is representative of the organizational unit.
- The sponsor affirms the accuracy of the ADS and authorizes the SEI to conduct any audits deemed necessary.

al Validity Period

V1.2 appraisal results are valid for a maximum of 3 years from the date of the ADS.

V1.1 appraisals will expire on August 31, 2007 or 3 years after the date the appraisal was conducted, whichever is later.

ıd Appraiser Requirements

Prior to conducting a v1.2 SCAMPI appraisal, the following must occur:

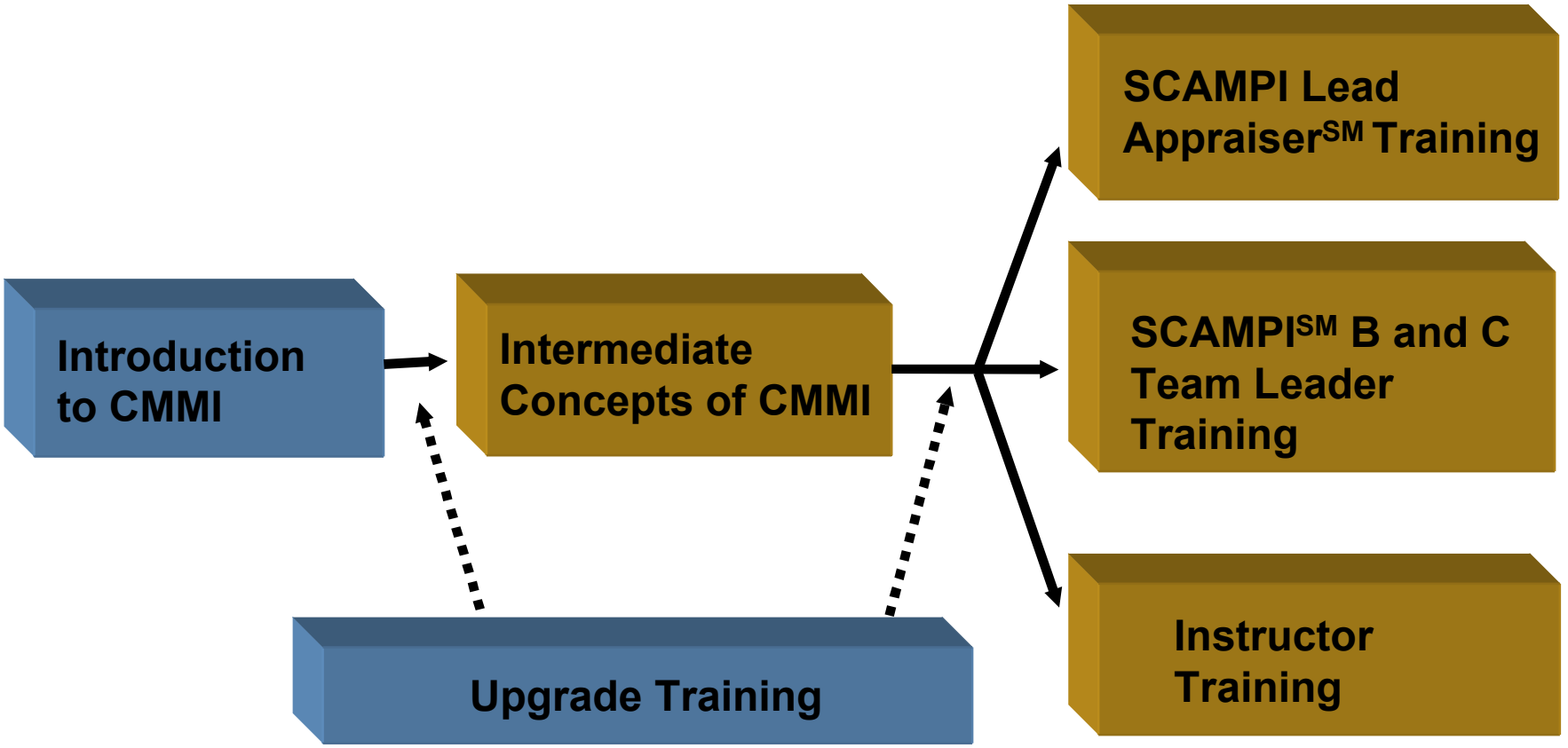
- Current candidate and authorized lead appraisers and team leaders must complete CMMI v1.2 Upgrade Training.
- Candidate and authorized lead appraisers must attend SCAMPI Face-to-Face Training.
- Those who want to conduct v1.2 SCAMPI level 4 or 5 appraisals must be certified. Certification requirements address the following:
  - education, training, and experience in level 4 and 5 concepts
  - completion of an oral exam

The SCAMPI A appraisal method was revised based on change requests received to

- reduce complexity and ambiguity
- provide additional guidance where needed
- strengthen appraisal planning and conduct
- strengthen appraisal reporting
- define the appraisal validity period
- strengthen lead appraiser requirements

The changes are intended to make appraisals more accurate, reliable, and efficient.

r CMMI



Changes

The following courses have all been updated to address change requests and CMMI Product Suite v1.2 changes:

- Introduction to CMMI
- Intermediate Concepts of CMMI
- CMMI Instructor Training
- SCAMPI Lead Appraiser Training
- SCAMPI B and C Team Leader Training

CMMI v1.2 Upgrade Training was also developed to help users move from v1.1 to v1.2, an online course with potential SEI Partner assistance

The construction and format of examinations have changed. v1.1 tests were largely short answer tests that were the same for all students.

For v1.2, tests will be generated from an item bank and now will be multiple choice. CMMI v1.2 Upgrade Training for Instructors, Lead Appraisers, and Team Leaders is the first course to use this approach. The Intermediate Concepts of CMMI and Instructor Training will follow.

e Examinations

This new approach, using an item bank and multiple choice questions, allows multiple versions of examinations that can be constructed more easily:

- The sequence of multiple choice responses can vary from test to test.
- The order of questions can vary from test to test.
- The selection of questions can vary from test to test, but cover the same categories.

This new approach allows the SEI to

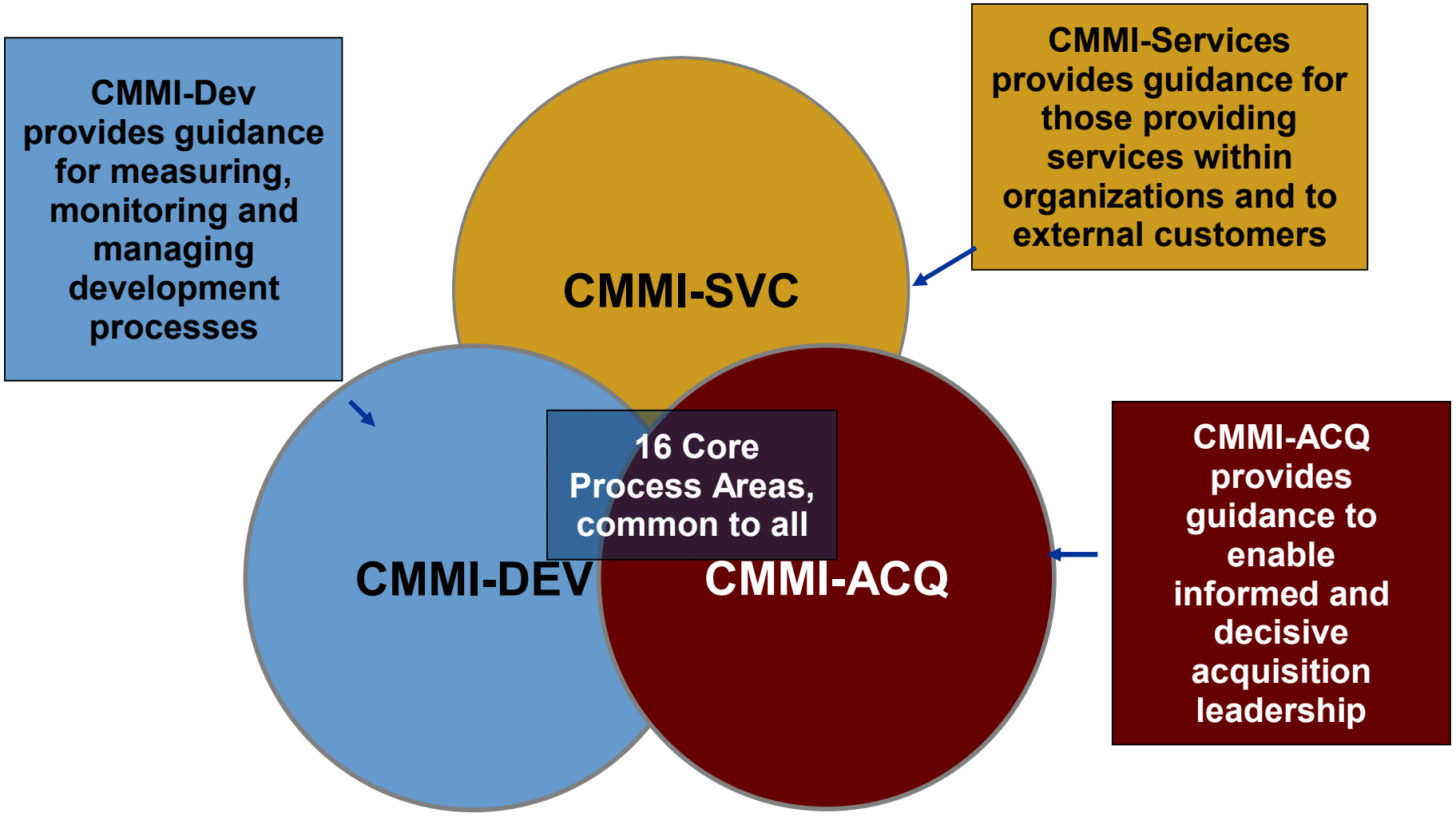
- add, modify, and delete questions from the test more easily
- better evaluate the student's knowledge

CMMI

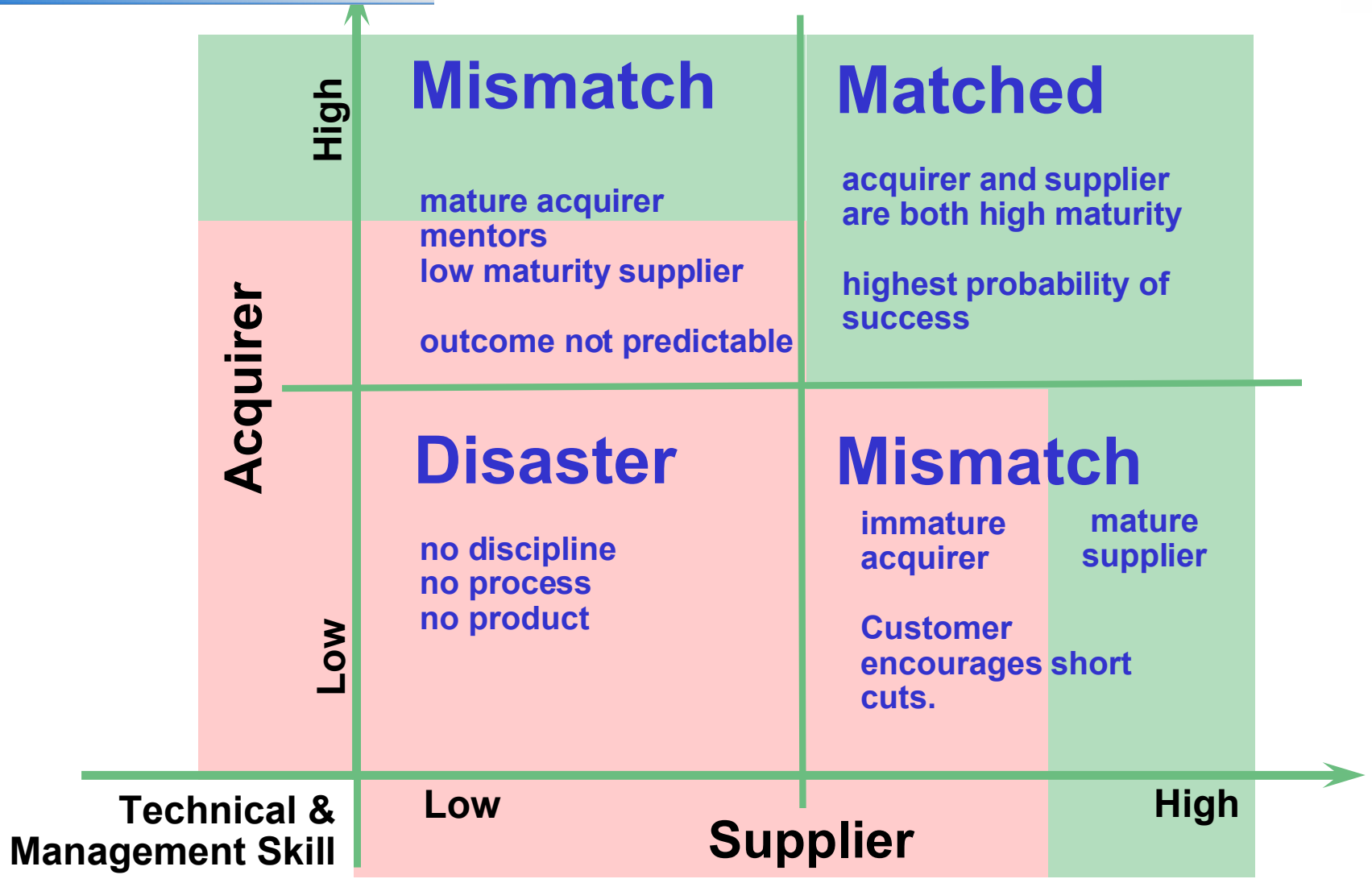
Improved architecture will allow post-V1.2 expansion.

- Extensions of the life cycle (Services, Outsourcing/Acquisition) could expand use of a common organizational framework:
  - allows coverage of more of the enterprise or potential partnering organizations
  - adapts model features to fit non-developmental efforts (e.g., CMMI Services, CMMI Acquisition)

ary "Constellations"

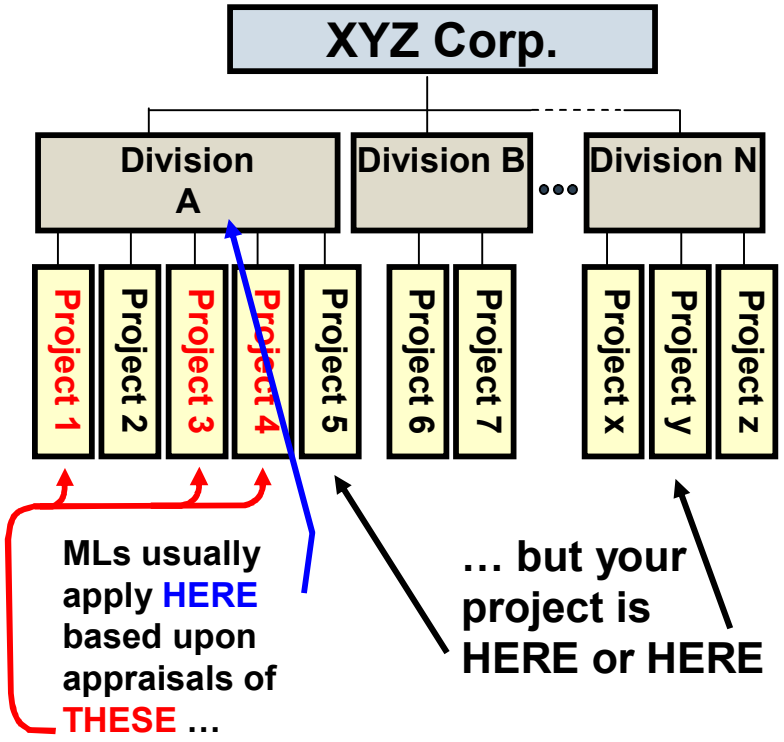


ier Mismatch

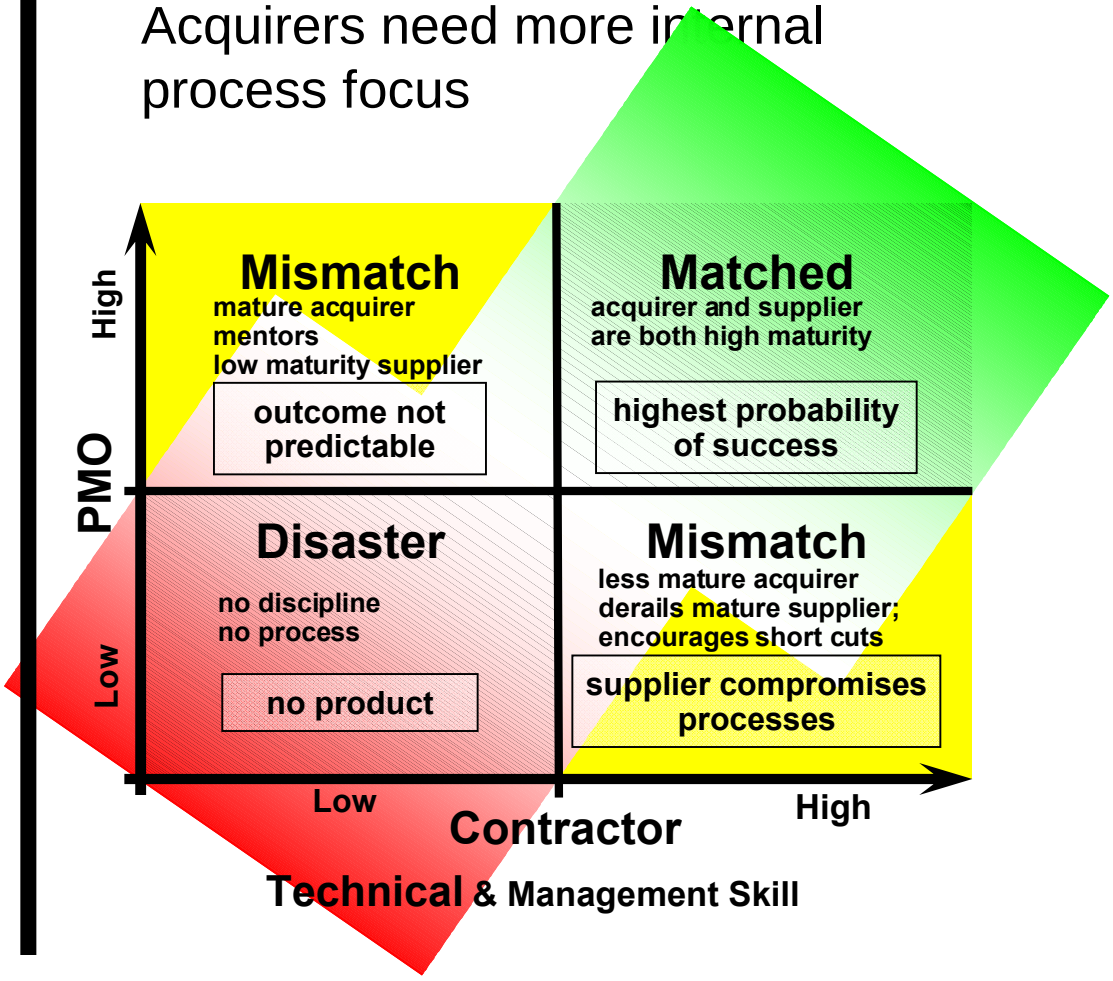


provement is Needed….

Acquirers cannot ensure that mature processes are applied to their programs



Acquirers need more internal process focus



ncept

Provide a õprocess toolboxòfor the acquirer

- Include practical guidance on how to recognize the real practitionersé
- Encourage the use of capability and maturity profiles vice "single level" approach
- Improve acquisition organizations' understanding of the meaning of high maturity (levels 4 and 5) and equivalent staging
- Include multiple tools and guidance that may be used throughout the acquisition lifecycle

n processes are Important

Improve acquisition office operating practices

- Improve Reviews ï documents, PMRs, PDRs, CDRsé
- Improve specific areas: risk mgt, requirements mgt, configuration control, contracting actions (including source selection)
- Improve communications
- Create a ñstrategic rhythmò
- Facilitate synergy between program segments/organizations, and even among ñsystems of systemsò

Facilitate supplier processes

- Oversight/Insight into supplier processes
- Encourage strategic acquirer-supplier teamwork that may last for years

rket challenges

ons from Chaos to Discipline

Random motion ï lots of energy, not much progress

No teamwork ï individual effort

Frequent conflict

You never know where you'll end up

Directed motion ï every step brings you closer to the goal

Coordinated efforts

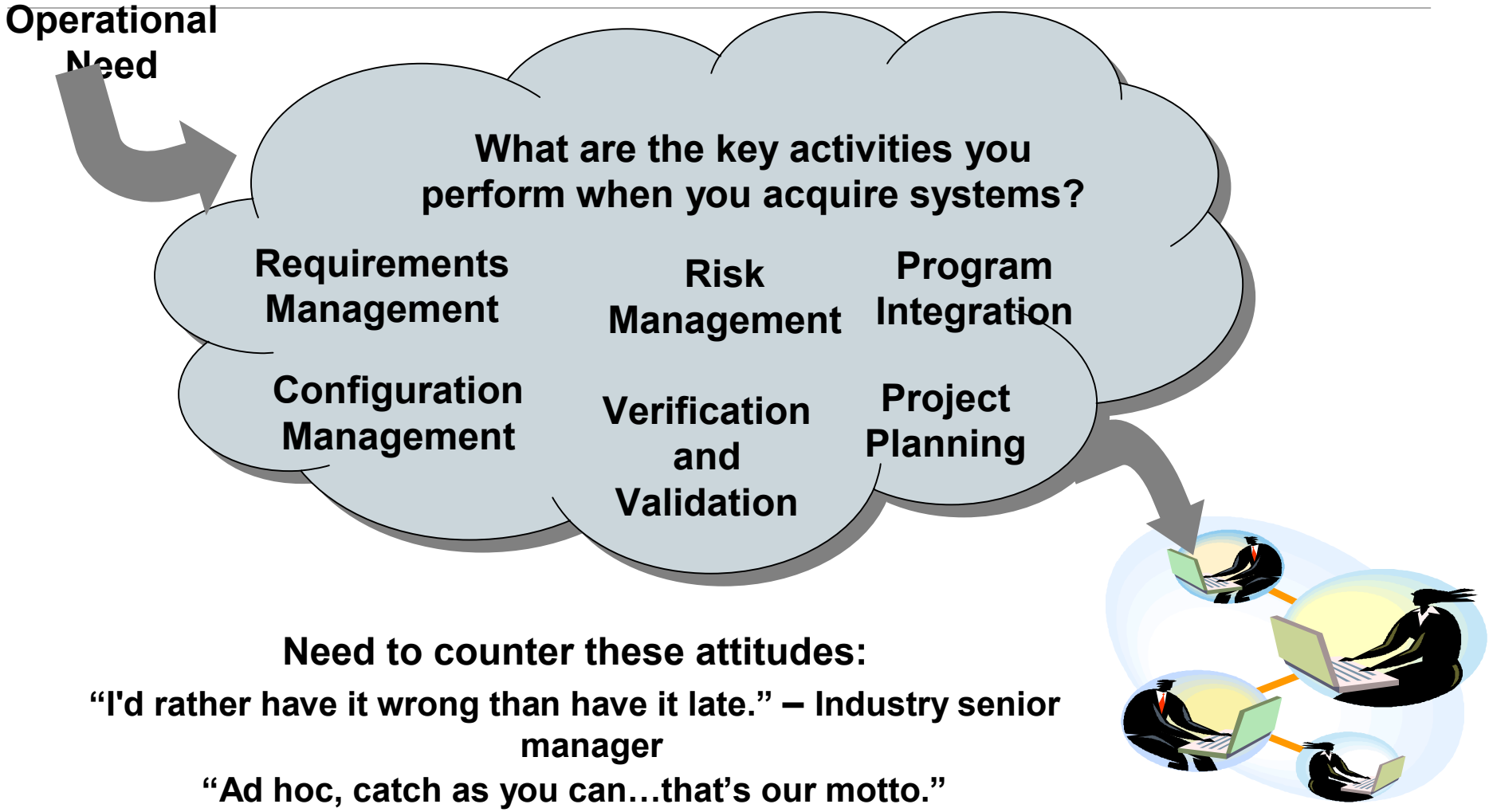
Cooperation

Predictable results

Processes can make the difference for Developers *and Acquirers*.

uirer's Mind

ilities?



Need to counter these attitudes:

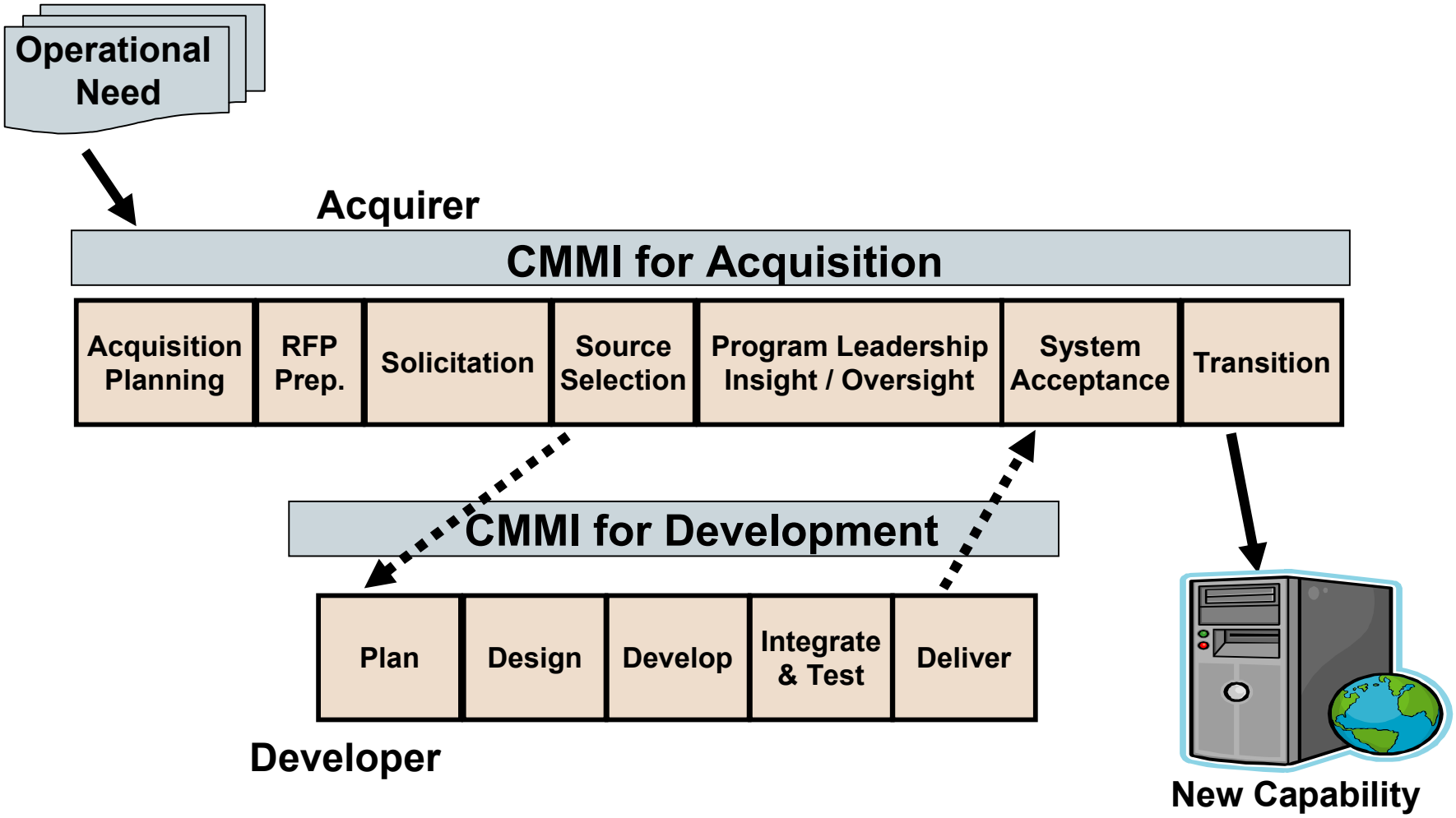
"I'd rather have it wrong than have it late." – Industry senior manager

"Ad hoc, catch as you can…that's our motto."

"We do not work problems until they're unrecoverable."

uirer's Mind - 2

s capabilities?



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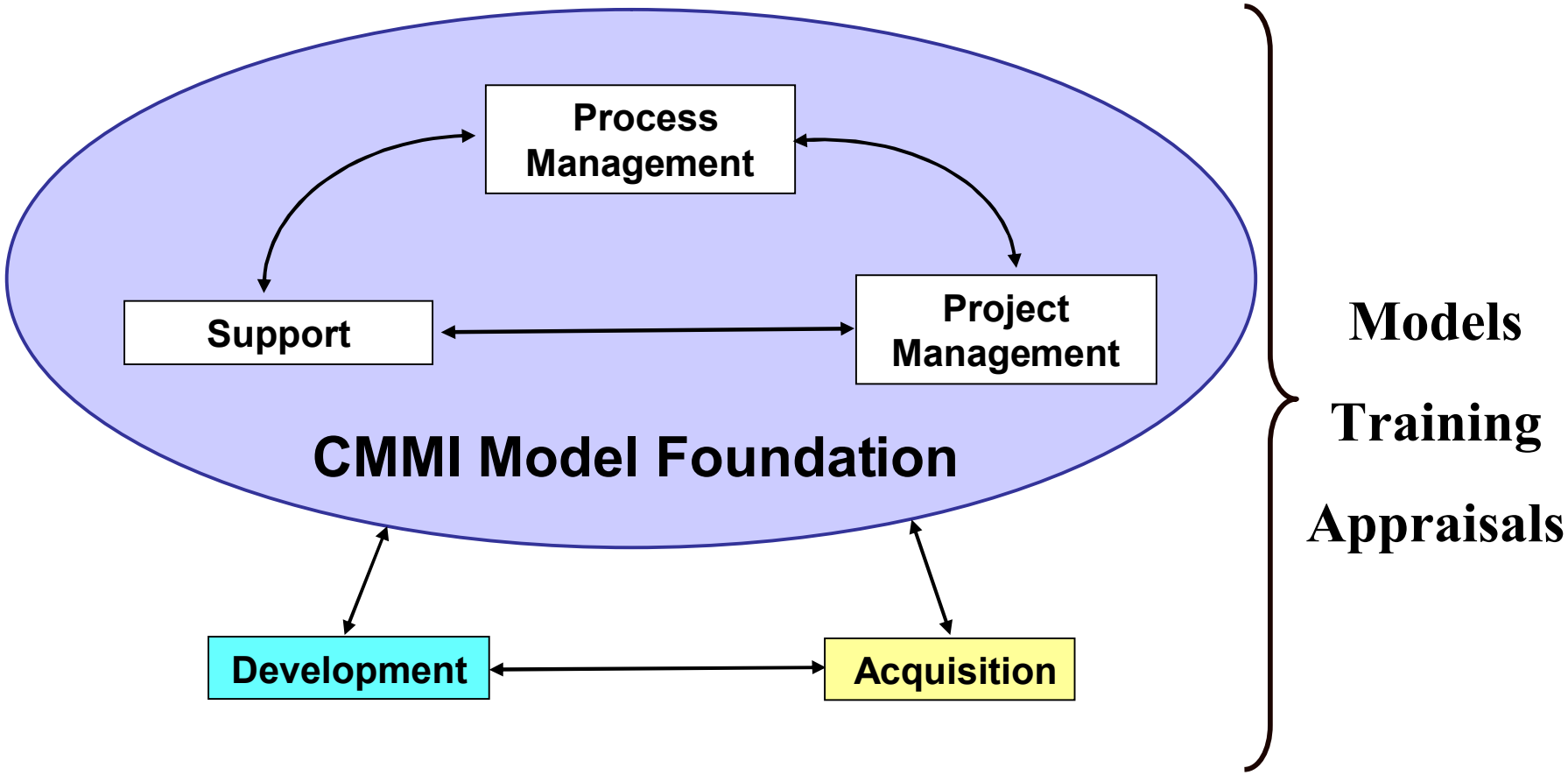
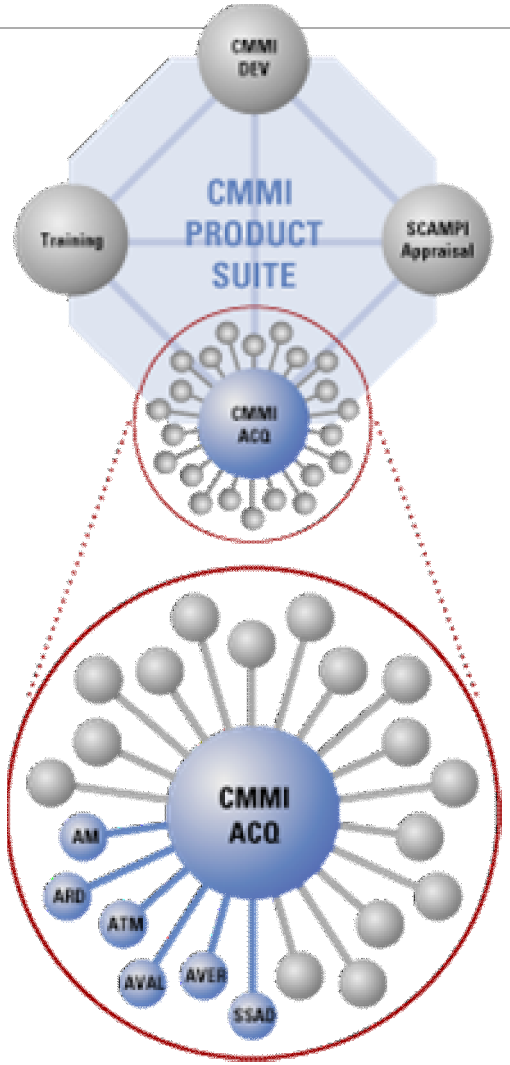


MI Product Suite? - 2

The Product Suite consists of:

- CMMI for Development
- Standard CMMI Appraisal Method for Process Improvement℠ (SCAMPI℠)
- Training and Education
- Licensing Opportunities
- and now CMMI for Acquisition



velopment Challenges

Model must explicitly apply to the acquisition of a wide range of both products and services (From IT outsourcing to DoD acquisition of a weapon system)

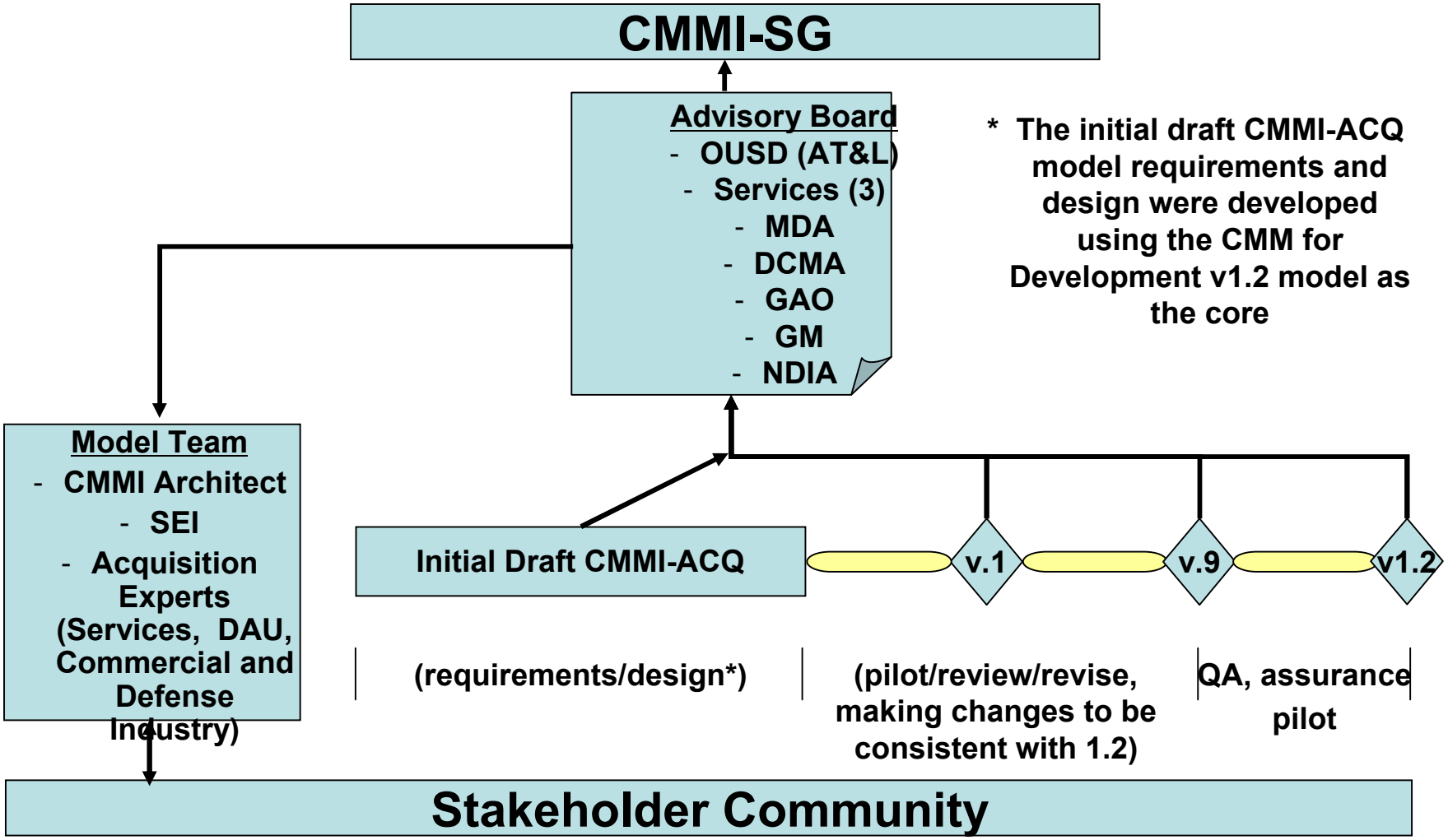
Applicable internationally - recognized references and glossary terms added, e.g., service level measurement

Model must apply to acquisition organizations from commercial industry to government agencies, both large and small

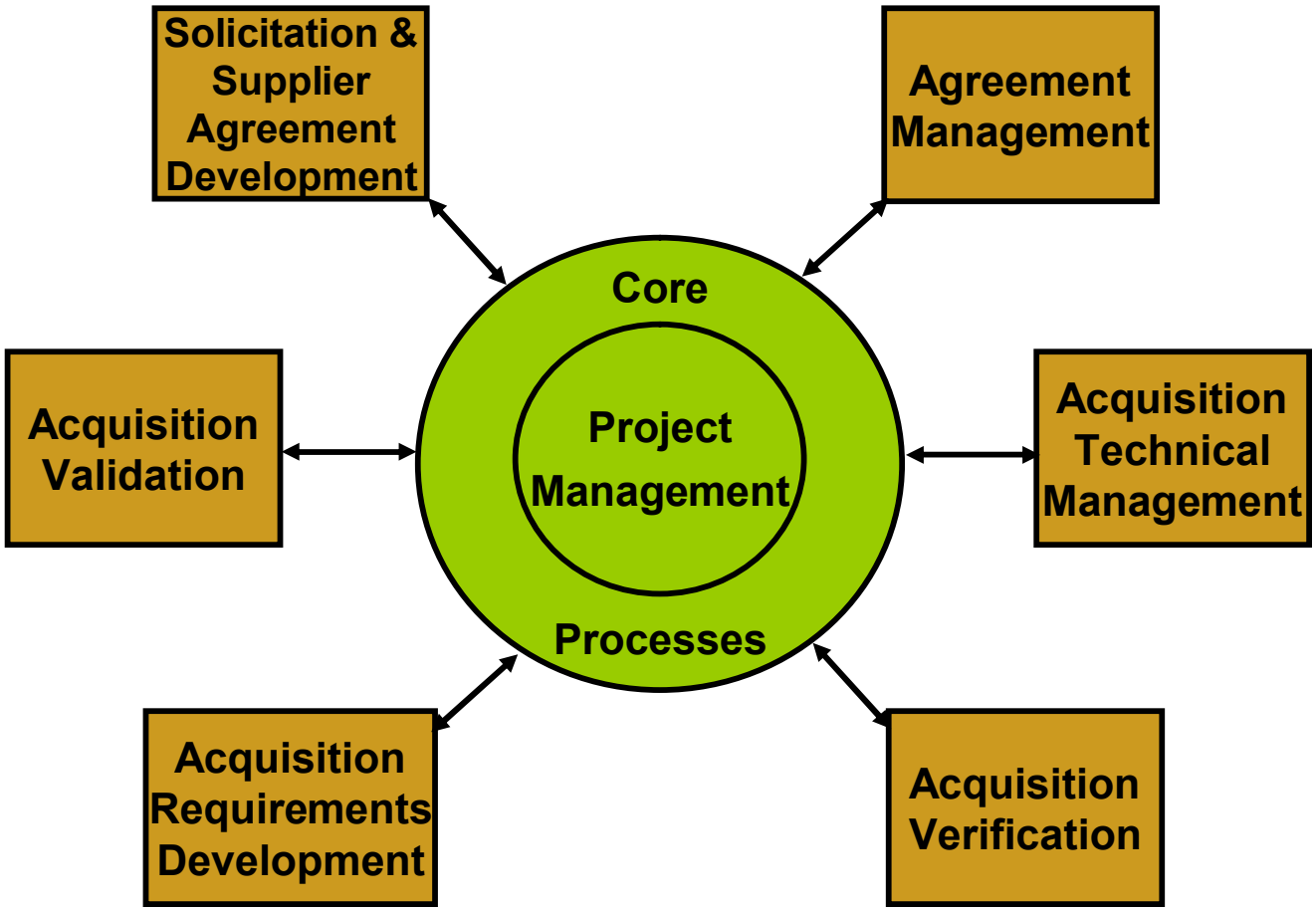
d Membership

Organization	Name
Office of the Secretary of Defense	Kristen Baldwin
Navy	Katie Smith
Air Force	Bob Swarz
Army	Larry Osiecki
Defense Contract Management Command	Guy Mercurio
Missile Defense Agency	Mike Smith
Government Accounting Office	Madhav Panwar
General Motors	Rich Frost
National Defense Industrial Association	Bob Rassa

velopment Approach



CQ Key Acquisition Processes

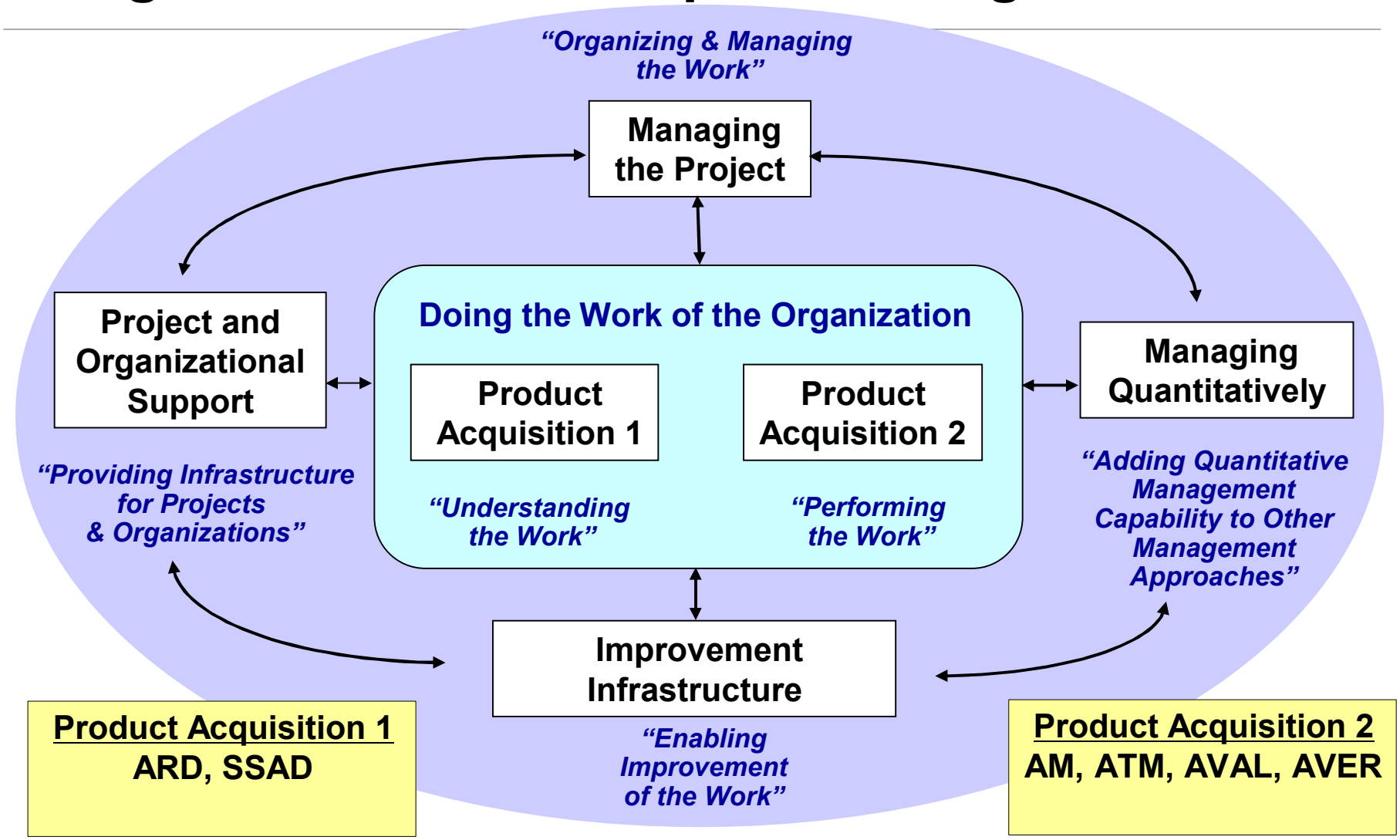


*based on initial CMMI-ACQ model developed by General Motors/SEI

ining

- Phased approach will be used for ACQ training
  - Initial training for CMMI-ACQ will be face-to-face
    - Assumes the completion of existing Introduction to CMMI training
    - One-day course will address ACQ concepts
      - Pilot offering in November
      - First public offering in December
      - Licensing opportunity will be available
  - On-line ACQ upgrade will be developed
  - A 3-day Introduction to CMMI course for Acquisition may be developed.
  - In FY 08, the Introduction to CMMI course will be revised to accommodate the "multiple model" approach:
    - 16 CMMI Model Foundation (CMF) process areas will be taught first
    - Additions for the "areas of interest" (development, acquisition) will be provided to meet audience needs
  - Other CMMI courses (e.g., Intermediate and instructor training) will be updated to include ACQ material

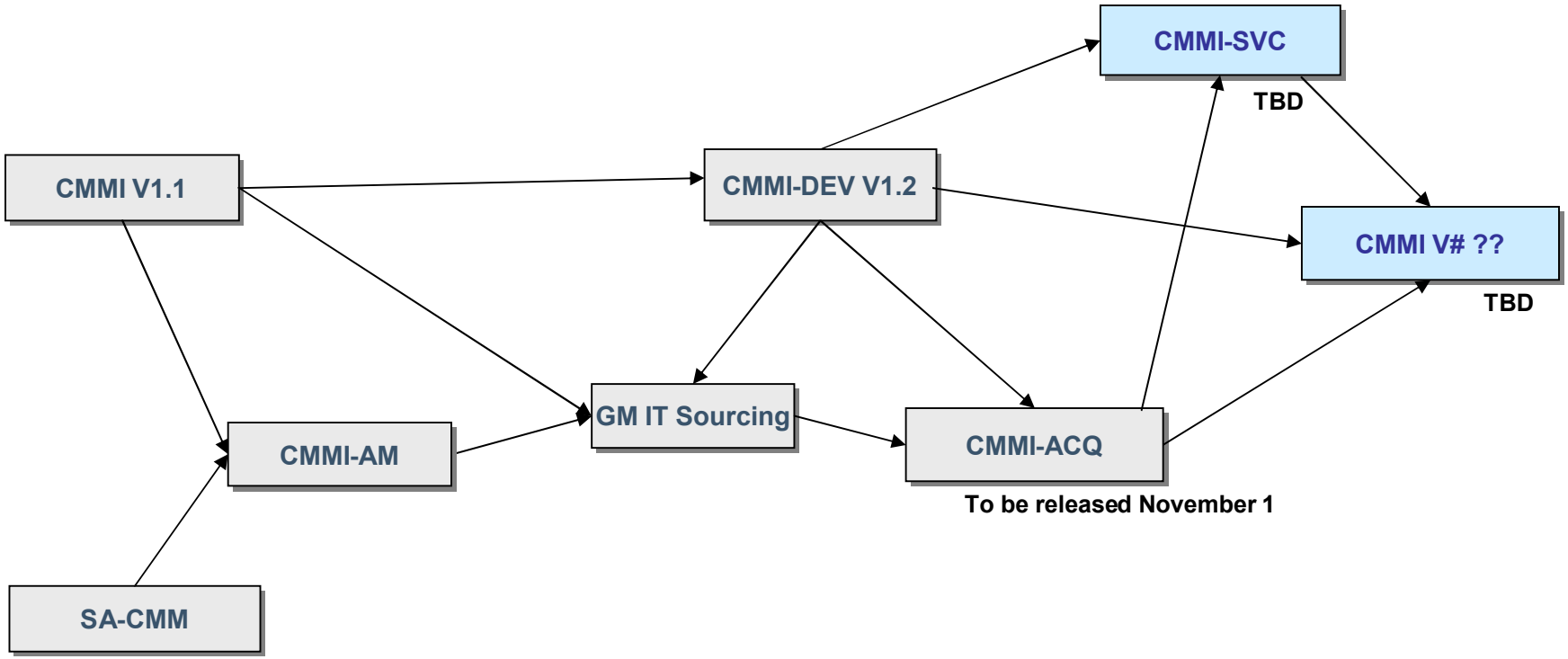
Doing the Work in an Acquisition Organization



oach

- Assure model understanding before allowing benchmark claims
  - Encourage Class B and C appraisals for six months
  - Uncover appraisal issues in a less intense environment
- Allow time to align appraisals with the new certification system for Lead Appraisers (March 08)
- Both Lead Appraisers and Instructors must pass a qualification test for CMMI-ACQ
- CMMI development and governance bodies are considering experience requirements for Lead Appraisers and Instructors

ence of Models



n for V2.0

- V1.2 concentrated on the project or program level acquisition best practices
- V2.0 will add more of the enterprise/organization level best practices for acquisition
  - Address enterprise level acquisition strategies, e.g., preferred supplier strategies
  - Address the Program Executive Office level
  - Address incorporation of lessons learned from acquisition project into acquisition management practices
- V2.0 will also benefit from change requests issued from lessons learned using the model globally

CMMI

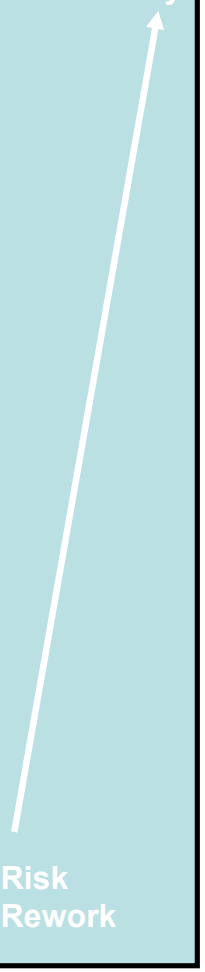
CMMI V1.2 and Beyond
The Details

resentation: PAs by Categories

Category	Process Areas
Process Management	Organizational Process Focus Organizational Process Definition +IPPD Organizational Training Organizational Process Performance Organizational Innovation and Deployment
Project Management	Project Planning Project Monitoring and Control Supplier Agreement Management Integrated Project Management +IPPD Risk Management Quantitative Project Management
Engineering	Requirements Management Requirements Development Technical Solution Product Integration Verification Validation
Support	Configuration Management Process and Product Quality Assurance Measurement and Analysis Decision Analysis and Resolution Causal Analysis and Resolution

entation: PAs by Maturity Level

Level	Focus	Process Areas
5 Optimizing	*Continuous Process Improvement*	Organizational Innovation and Deployment Causal Analysis and Resolution
4 Quantitatively Managed	*Quantitative Management*	Organizational Process Performance Quantitative Project Management
3 Defined	*Process Standardization*	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition +IPPD Organizational Training Integrated Project Management +IPPD Risk Management Decision Analysis and Resolution
2 Managed	*Basic Project Management*	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Initial		



Staged Representation: PAs by Maturity Level

Maturity Level	Process Areas
Optimizing	Causal Analysis and Resolution Organizational Innovation and Deployment
Quantitatively Managed	Quantitative Project Management Organizational Process Performance
Defined	Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Acquisition Technical Management Acquisition Verification Acquisition Validation Decision Analysis and Resolution
Managed	Acquisition Requirements Development Agreement Management Project Planning Project Monitoring and Control Requirements Management Configuration Management Process and Product Quality Assurance Measurement and Analysis Solicitation and Supplier Agreement Development

ns Among Processes

performed	vs.	managed

the extent to which the process is planned; performance is managed against the plan; corrective actions are taken when needed

managed	vs.	defined

the scope of application of the process descriptions, standards, and procedures (i.e., project vs. organization)

defined	vs.	quantitatively managed

the predictability of process performance

quantitatively managed	vs.	optimizing

whether the process is continually improved by addressing common causes of process variation

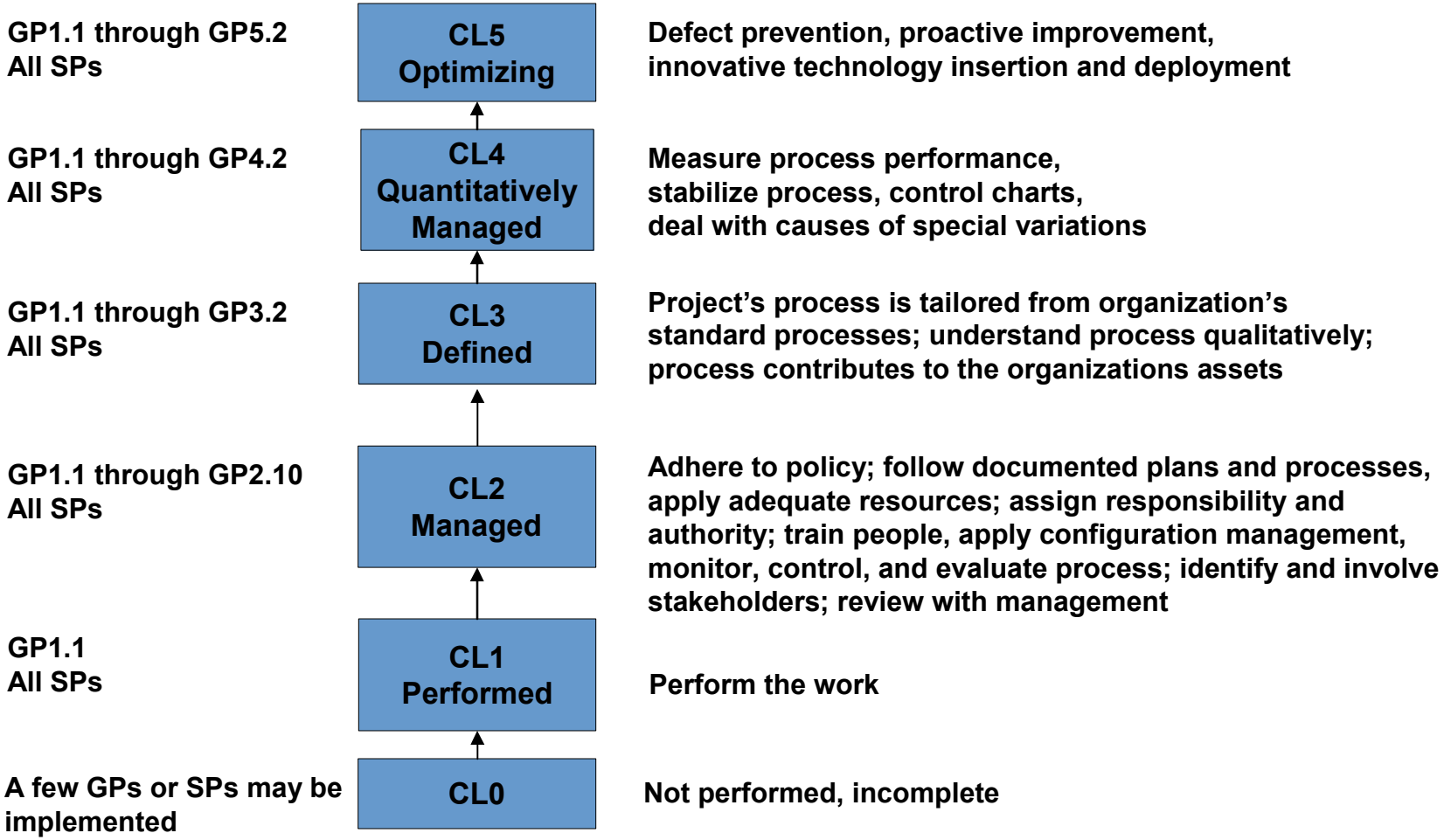
Levels

Levels are used in CMMI to describe an evolutionary path for an organization that wants to improve the processes it uses to develop and maintain its products and services.

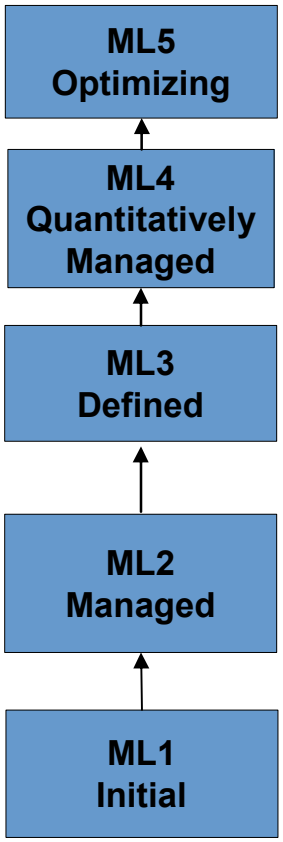
CMMI supports two improvement paths:

- continuous - enabling an organization to incrementally improve processes corresponding to an individual process area (or set of process areas) selected by the organization
- staged - enabling the organization to improve a set of related processes by incrementally addressing successive predefined sets of process areas

ability Levels (CL) for a Process Area



urity Levels



GP2.1 through GP3.2 All ML2, ML3, ML4, and ML5 PAs

Prevent defects; proactively improve; insert and deploy innovative technology

GP2.1 through GP3.2 All ML2, ML3, and ML4 PAs

Measure process performance; stabilize process and control charts; deal with causes of special variations

GP2.1 through GP3.2 All ML2 and ML3 PAs

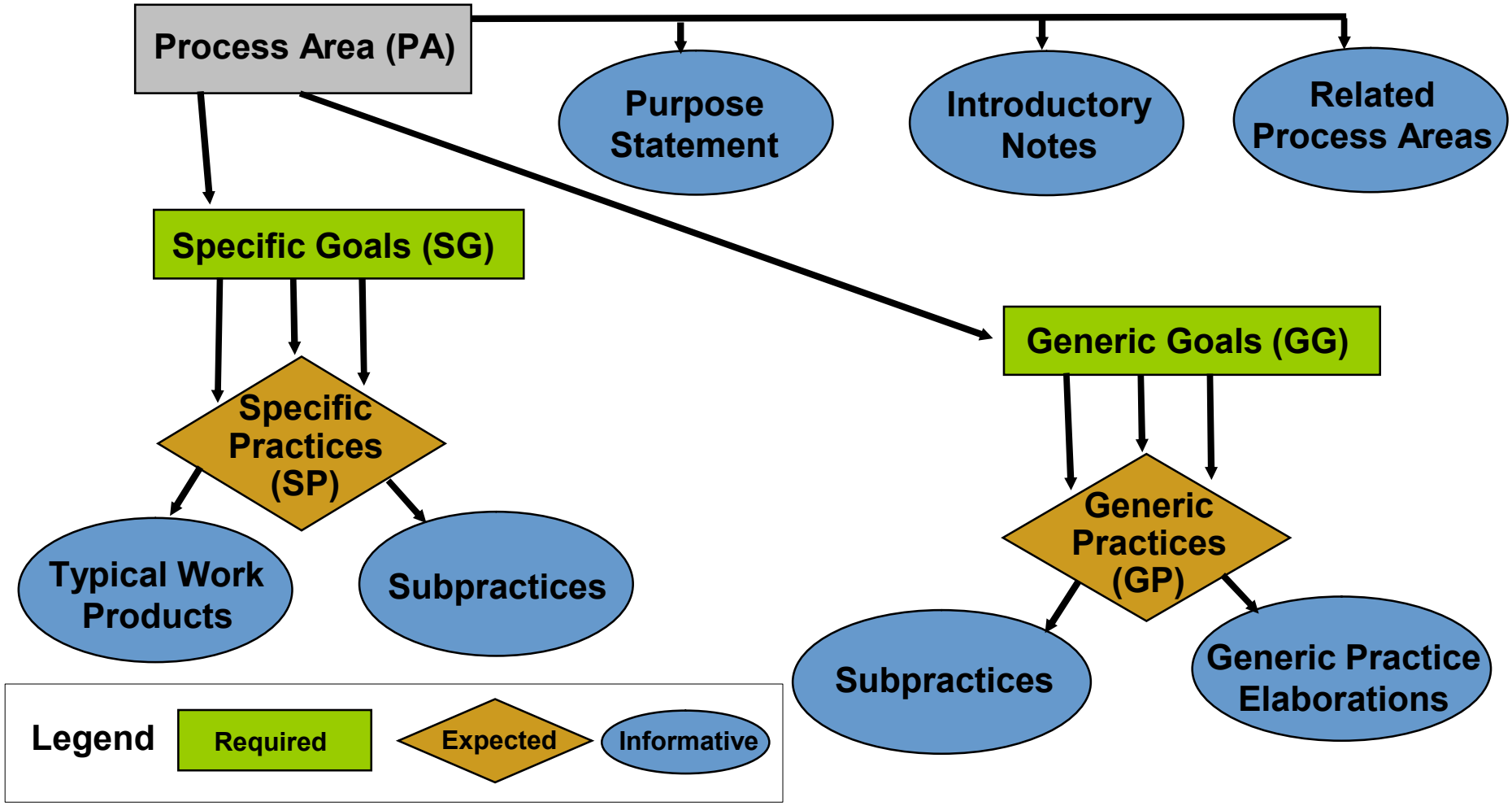
Tailor the project's process from organization's standard processes; understand processes qualitatively; ensure that projects contribute to organization assets

GP2.1 through GP2.10 All ML2 PAs

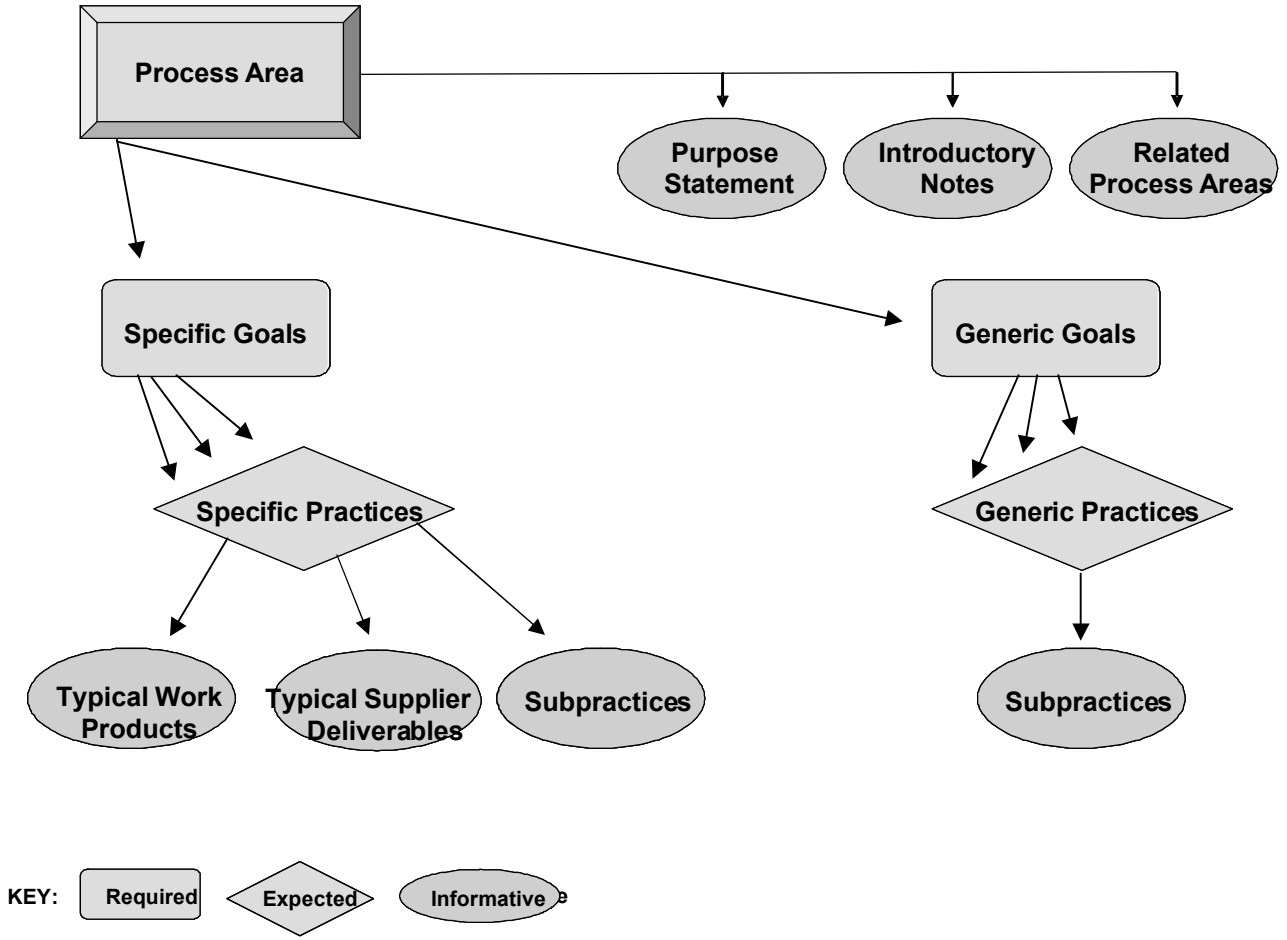
Adhere to policy; follow documented plans and processes; apply adequate resources; assign responsibility and authority; train people; apply CM; monitor, control, and evaluate process; identify and involve stakeholders; review with management

Processes are ad hoc and chaotic

Components



ture

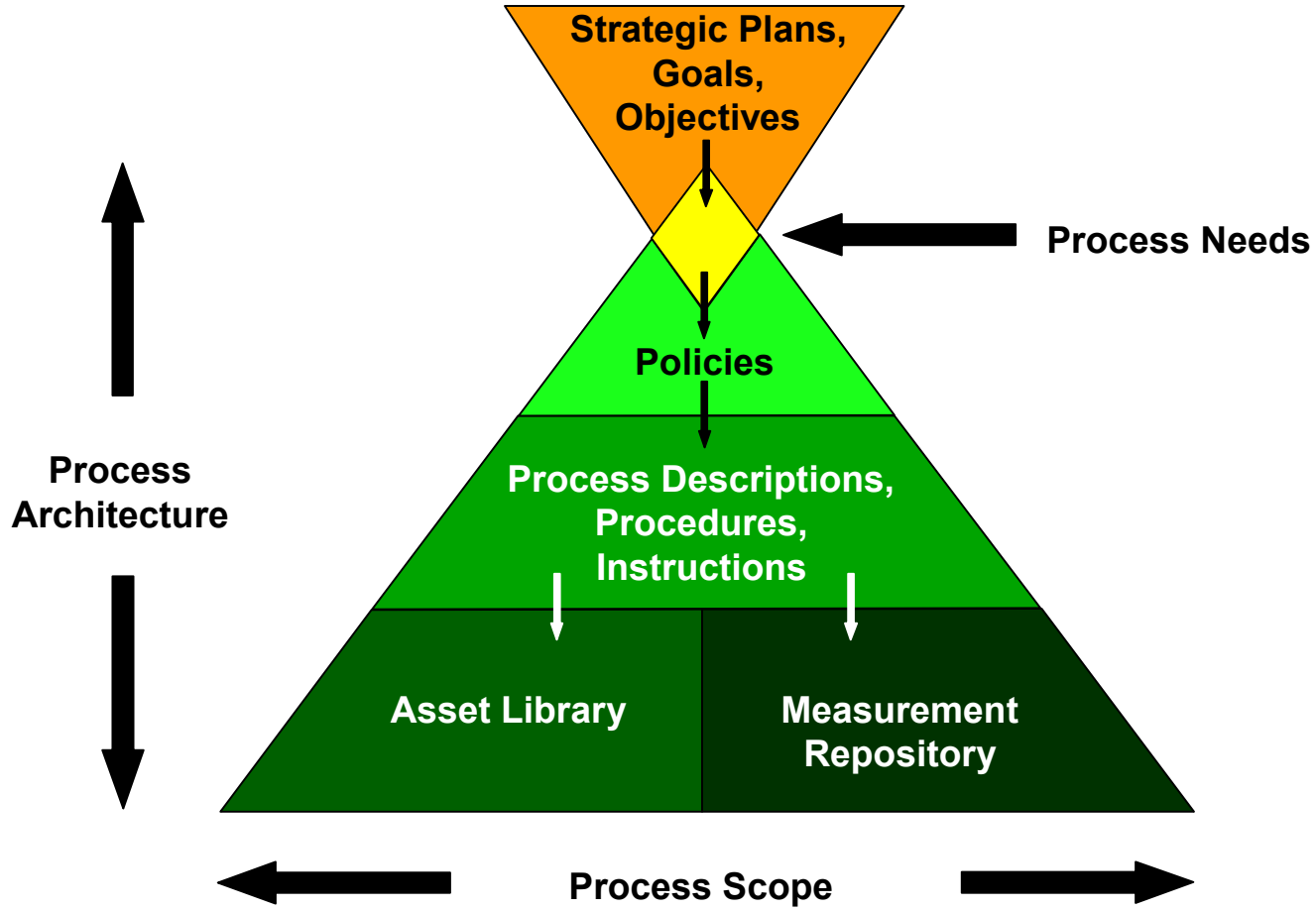


eneric Goals and Practices

Generic Goals	Generic Practices
GG1: Achieve Specific Goals	GP 1.1: Perform Specific Practices
GG2: Institutionalize a Managed Process	GP 2.1: Establish an Organizational Policy GP 2.2: Plan the Process GP 2.3: Provide Resources GP 2.4: Assign Responsibility GP 2.5: Train People GP 2.6: Manage Configurations GP 2.7: Identify and Involve Relevant Stakeholders GP 2.8: Monitor and Control the Process GP 2.9: Objectively Evaluate Adherence GP 2.10: Review Status with Higher Level Management
GG3: Institutionalize a Defined Process	GP 3.1: Establish a Defined Process GP 3.2: Collect Improvement Information
GG4: Institutionalize a Quantitatively Managed Process	GP 4.1: Establish Quantitative Objectives for the Process GP 4.2: Stabilize Subprocess Performance
GG5: Institutionalize an Optimizing Process	GP 5.1: Ensure Continuous Process Improvement GP 5.2: Correct Root Causes of Problems

Adapted from Cepeda Systems & Software Analysis, Inc.

tion Inputs



Area Category Topics

Process Management

Support

Project Management

Engineering

Acquisition

Process Definition +IPPD -1

Specific Goal	Specific Practice
Establish Organizational Process Assets	1.1 – Establish Standard Processes 1.2 – Establish Lifecycle Model Descriptions 1.3 – Establish Tailoring Criteria and Guidelines 1.4 – Establish the Organization's Measurement Repository 1.5 – Establish the Organization's Process Asset Library 1.6 – Establish Work Environment Standards

- Added "and work environment standards" to the purpose statement.
- Added SP 1.6 "Establish Work Environment Standards." (This practice is new to CMMI.)

Process Definition +IPPD -2

Specific Goal	Specific Practice
Enable IPPD Management	2.1 – Establish Empowerment Mechanisms
	2.2 – Establish Rules and Guidelines for Integrated Teams
	2.3 – Balance Team and Home Organization Responsibilities

- Added an IPPD Addition to OPD (SG2 "Enable IPPD Management" and its practices).
- To emphasize the IPPD Addition, the name the process area is now "Organizational Process Definition +IPPD" or "OPD +IPPD."

Process Focus -1

Specific Goal	Specific Practice
Determine Process Improvement Opportunities	1.1 – Establish Organizational Process Needs
	1.2 – Appraise the Organization's Processes
	1.3 – Identify the Organization's Process Improvements

- Modified the purpose statement to emphasize deployment.
- SP 1.2 "Appraise the organization's processes periodically and as needed to maintain an understanding of their strengths and weaknesses." uses "organization's processes" instead of "processes of the organization."

Process Focus -2

Specific Goal	Specific Practice
Plan and Implement Process Improvements	**2.1 – Establish Process Action Plans** **2.2 – Implement Process Action Plans**

- Modified SG2 from "Plan and Implement Process Improvement Activities" to "Plan and Implement Process Improvements."
- Moved to a new SG3 and modified what were SP 2.3 and SP 2.4 in v1.1.

Process Focus -3

Specific Goal	Specific Practice
Deploy Organizational Process Assets and Incorporate Lessons Learned	**3.1 – Deploy Organizational Process Assets** **3.2 – Deploy Standard Processes** **3.3 – Monitor Implementation** **3.4 – Incorporate Process-Related Experiences into the Organizational Process Assets**

- Added new SG3, "Deploy Organizational Process Assets and Incorporate Lessons Learned."
- Moved what were SP 2.3 and SP 2.4 in v1.1 to the new SG3 as SP 3.1 and SP 3.4.
- Added two new SPs: SP 3.2 "Deploy Standard Processes," and SP 3.3 "Monitor Implementation."

Training Goals

CMMI

SG 1: Establish an Organizational Training Capability

A training capability that supports the organizationôs management and technical roles is established and maintained.

SG 2: Provide Necessary Training

Training necessary for individuals to perform their roles effectively is provided.

The process area also has generic goals to support institutionalization.

Note relationship with

- Organizational Training ⇔ GP 2.5

Organizational Innovation and Deployment Goals

SG 1: Select Improvements

Process and technology improvements that contribute to meeting quality and process-performance objectives are selected.

SG 2: Deploy Improvements

Measurable improvements to the organizationôs processes and technologies are continually and systematically deployed.

The process area also has generic goals to support institutionalization.

Note relationship with

- Organizational Innovation and Deployment ⇔ GP 5.1

Process Performance Goals

SG 1: Establish Performance Baselines and Models

Baselines and models that characterize the expected process performance of the organizationôs set of standard processes are established and maintained.

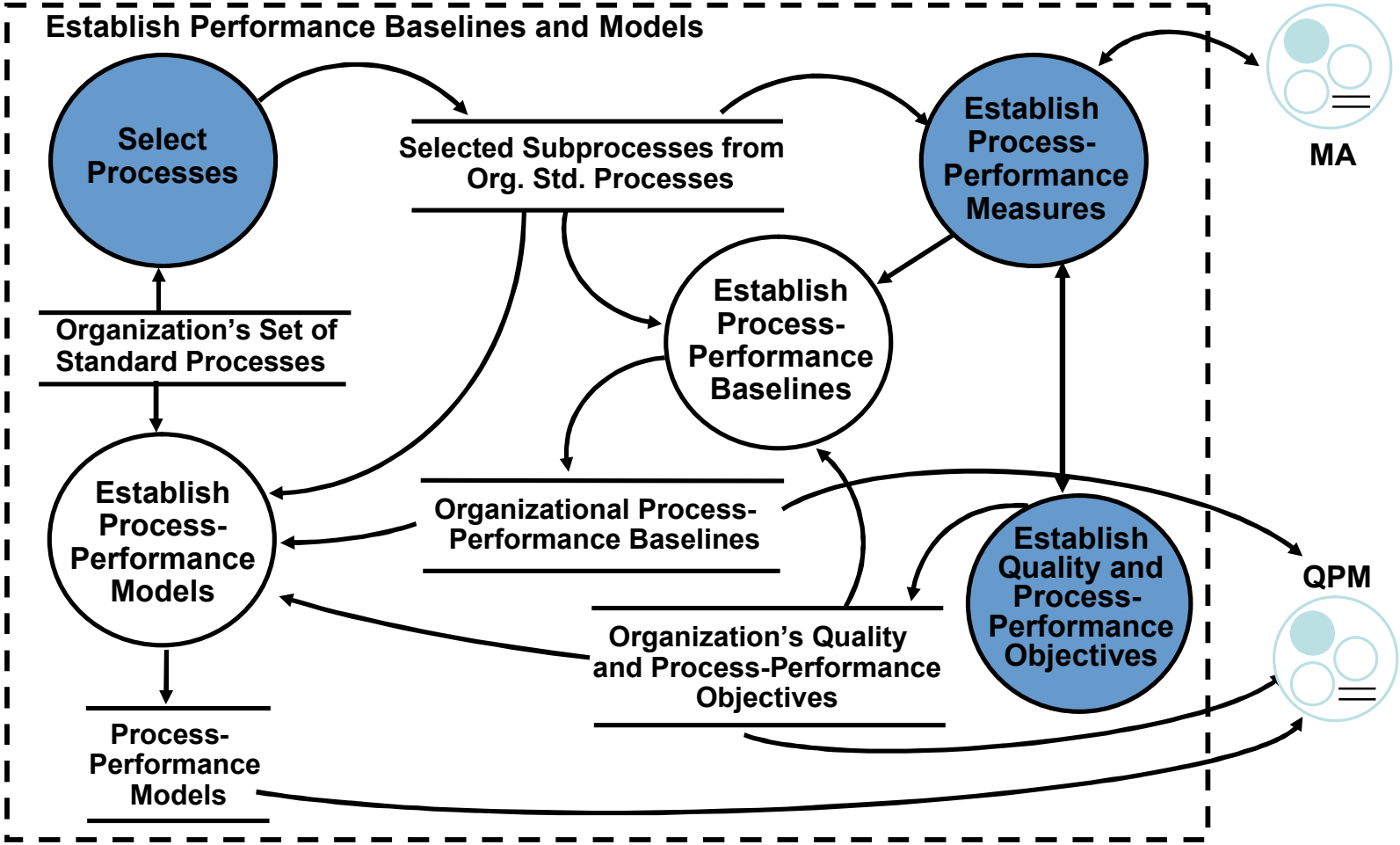
The process area also has generic goals to support institutionalization.

Note relationship with

- Organizational Process Performance ⟺ GP 4.1

CMMI

The shaded SPs interrelate and may need to be performed iteratively.



Area Category Topics

Process Management

Support

Project Management

Engineering

Acquisition

Management Goals

CMMI

SG 1: Establish Baselines

Baselines of identified work products are established.

SG 2: Track and Control Changes

Changes to the work products under configuration management are tracked and controlled.

SG 3: Establish Integrity

Integrity of baselines is established and maintained.

The process area also has generic goals to support institutionalization.

Note relationship with

- Configuration Management ⟺ GP 2.6

nd Analysis Goals

CMMI

SG 1: Align Measurement and Analysis Activities

Measurement objectives and activities are aligned with identified information needs and objectives.

SG 2: Provide Measurement Results

Measurement results that address identified information needs and objectives are provided.

The process area also has generic goals to support institutionalization.

roduct Quality Assurance

Goals

SG 1: Objectively Evaluate Processes and Work Products

Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated.

SG 2: Provide Objective Insight

Noncompliance issues are objectively tracked and communicated, and resolution is ensured.

The process area also has generic goals to support institutionalization.

Note relationship with

- Process and Product Quality Assurance ⟺ GP 2.9

sis and Resolution Goals

SG 1: Evaluate Alternatives

Decisions are based on an evaluation of alternatives using established criteria.

The process area also has generic goals to support

institutionalization.

s and Resolution Goals

CMMI

SG 1: Determine Causes of Defects

Root causes of defects and other problems are systematically determined.

SG 2: Address Causes of Defects

Root causes of defects and other problems are systematically addressed to prevent their future occurrence.

The process area also has generic goals to support institutionalization.

Note relationship with

- Causal Analysis and Resolution ⟺ GP 5.2

Area Category Topics

Process Management

Support

Project Management

Engineering

Acquisition

ng Goals

CMMI

SG 1: Establish Estimates

Estimates of project planning parameters are established and maintained.

SG 2: Develop a Project Plan

A project plan is established and maintained as the basis for managing the project.

SG 3: Obtain Commitment to the Plan

Commitments to the project plan are established and maintained.

The process area also has generic goals to support institutionalization.

Note relationship with

- Project Planning ⟺ GP 2.2, GP 2.7

ring and Control Goals

CMMI

SG 1: Monitor Project Against Plan

Actual performance and progress of the project are monitored against the project plan.

SG 2: Manage Corrective Action to Closure

Corrective actions are managed to closure when the projectôs performance or results deviate significantly from the plan.

The process area also has generic goals to support institutionalization.

Note relationship with

- Project Monitoring and Control ⇔ GP 2.8

ment Management

Specific Goal	Specific Practice
Establish Supplier Agreements	1.1 – Determine Acquisition Type 1.2 – Select Suppliers 1.3 – Establish Supplier Agreements
Satisfy Supplier Agreements	2.1 – Execute the Supplier Agreement 2.2 – Monitor Selected Supplier Processes 2.3 – Evaluate Selected Supplier Work Products 2.4 – Accept the Acquired Product 2.5 – Transition Products

- V1.1 SAM SP2.1 ñReview COTS Products,òwas eliminated. ñIdentify candidate COTS products that satisfy requirementsòis a new subpractice under the Technical Solutions Process Area SP1.1, ñDevelop Alternative Solutions and Selection Criteria.ò
- SP2.2 and SP2.3 were added because ISM was eliminated.
- The purpose of SAM was also updated.

ect Management +IPPD -1

Specific Goal	Specific Practice
Use the Project's Defined Process	1.1 – Establish the Project's Defined Process
	1.2 – Use Organizational Process Assets for Planning Project Activities
	1.3 – Establish the Project's Work Environment
	1.4 – Integrate Plans
	1.5 – Manage the Project Using the Integrated Plans
	1.6 – Contribute to the Organizational Process Assets

- Modified SP 1.1 from "Establish and maintain the project's defined process" to "Establish and maintain the project's defined process from project startup through the life of the project."
- Added SP 1.3 "Establish the Project's Work Environment." (This practice is new to CMMI.)

ect Management +IPPD -2

Specific Goal	Specific Practice
Coordinate and Collaborate with Relevant Stakeholders	2.1 – Manage Stakeholder Involvement 2.2 – Manage Dependencies 2.3 – Resolve Coordination Issues
Apply IPPD Principles	3.1 – Establish the Project's Shared Vision 3.2 – Establish the Integrated Team Structure 3.3 – Allocate Requirements to Integrated Teams 3.4 – Establish Integrated Teams 3.5 – Ensure Collaboration among Interfacing Teams

- Reduced the IPPD Addition to one goal (SG3 "Apply IPPD Principles") and its practices.
- To emphasize the IPPD Addition, the name of this process area is now "Integrated Project Management +IPPD" or "IPM +IPPD."

ms - IPM

- **IPM SP 1.6 Establish and maintain integrated teams.**
  - The project is managed using integrated teams that reflect the organizational rules and guidelines for team structuring and forming. The projectôs shared vision is established prior to establishing the team structure, which may be based on the WBS. For small acquirer organizations, the whole organization and the relevant external stakeholders can be treated as an integrated team.
  - Integrated team members must understand the standards for work and participate according to those standards.
  - Structuring the integrated teams involves defining the number of teams, the type of each team, and how each team relates with the others in the structure. Forming the integrated teams involves chartering each team, assigning team members and team leaders, and providing resources to each team to accomplish its work.

ent Goals

CMMI

SG 1: Prepare for Risk Management

Preparation for risk management is conducted.

SG 2: Identify and Analyze Risks

Risks are identified and analyzed to determine their relative importance.

SG 3: Mitigate Risks

Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.

The process area also has generic goals to support institutionalization.

oject Management Goals

SG 1: Quantitatively Manage the Project

The project is quantitatively managed using quality and process-performance objectives.

SG 2: Statistically Manage Subprocess Performance

The performance of selected subprocesses within the projectôs defined process is statistically managed.

The process area also has generic goals to support institutionalization.

Note relationship with

- Quantitative Project Management ⇔ GP 4.1, GP 4.2

Area Category Topics

Process Management

Support

Project Management

Engineering

Acquisition

Management

Specific Goal	Specific Practice
Manage Requirements	1.1 – Obtain an Understanding of Requirements
	1.2 – Obtain Commitment to Requirements
	1.3 – Manage Requirements Changes
	1.4 – Maintain Bidirectional Traceability of Requirements
	1.5 – Identify Inconsistencies Between Project Work and Requirements

- V1.2 REQM SP 1.4 practice statement now reads, ñMaintain bidirectional traceability among the requirements and work products.ò
- Project plans are no longer mentioned in this SP statement.
- The description of bidirectional traceability is improved as is its definition in the glossary.

Development -1

Specific Goal	Specific Practice
Develop Customer Requirements	1.1 – Elicit Needs 1.2 – Develop the Customer Requirements
Develop Product Requirements	2.1 – Establish Product and Product Component Requirements 2.2 – Allocate Product Component Requirements 2.3 – Identify Interface Requirements

- Former base practice "Collect Stakeholder Needs" is eliminated and former advanced practice, "Elicit Needs" is kept.
- Informative text is added to the introductory notes about applying RD to maintenance projects.

Development -2

Specific Goal	Specific Practice
Analyze and Validate Requirements	3.1 – Establish Operational Concepts and Scenarios
	3.2 – Establish a Definition of Required Functionality
	3.3 – Analyze Requirements
	3.4 – Analyze Requirements to Achieve Balance
	3.5 – Validate Requirements

- Material from V1.1 TS SP 1.2, "Evolve Operational Concepts and Scenarios," is incorporated into RD SP 3.1.
- Material from V1.1 RD SP 3.5-1, "Validate Requirements," and RD SP 3.5-2, "Validate Requirements with Comprehensive Methods" were consolidated into a single practice.

tion -1

Specific Goal	Specific Practice
Select Product-Component Solutions	1.1 – Develop Alternative Solutions and Selection Criteria
	1.2 – Select Product-Component Solutions

- V1.1 TS SP 1.1-1, ñDevelop Alternative Solutions and Selection Criteria,òand TS SP 1.1-2, ñDevelop Detailed Alternative Solutions and Selection Criteriaòare consolidated into a single practice.
- ñIdentify candidate COTS products that satisfy requirementsòis a new subpractice under SP1.1.
- V1.1 TS SP 1.2 ñEvolve Operational Concepts and Scenariosòis incorporated into RD SP 3.1, ñEstablish Operational Concepts and Scenarios.ò

tion -2

Specific Goal	Specific Practice
Develop the Design	2.1 – Design the Product or Product Component 2.2 – Establish a Technical Data Package 2.3 – Design Interfaces Using Criteria 2.4 – Perform Make, Buy, or Reuse Analyses
Implement the Product Design	3.1 – Implement the Design 3.2 – Develop Product Support Documentation

ÅV1.1 TS SP 2.3-1, ñEstablish Interface Descriptions,òand TS SP 2.3-3, ñDesign Interfaces Using Criteriaòare consolidated into a single practice.

ation Goals

CMMI

SG 1: Prepare for Product Integration

Preparation for product integration is conducted.

SG 2: Ensure Interface Compatibility

The product component interfaces, both internal and external, are compatible.

SG 3: Assemble Product Components and Deliver the Product

Verified product components are assembled and the integrated, verified, and validated product is delivered.

The process area also has generic goals to support institutionalization.

CMMI

Specific Goal	Specific Practice
Prepare for Verification	1.1 – Select Work Products for Verification 1.2 – Establish the Verification Environment 1.3 – Establish Verification Procedures and Criteria
Perform Peer Reviews	2.1 – Prepare for Peer Reviews 2.2 – Conduct Peer Reviews 2.3 – Analyze Peer Review Data

- No changes to SG1, SG2, or their practices.

Specific Goal	Specific Practice
Verify Selected Work Products	**3.1 – Perform Verification** **3.2 – Analyze Verification Results**

- The phrase "and identify corrective action" was deleted from both the title and statement of SP 3.2 "Analyze Verification Results. (Corrective action is handled in PMC SG2, "Manage Corrective Action to Closure.)

Specific Goal	Specific Practice
Prepare for Validation	1.1 – Select Products for Validation 1.2 – Establish the Validation Environment 1.3 – Establish Validation Procedures and Criteria
Validate Product or Product Components	2.1 – Perform Validation 2.2 – Analyze Validation Results

- Notes were added to VAL to stress that validation activities are performed incrementally and involve relevant stakeholders.
- The phrase "and identify issues" was deleted from the statement of SP 2.2 "Analyze Validation Results" to maintain parallelism with VER SP 3.2 "Analyze Verification Results."

Area Category Topics

Process Management

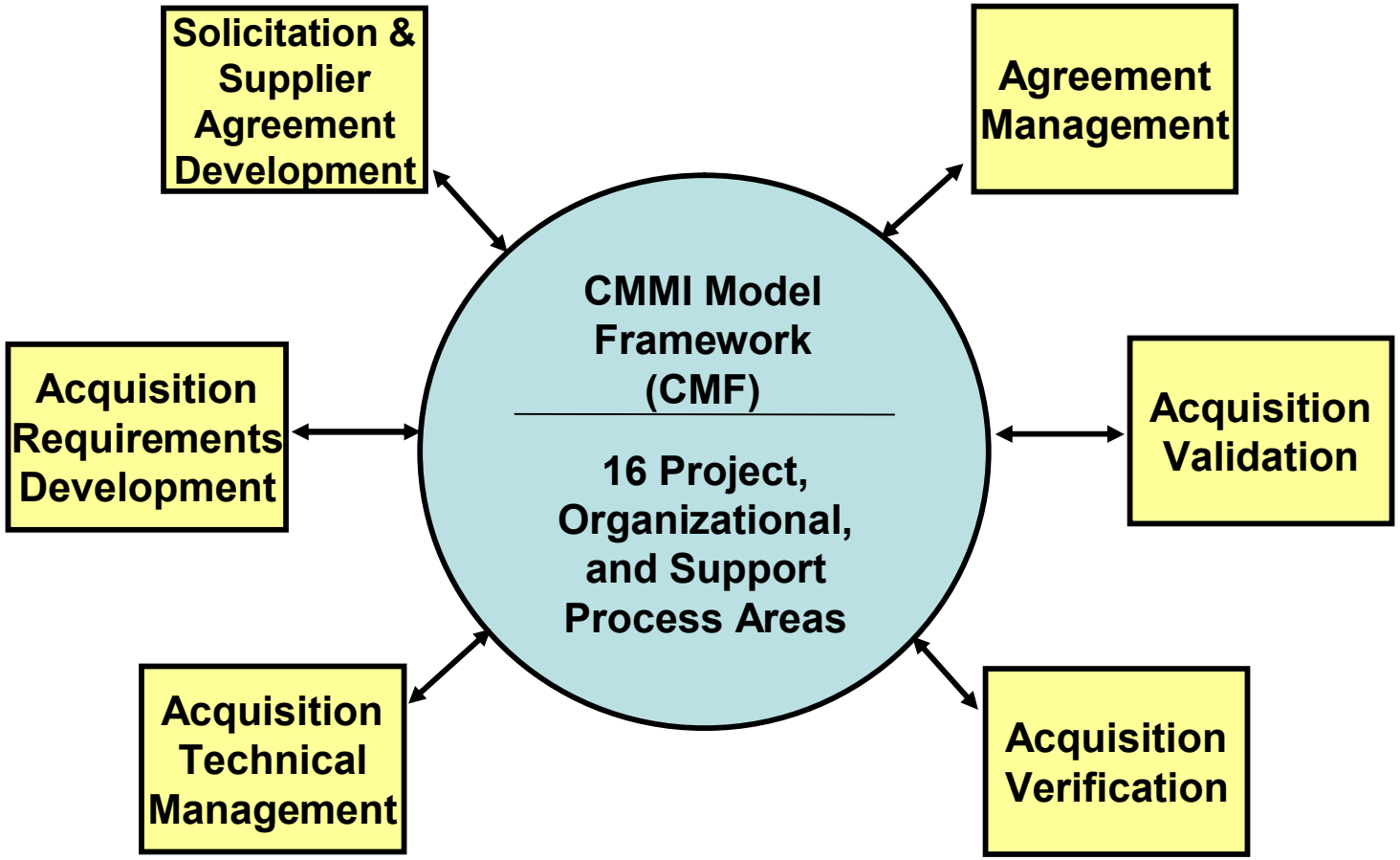
Support

Project Management

Engineering

Acquisition

2
tegory Process Areas



rements Development - Goals

SG 1: Develop Customer Requirements

Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.

SG 2: Develop Contractual Requirements

Customer requirements are refined and elaborated to develop contractual requirements.

SG 3: Analyze and Validate Requirements

The requirements are analyzed and validated.

upplier Agreement Development - Goals

SG 1: Prepare for Solicitation and Supplier Agreement Development

Preparation for solicitation and supplier agreement is performed.

SG 2: Select Suppliers

Suppliers are selected based on an evaluation of their ability to meet the specified requirements and established criteria.

SG 3: Establish Supplier Agreements

Supplier agreements are established and maintained.

nical Management - Goals

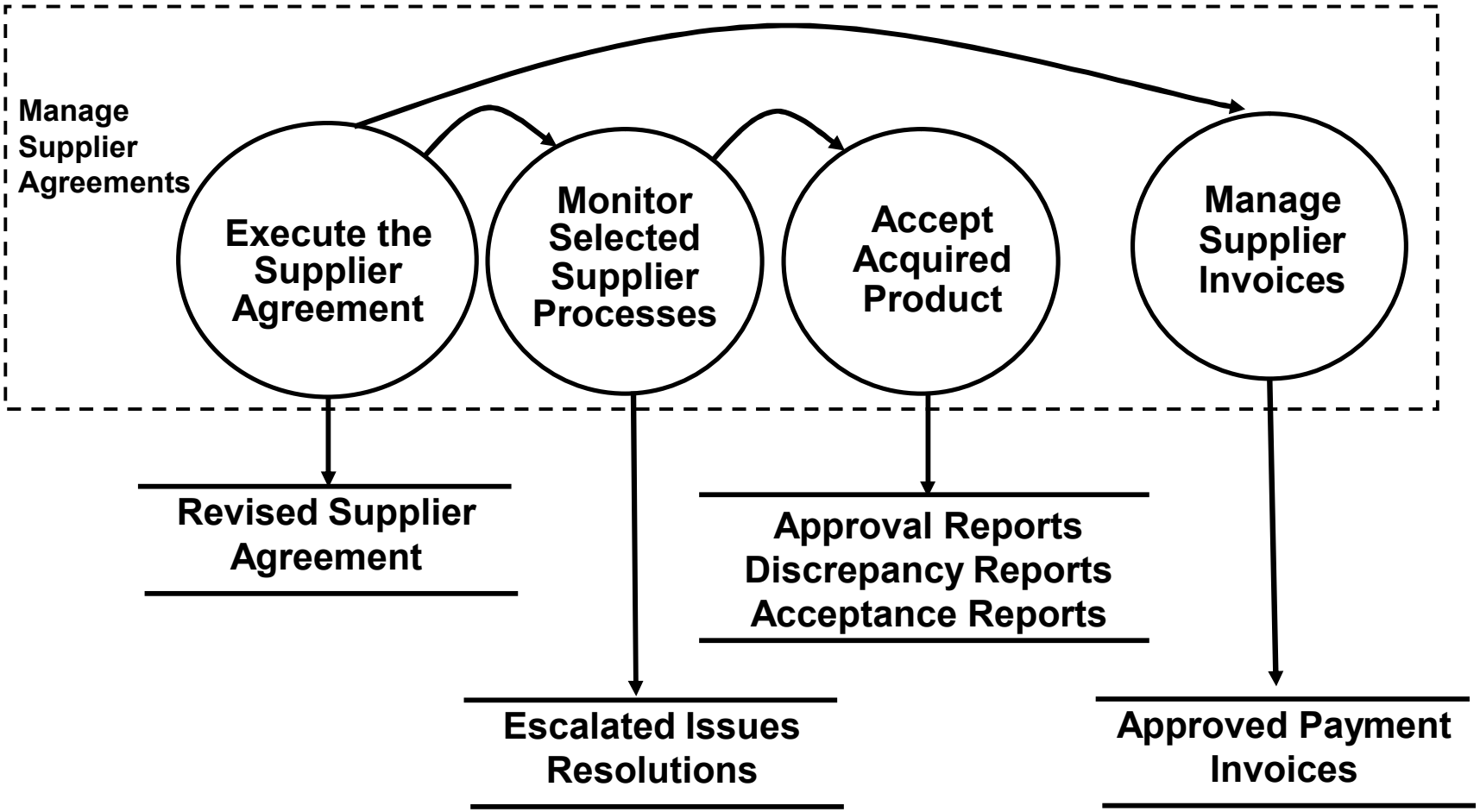
SG 1: Evaluate Technical Solutions

Supplier technical solutions are evaluated to confirm that contractual requirements continue to be met.

SG 2: Perform Interface Management

Selected interfaces are managed.

nagement - Context



ification - Specific Goals

SG 1: Prepare for Verification

Preparation for verification is conducted.

SG 2: Perform Peer Reviews

Peer reviews are performed on selected work products.

SG 3: Verify Selected Work Products

Selected work products are verified against their specified requirements.

Acquisition Validation - Goals

SG 1: Prepare for Validation

Preparation for validation is conducted.

SG 2: Validate Selected Products and Product Components

Selected products and product components are validated to ensure that they are suitable for use in their intended operating environment.

the CMF

The key additions to the CMF include the following:

- Acquisition Strategy
- Transition to Operations and Support
- Integrated Product and Process Development (Teaming)

There are informative materials unique to the Acquisition Constellation in every process area.

ategy

- **Acquisition strategy** - Planning begins with the acquisition strategy that provides the framework for the acquisition project and its plans.
- **PP SP 1.1 Establish and maintain the acquisition strategy.**
- The strategy has the following attributes:
  - used to focus on specifying customer and contractual requirements that express customer value in the Acquisition Requirements Development process area practices.
  - is the business and technical management framework for planning, executing, and managing agreements for a project.
  - relates to the objectives for the acquisition, the constraints, availability of resources and technologies, consideration of acquisition methods, potential supplier agreement types, terms and conditions, accommodation of business considerations, considerations of risk, and support for the acquired product over its lifecycle.
  - reflects the entire scope of the project.
  - encompasses the work to be performed by the acquirer and the work to be performed by the supplier, or in some cases multiple suppliers, for the full lifecycle of the product

perations and Support

Transition to operations and support includes the approach for introducing and maintaining the readiness, sustainment, and operational capability of the product(s) delivered by the supplier.

- PP SP 2.7 - Plan for transition to lifecycle operations and support for the product.
- PMC SP 1.8 - Monitor the transition to operations and support.

Typically, the supplier has a role in integrating and packaging the products and prepares for the transition to operations and support, including support for business user acceptance. The acquirer monitors supplier activities.

Integrated Teams - OPD

Integrated Teams- The project is managed using integrated teams (IPM SP 1.6) that reflect the organizational rules and guidelines (OPD SP 1.7) for team structuring and forming.

- **OPD SP 1.7 Establish and maintain organizational rules and guidelines for the structure and operation of integrated teams.**
  - In an acquisition organization, integrated teams are useful not just in the acquirerôs organization, but between the acquirer and supplier, and among the acquirer, supplier and other relevant stakeholders as appropriate. Integrated teaming may be especially important in a system of systems environment.
  - Operating rules and guidelines for integrated teams define and control how teams are created and how they interact to accomplish objectives.

mation…

For more information about CMMI

- http://www.sei.cmu.edu/cmmi/ (main CMMI site)

Other Web sites of interest include

- http://seir.sei.cmu.edu/seir/ (Software Engineering Information Repository)
- http://dtic.mil/ndia (annual CMMI Technology Conferences)
- http://seir.sei.cmu.edu/pars (publicly released SCAMPI appraisal summaries)
- https://bscw.sei.cmu.edu/pub/bscw.cgi/0/79783

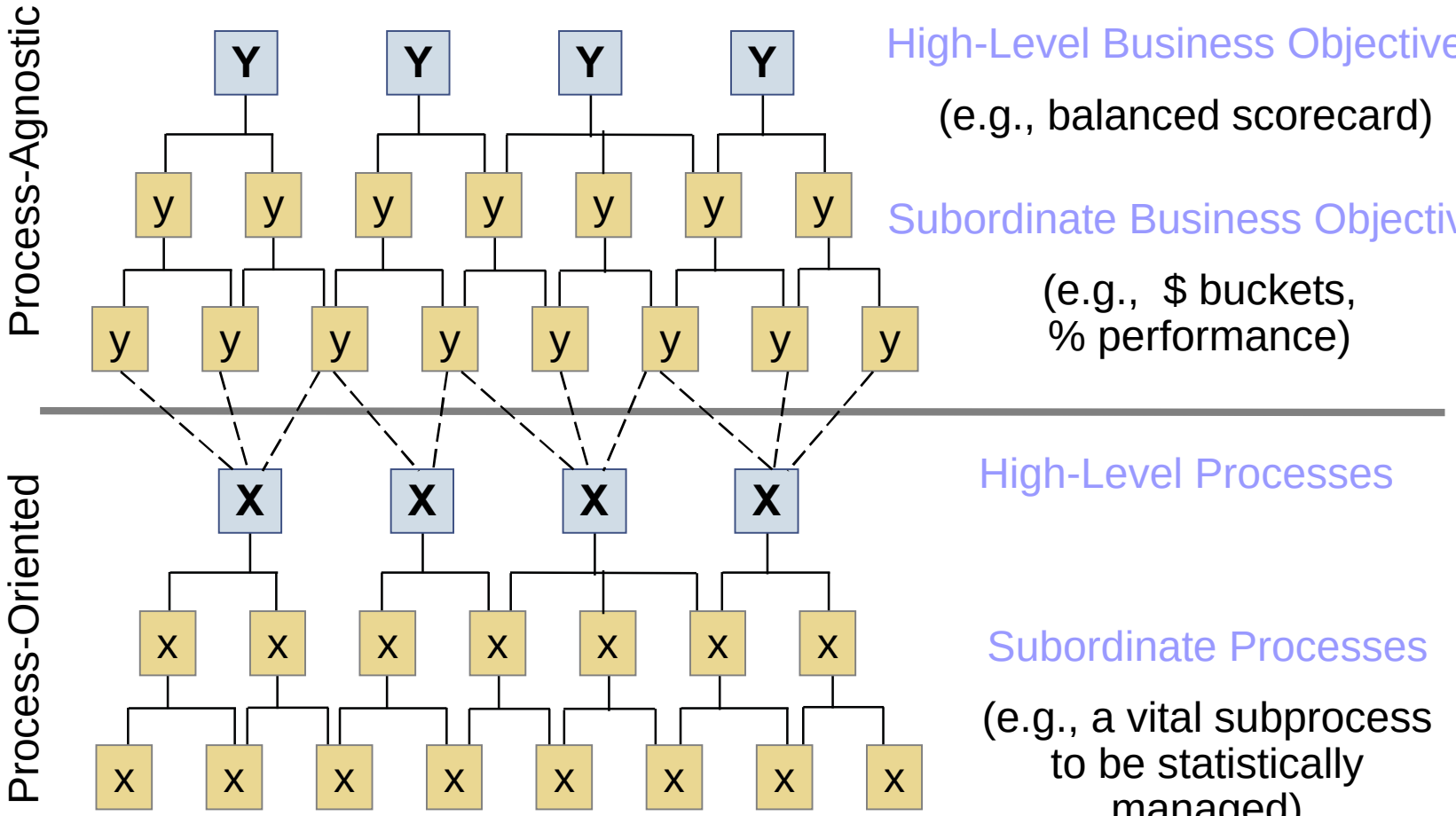
Or, contact

SEI Customer Relations

Phone: 412 / 268-5800

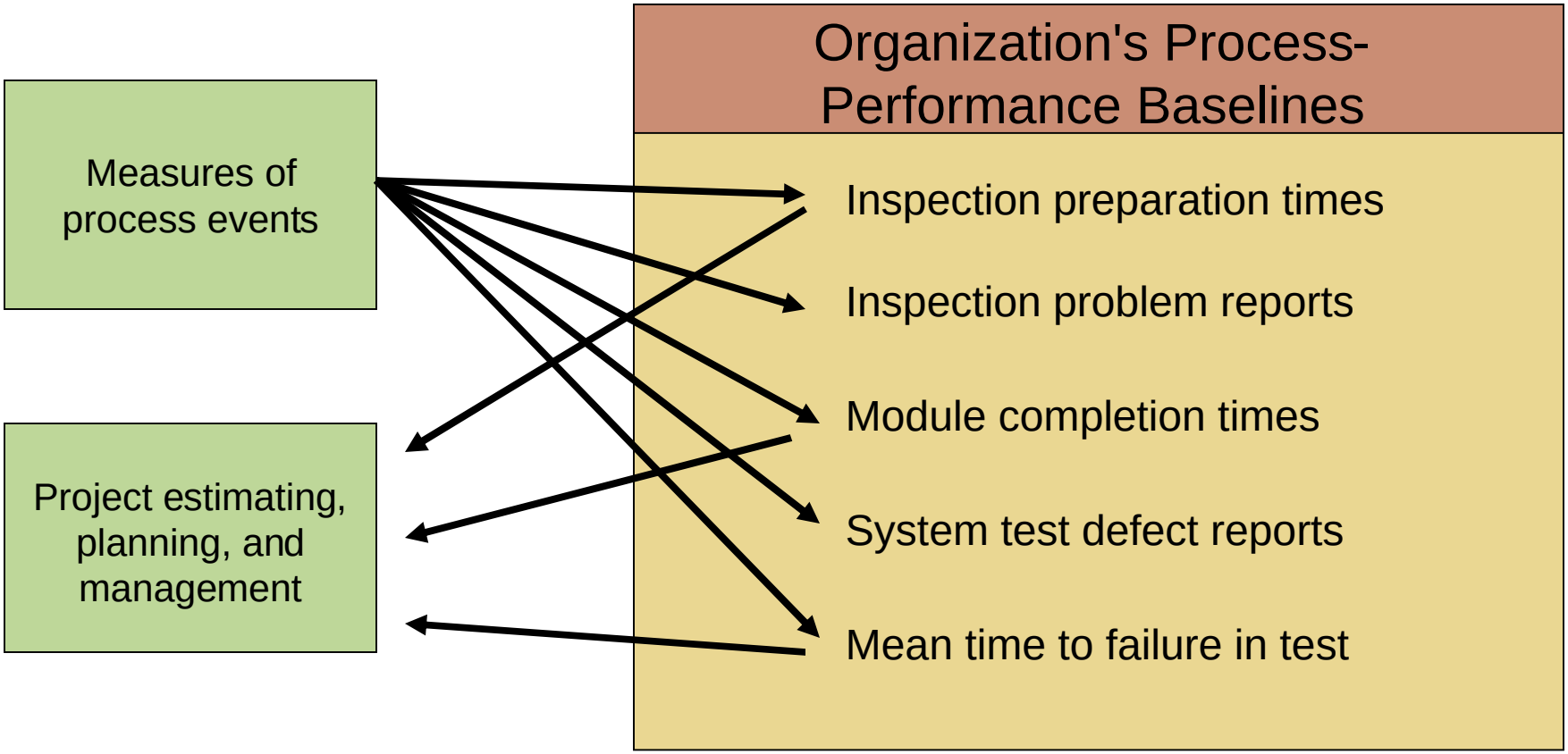
Email: customer-relations@sei.cmu.edu

uld Flow-Down to cesses



rmance Baselines

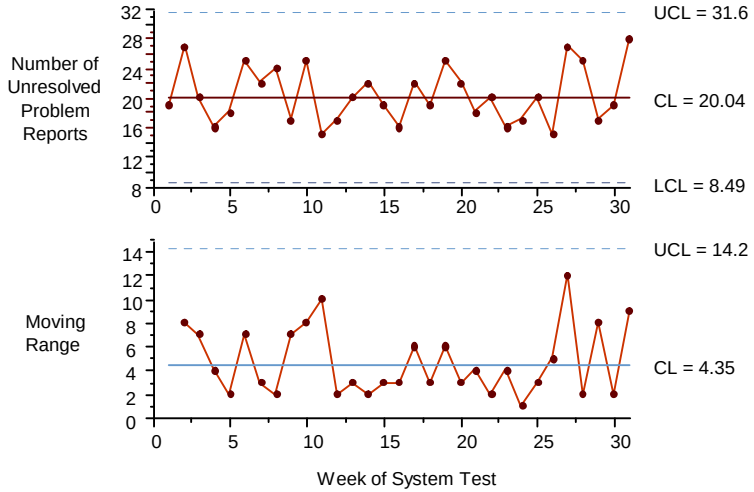
Process-performance baselines are built from project data.

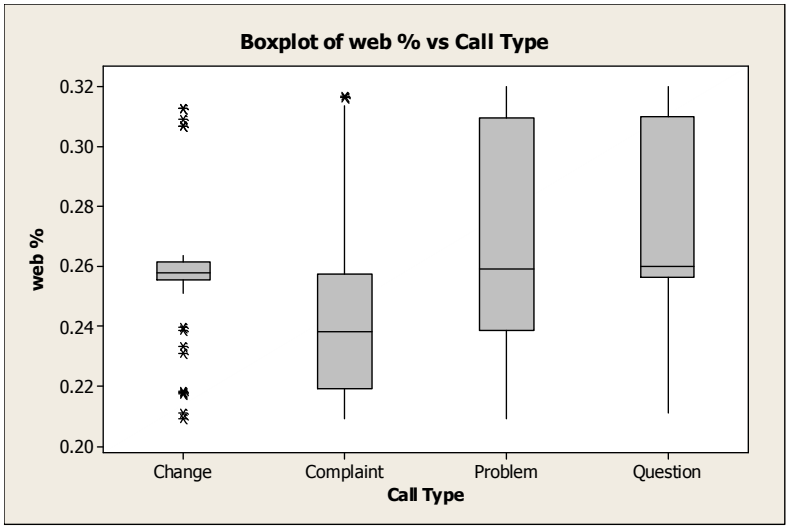


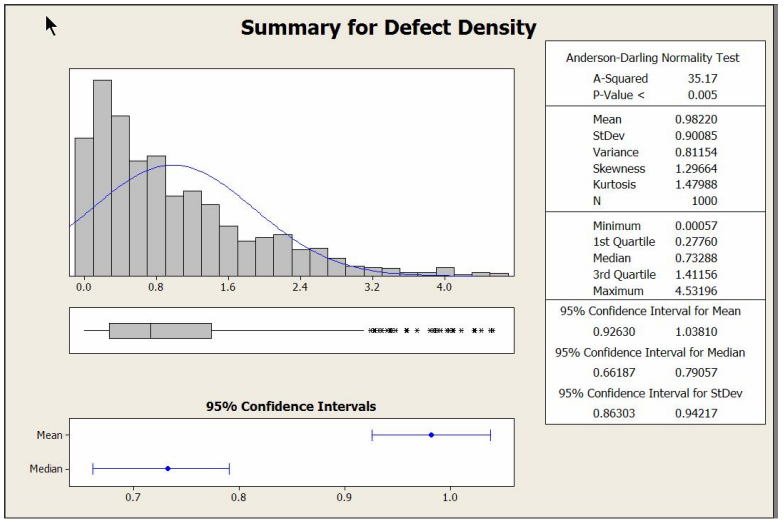
Projects use the organization's process-performance baselines in managing quality and performance results

ss-Performance Baselines

PPBs are derived by analyzing the collected measures to establish a distribution and range of results that characterize the expected performance for selected processes when used on any individual project in the organization.







sting and PPBs

- To determine whether a process change (improvement or degradation) has occurred by comparing the before and after baselines.
- To determine whether or not a new sample of data representing the current process behavior is consistent with previous process behavior (e.g., a historical baseline).
- To determine whether or not stratification or segmentation of the data is appropriate by comparing a baseline from each segment or strata layer to other segments or strata layers.
- To enable benchmark comparisons between projects or organizations.

ss-Performance Models (PPMs)?

The organization uses PPMs

- for estimating, analyzing, and predicting the process performance of processes in the organization's set of standard processes.
- to assess the (potential) return on investment of process improvement activities.

Projects use PPMs

- for estimating, analyzing, and predicting the performance of their defined processes.
- for selecting which processes to include in the projectôs defined process.

dients of PPMs -1

- The essential ingredients of process-performance models include the following:
  - The models relate the behavior or circumstance of a process or subprocess to an outcome.
  - The models predict future outcomes based on possible or actual changes to factors (e.g., support ñwhat-ifò analysis).
  - The models use factors from one or more subprocesses to conduct the prediction. These factors are preferably controllable so that projects may take action to influence outcomes.
  - The models are statistical or probabilistic in nature rather than deterministic (e.g., the models account for statistical variation like QPM does; the models depict uncertainty in the factors and predict the uncertainty or range of values in the outcome).

dients of PPMs -2

- High maturity organizations generally possess a collection of process-performance models that go beyond earned value measures that predict cost and schedule variance.
- Specifically, the models predict quality and performance outcomes from factors related to one or more subprocesses involved in the development, maintenance, service, or acquisition processes performed by the projects. Example outcomes include the following:
  - schedule, effort, or cost variance
  - reliability of delivery to the customer
  - defect identification and removal rates
  - customer satisfaction
  - success indicators identified by the organization or project
  - a combination of these outcomes

to Be Modeled – Examples

- **Lifecycle phase subprocesses**
  Consider lifecycle phases such as the following: requirements, architecture, design, code, and test. Example subprocesses include requirements elicitation, requirements allocation, architecture selection, and design, code and test review. Example attributes of these subprocesses include cycle time, quality performance or defect density, productivity, staff attributes, and risk indices.
- Keep in mind attributes such as downtime of parts of the project environment (e.g., computing resources, test equipment, and specialized tools and compilers).
- **Inspection and peer review subprocesses**
  Consider subprocesses that are important to understand quality and therefore are important to your business such as preparation, meeting conduct and review. Example attributes of these subprocesses include preparation times, review rates, and defect densities.
- **Other subprocesses**
  Consider subprocesses (e.g, supplier agreement development, supplier monitoring, customer interaction, partner development) that involve responding to inquiries or actions related to key interfaces with suppliers, customers, and

mers – Example

- Olympic swimmers use process-performance models to evaluate their overall race time. With years of experience, they have identified several key subprocesses that dominate the overall race time:
  - the time off the blocks at the start of the race
  - the time it takes to complete a turn at the end of the pool
- By controlling and managing these times, Olympic swimmers have attained world class performance.

Many changes were made to the CMMI models to improve quality. The major changes include

- name changed to ñCMMI for Developmentò
- both representations in one document
- amplifications improved; added hardware amplifications
- common features and advanced practices eliminated
- SS addition eliminated; ISM brought into SAM
- guidelines for ñnot applicableò process areas clarified
- overview and glossary improved
- work environment material added to OPD and IPM
- IPPD material simplified and consolidated
- process deployment strengthened in IPM and OPF

ween OPD and IPM