Life Cycle Models, CMMI, Lean, Six Sigma – Why use them?

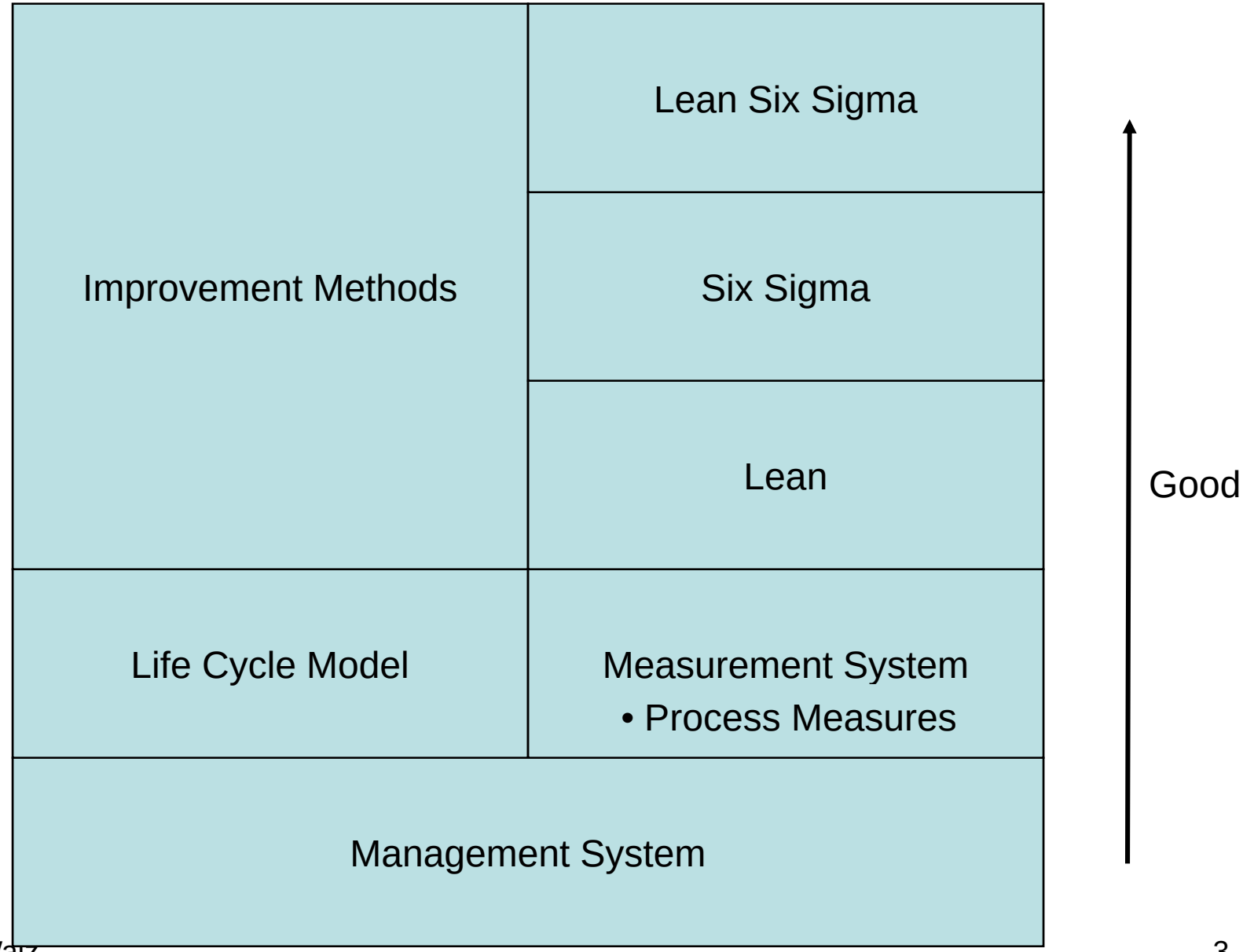
John Walz
ASQ Electronics & Communications Division,
Membership Chair,
IEEE Computer Society, VP for Standards

QuEST Forum Best Practices Conference
Track 3 – What, Where, How & Why
Monday, 24-Sep-07, 4:30 – 5:30

John Walz

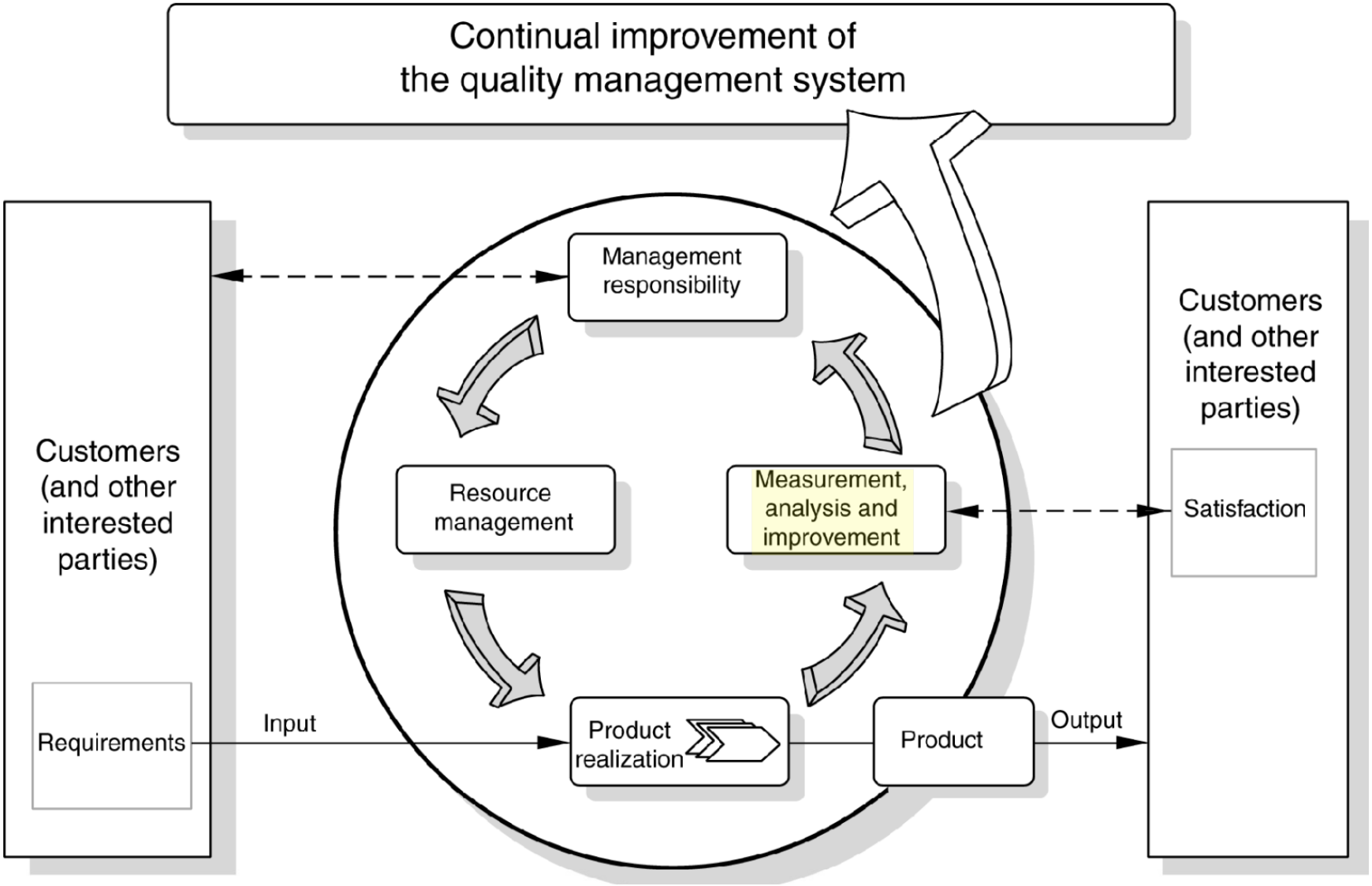
- Sr. Consultant, The Sutton Group
  - Software / CMMI®
- Retired Lucent / AT&T
- Sr. Member IEEE, Standards Assoc.
- VP for Standards, IEEE Computer
- Vice-Chair Planning, IEEE Software & Systems Standards Committee
- Secretary, TL 9000 SIG
- Membership, Electronics & Communication Division, ASQ
- Blog Author, ASQ Sarbanes-Oxley

Building for Business Success



Management Systems

ISO 9001 Model of a process-based quality management system



ISO 9001 Quality Management System

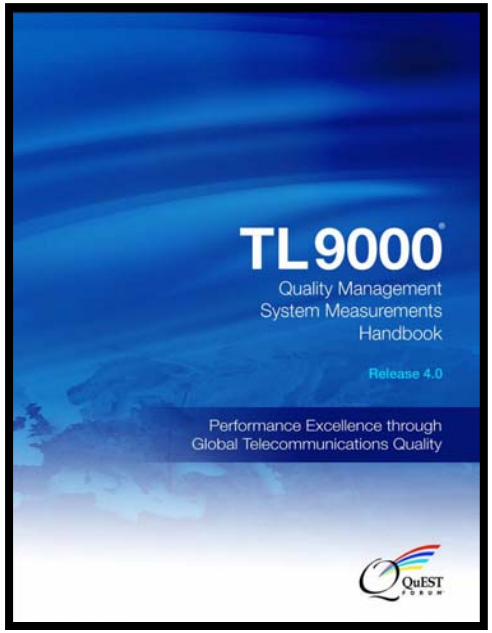
- **The organization shall:**
  - **Determine** the needs and expectations of customers and other interested parties
  - **Establish** policies, objectives and a work environment necessary to motivate the organization to satisfy these needs
  - **Design, resource and manage** a system of interconnected processes necessary to implement the policy and attain the objectives
  - **Measure and analyze** the adequacy, efficiency and effectiveness of each process in fulfilling its purpose and objectives and
  - **Pursue** the continual improvement of the system from an objective evaluation of its performance.

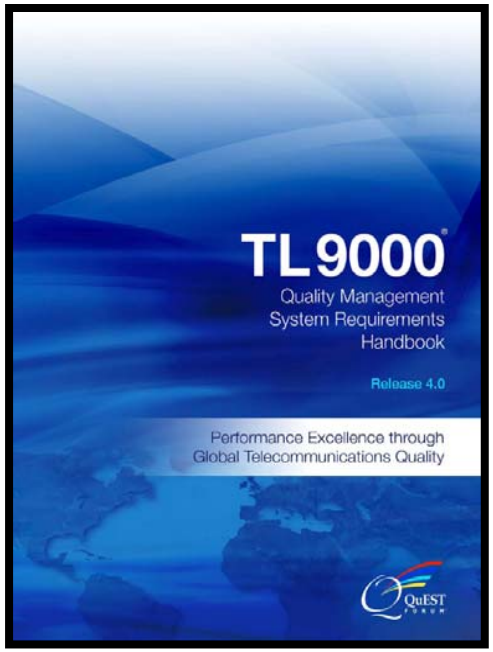
ISO 9001 Quality Management System

- **Foundation of several industry sector standards**
  - Aerospace, AS9100,
  - Automobile, ISO/TS 16949,
  - Chemical, Responsible Care 14001,
  - Medical devices, ISO 13485,
  - Petroleum and natural gas, ISO/TS 29001,
  - Telecom TL 9000

TL 9000

Quality Management System,
QuEST Forum





TL 9000 Model

Measurement Collection and Reporting System

Hardware Measurements	Software Measurements	Services Measurements

Common TL 9000 Measurements

Hardware-Specific Requirements	Software-Specific Requirements	Services-Specific Requirements

Common TL 9000 Requirements

International Standard ISO 9001:2000

TL 9000 QMS and Measurements System

- ISO 9001 + best practices + best measures = TL 9000
  - 90 Requirement Adders by engineering domains: H, S, V, C
  - 10 Measurements areas for 100+ Product Categories
    - Product, not Process measurements
- TL 9000 requires
  - Life Cycle Model [7.1.C.1],
  - Effectiveness of each process [8.2.3.C.1],
    - Process measurements
  - Error elimination [7.3.5.HS1,2]
    - Focus on defects

Life Cycle Models

TL 9000 Life Cycle Model

7.1.C.1 Life Cycle Model

- The organization shall establish and maintain an integrated set of method(s) that covers the life cycle of its products. The method(s) shall contain, as appropriate, the processes, activities, and tasks involved in the
  - concept,
  - definition,
  - development,
  - introduction,
  - production,
  - operation,
  - maintenance, and
  - (if required) disposal of products, spanning the life of the products.

Life Cycle Models

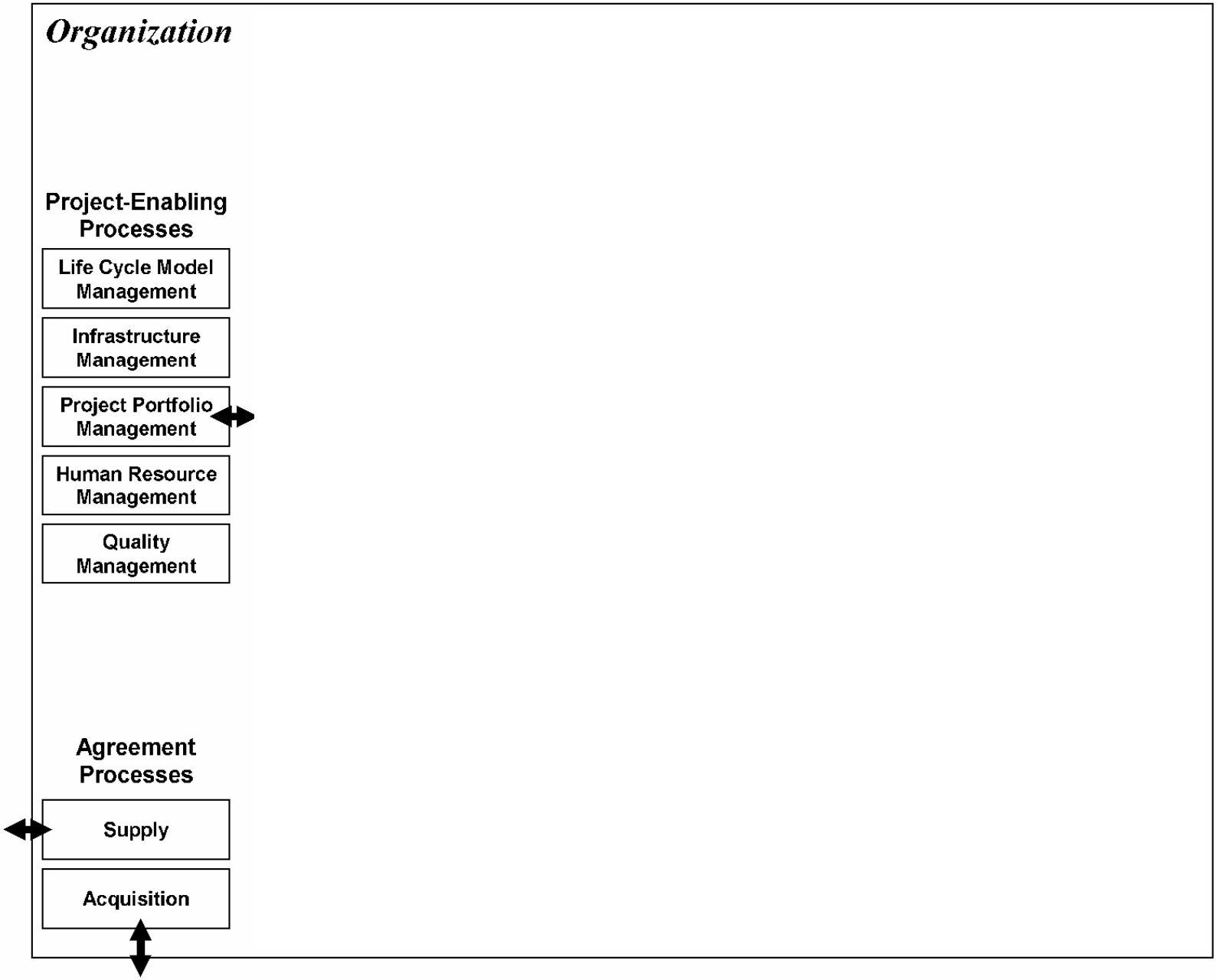
- waterfall,
- incremental delivery,
- evolutionary development,
- etc.

- Model includes many processes

Life Cycle Processes

- IS 12207 Software Engineering Life Cycle
  - 18 processes
- IS 15288 System Engineering Life Cycle
  - 25 processes
- IS 20000 Service Management
  - 11 processes
- Control Objectives for Information and related Technology (CobiT)
  - 34 processes
- CMMI-DEV Process Areas (PA)
  - 22 processes

Life cycle processes



Life Cycle Process Groups, IS12207, IS 15288

System Life Cycle Processes

Agreement Processes

- Acquisition Process (Clause 6.1.1)
- Supply Process (Clause 6.1.2)

Project-Enabling Processes

- Life Cycle Model Management Process (Clause 6.2.1)
- Infrastructure Management Process (Clause 6.2.2)
- Project Portfolio Management Process (Clause 6.2.3)
- Human Resource Management Process (Clause 6.2.4)
- Quality Management Process (Clause 6.2.5)

Project Processes

- Project Planning Process (Clause 6.3.1)
- Project Assessment and Control Process (Clause 6.3.2)
- Decision Management Process (Clause 6.3.3)
- Risk Management Process (Clause 6.3.4)
- Configuration Management Process (Clause 6.3.5)
- Information Management Process (Clause 6.3.6)
- Measurement Process (Clause 6.3.7)

Technical Processes

- Stakeholder Requirements Definition Process (Clause 6.4.1)
- System Requirements Analysis Process (Clause 6.4.2)
- System Architectural Design Process (Clause 6.4.3)
- Implementation Process (Clause 6.4.4)
- System Integration Process (Clause 6.4.5)
- System Qualification Testing Process (Clause 6.4.6)
- Software Installation Process (Clause 6.4.7)
- Software Acceptance Support Process (Clause 6.4.8)
- Software Operation Process (Clause 6.4.9)
- Software Maintenance Process (Clause 6.4.10)
- Software Disposal Process (Clause 6.4.11)

Software Life Cycle Processes

SW Implementation Processes

- Software Implementation Process (Clause 7.1.1)
- Software Requirements Analysis Process (Clause 7.1.2)
- Software Architectural Design Process (Clause 7.1.3)
- Software Detailed Design Process (Clause 7.1.4)
- Software Construction Process (Clause 7.1.5)
- Software Integration Process (Clause 7.1.6)
- Software Qualification Testing Process (Clause 7.1.7)

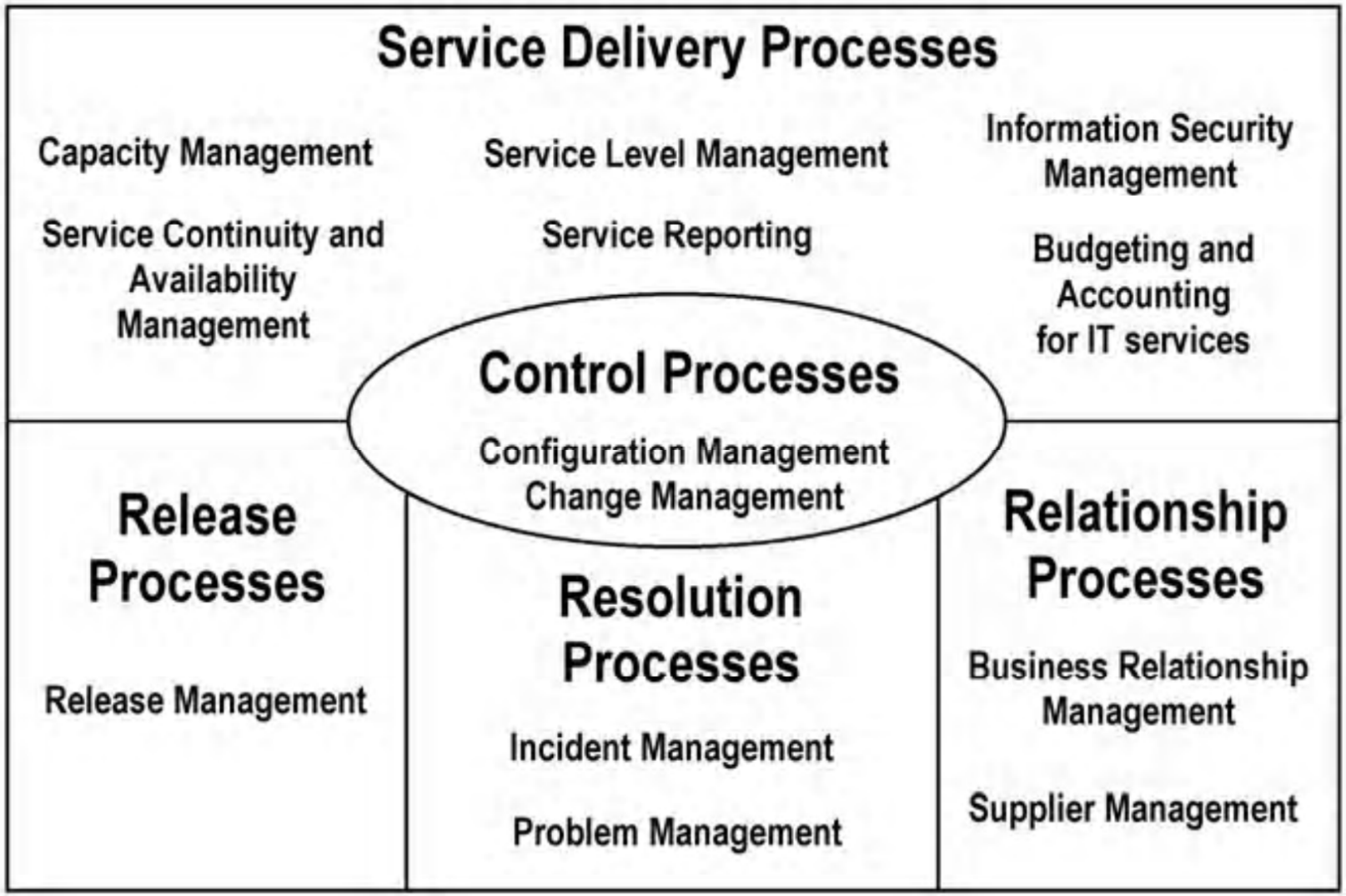
SW Support Processes

- Software Documentation Management Process (Clause 7.2.1)
- Software Configuration Management Process (Clause 7.2.2)
- Software Quality Assurance Process (Clause 7.2.3)
- Software Verification Process (Clause 7.2.4)
- Software Validation Process (Clause 7.2.5)
- Software Review Process (Clause 7.2.6)
- Software Audit Process (Clause 7.2.7)
- Software Problem Resolution Process (Clause 7.2.8)

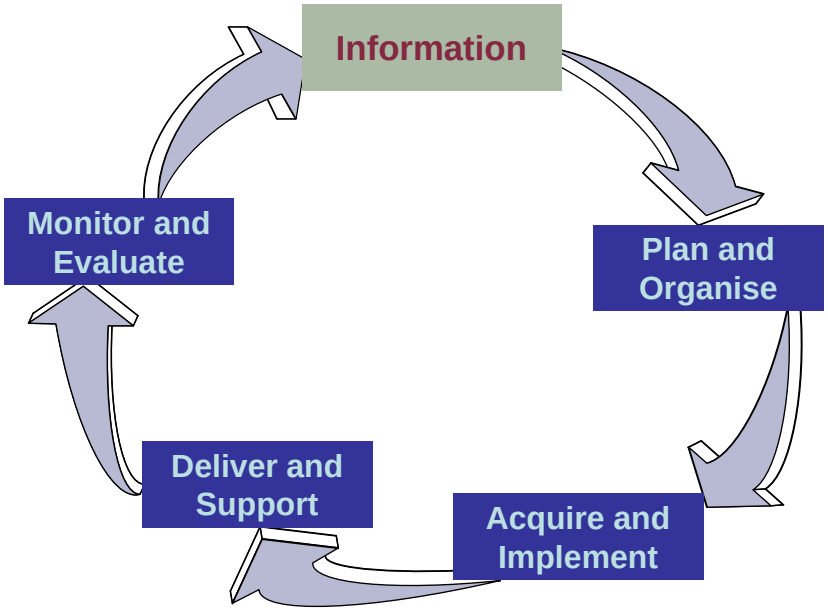
Software Reuse Processes

- Domain Engineering Process (Clause 7.3.1)
- Reuse Program Management Process (Clause 7.3.3)
- Reuse Asset Management Process (Clause 7.3.2)

Service Management processes, IS 20000



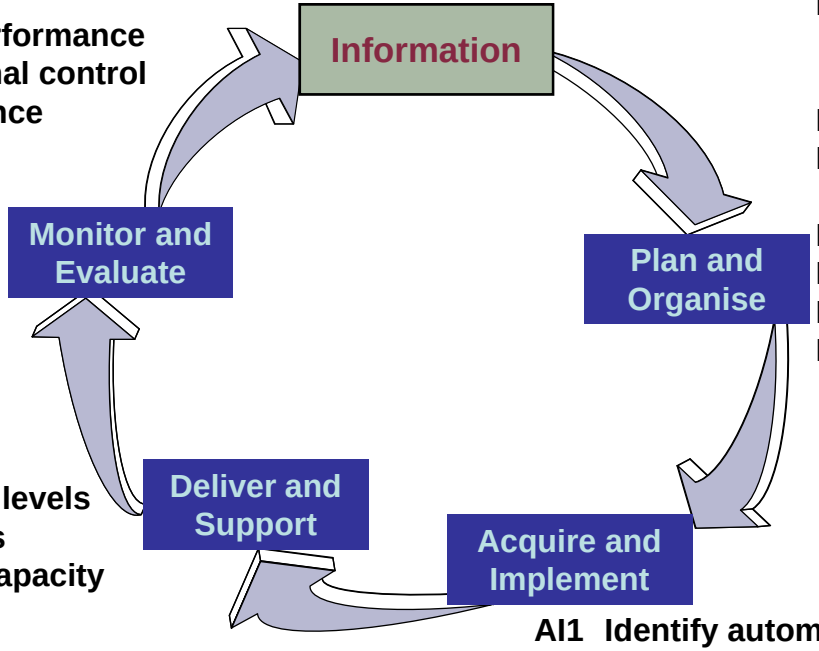
Control Objectives for Information and related Technology (CobiT) Processes



Control Objectives for Information and related Technology (CobiT) Processes

PO1 Define a strategic IT plan
PO2 Define the information architecture
PO3 Determine technological direction
PO4 Define the IT processes, organisation and relationships
PO5 Manage the IT investment
PO6 Communicate management aims and direction
PO7 Manage IT human resources
PO8 Manage quality
PO9 Assess and manage IT risks
PO10 Manage projects

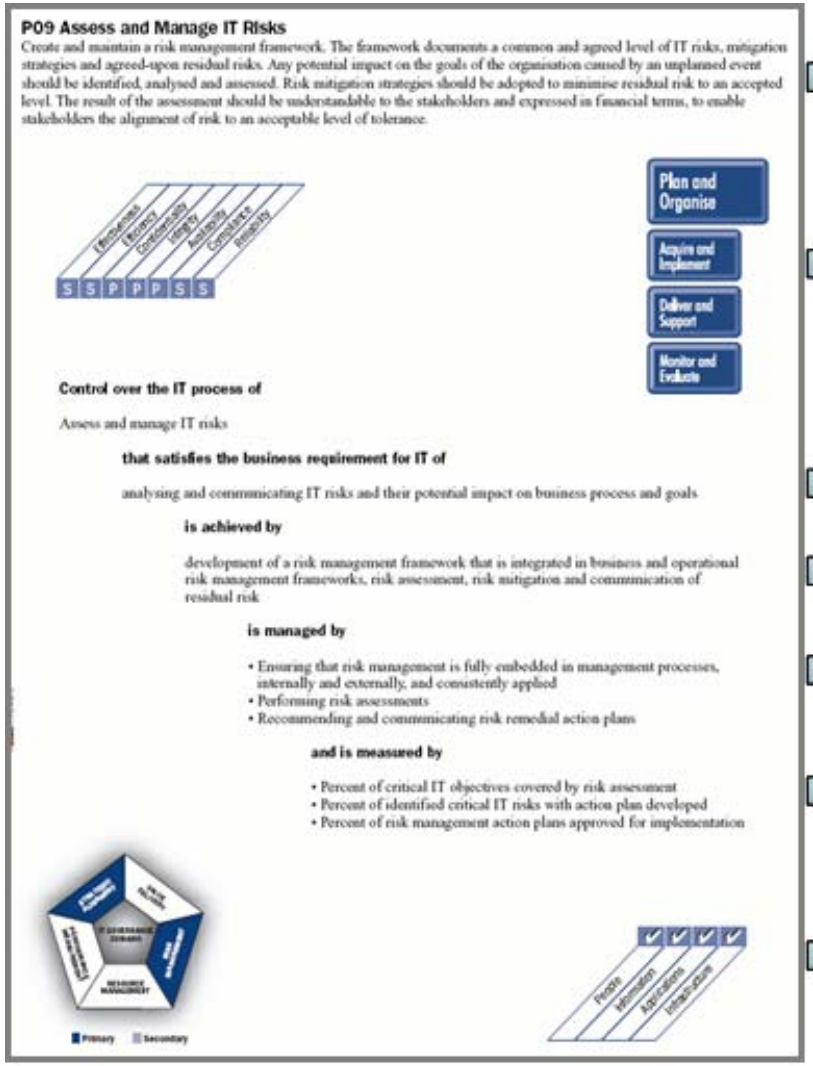
ME1 Monitor and evaluate IT performance
ME2 Monitor and evaluate internal control
ME3 Ensure regulatory compliance
ME4 Provide IT governance



DS1 Define and manage service levels
DS2 Manage third-party services
DS3 Manage performance and capacity
DS4 Ensure continuous service
DS5 Ensure systems security
DS6 Identify and allocate costs
DS7 Educate and train users
DS8 Manage service desk and incidents
DS9 Manage the configuration
DS10 Manage problems
DS11 Manage data
DS12 Manage the physical environment
DS13 Manage operations

AI1 Identify automated solutions
AI2 Acquire and maintain application software
AI3 Acquire and maintain technology infrastructure
AI4 Enable operation and use
AI5 Procure IT resources
AI6 Manage changes
AI7 Install and accredit solutions and changes

For 34 CobiT processes you have …



P09 Assess and Manage IT Risks

Create and maintain a risk management framework. The framework documents a common and agreed level of IT risks, mitigation strategies and agreed-upon residual risks. Any potential impact on the goals of the organisation caused by an unplanned event should be identified, analysed and assessed. Risk mitigation strategies should be adopted to minimise residual risk to an accepted level. The result of the assessment should be understandable to the stakeholders and expressed in financial terms, to enable stakeholders the alignment of risk to an acceptable level of tolerance.

Effectiveness | Efficiency | Confidentiality | Integrity | Availability | Compliance | Reliability

S S P P P S S

Plan and Organise | Acquire and Implement | Deliver and Support | Monitor and Evaluate

Control over the IT process of

Assess and manage IT risks

that satisfies the business requirement for IT of

analysing and communicating IT risks and their potential impact on business process and goals

is achieved by

development of a risk management framework that is integrated in business and operational risk management frameworks, risk assessment, risk mitigation and communication of residual risk

is managed by

- Ensuring that risk management is fully embedded in management processes, internally and externally, and consistently applied
- Performing risk assessments
- Recommending and communicating risk remedial action plans

and is measured by

- Percent of critical IT objectives covered by risk assessment
- Percent of identified critical IT risks with action plan developed
- Percent of risk management action plans approved for implementation

Primary | Secondary

People | Information | Applications | Infrastructure

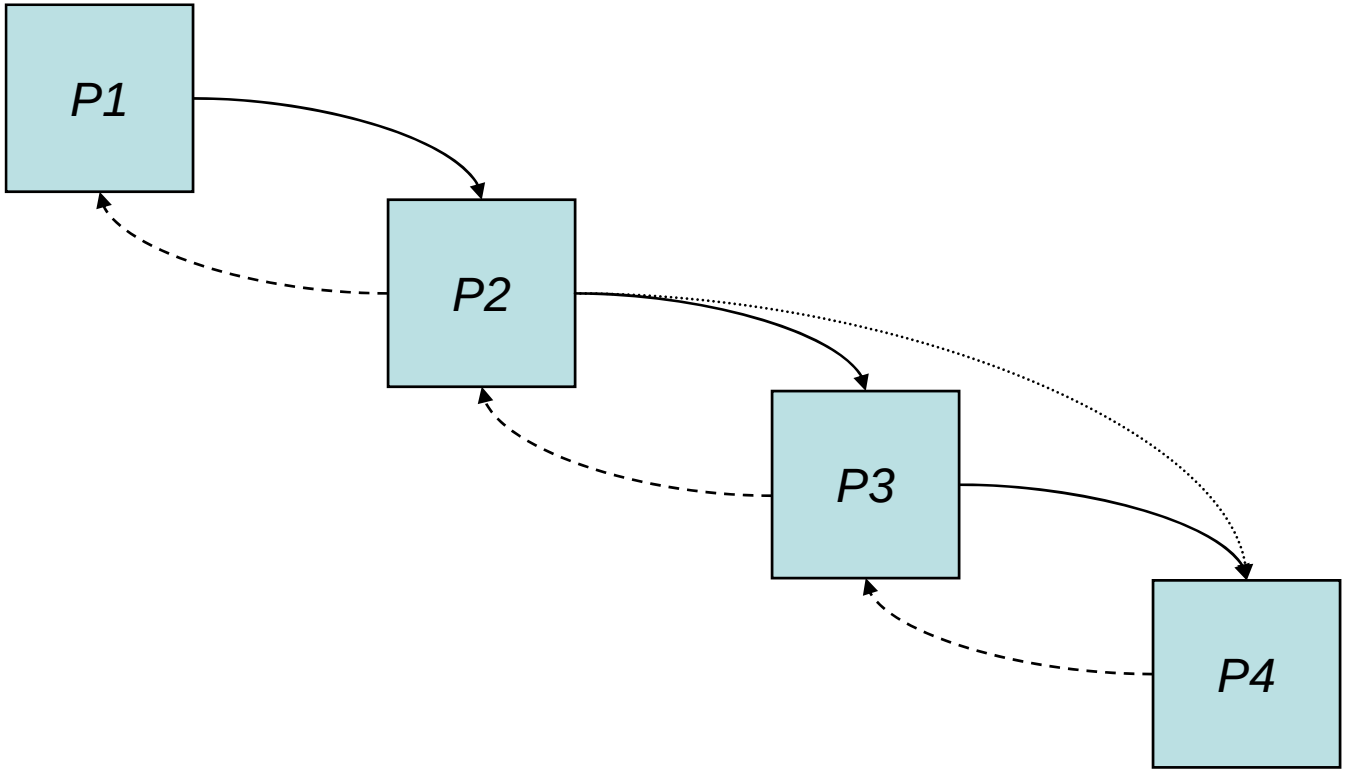
- Process description
- IT domains & Information Indicators
- IT goals
- Process goals
- Key practices
- Key measurements
- IT Governance & IT resource indicators

CMMI-DEV Process Areas

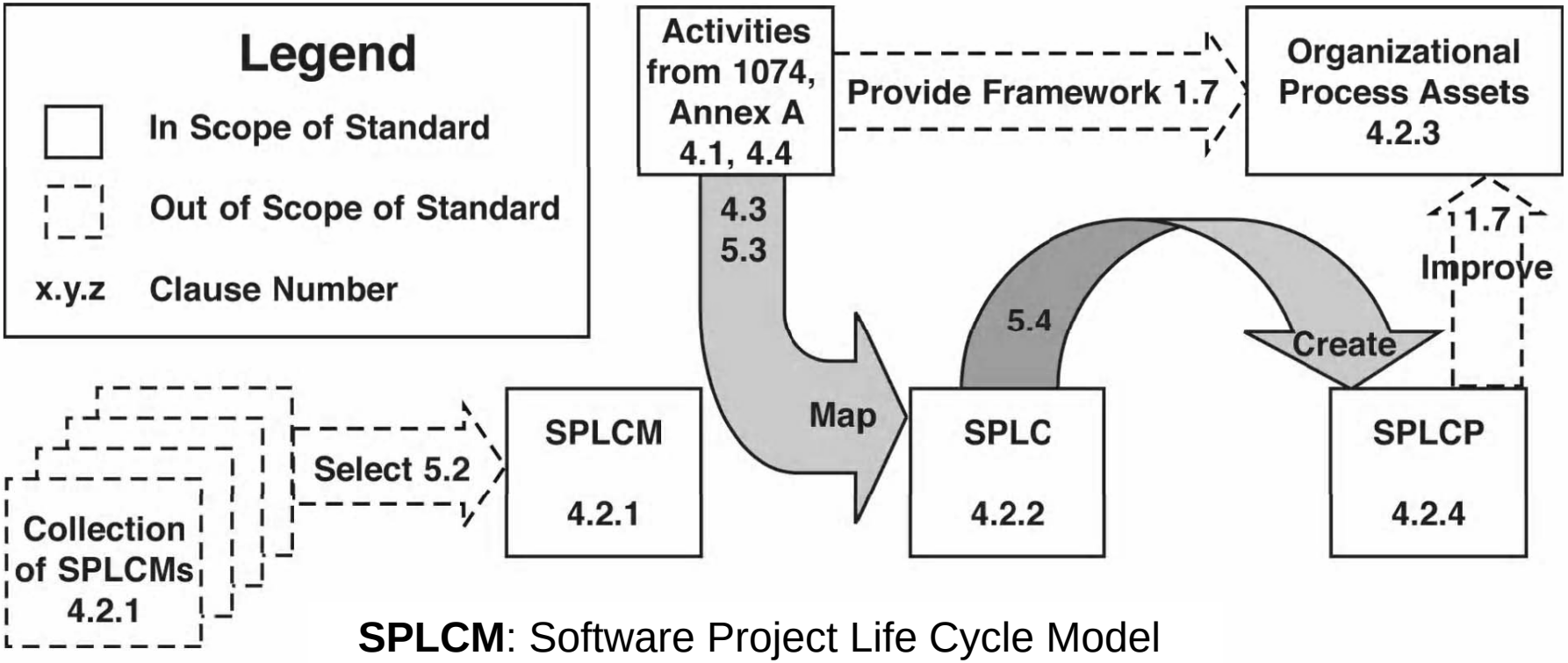
	Process Areas
Process Management	Organizational Process Focus Organizational Process Definition *(+ IPPD Elements)* Organizational Training Organizational Process Performance Organizational Innovation and Deployment
Project Management	Project Planning Project Monitoring and Control Supplier Agreement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

Network of processes for Life Cycle Model

- List of processes
- Network of processes



Developing software project life cycle process, IEEE 1074

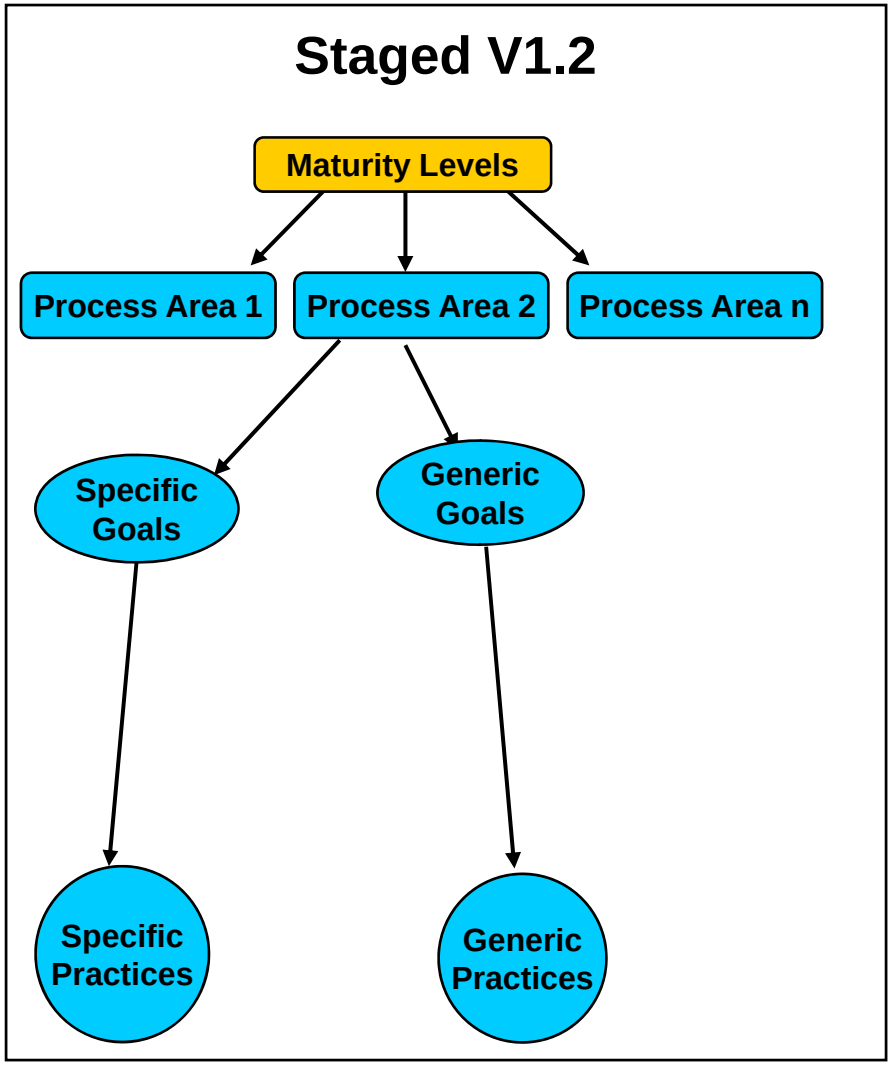


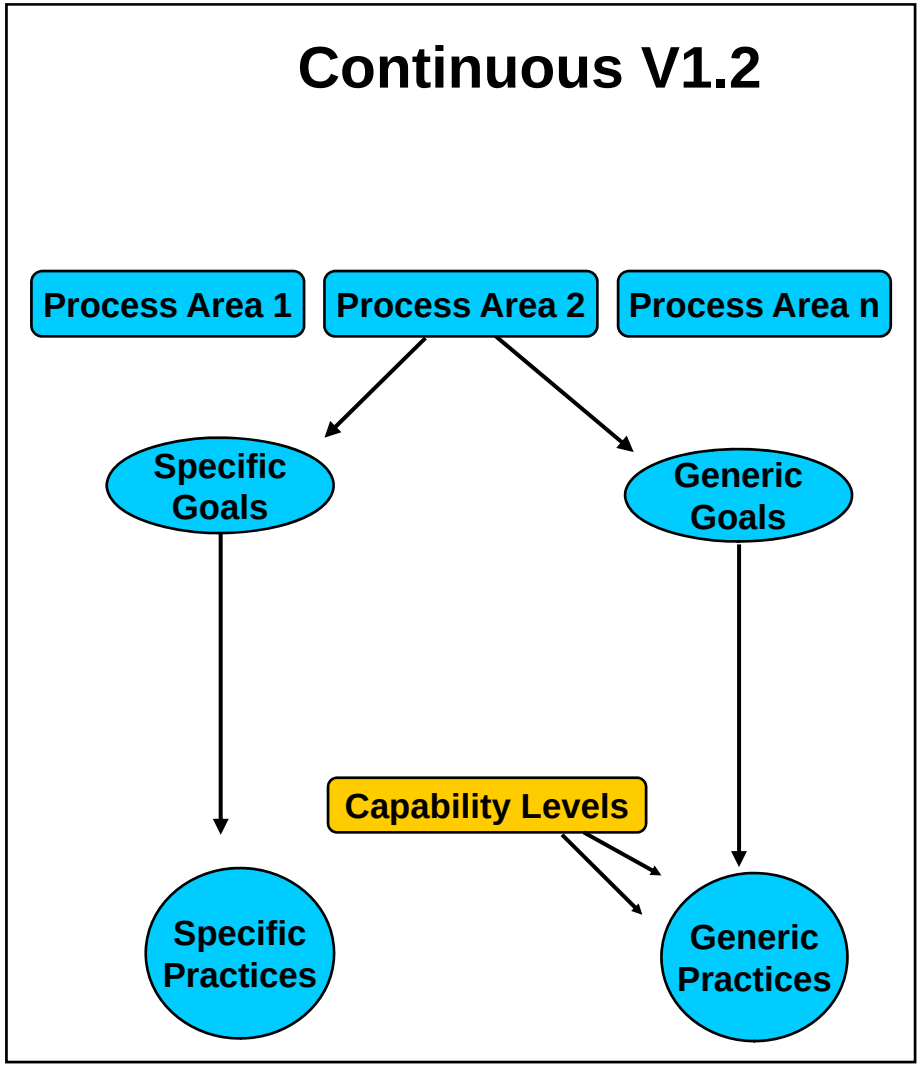
SPLCM: Software Project Life Cycle Model
SPLC: Software Project Life Cycle
SPLCP: Software Project Life Cycle Process

CMMI®

Capability Maturity Model Integrated for Development, V1.2, SEI

CMMI-DEV Model Structure





Mike Phillips, SEI -2006

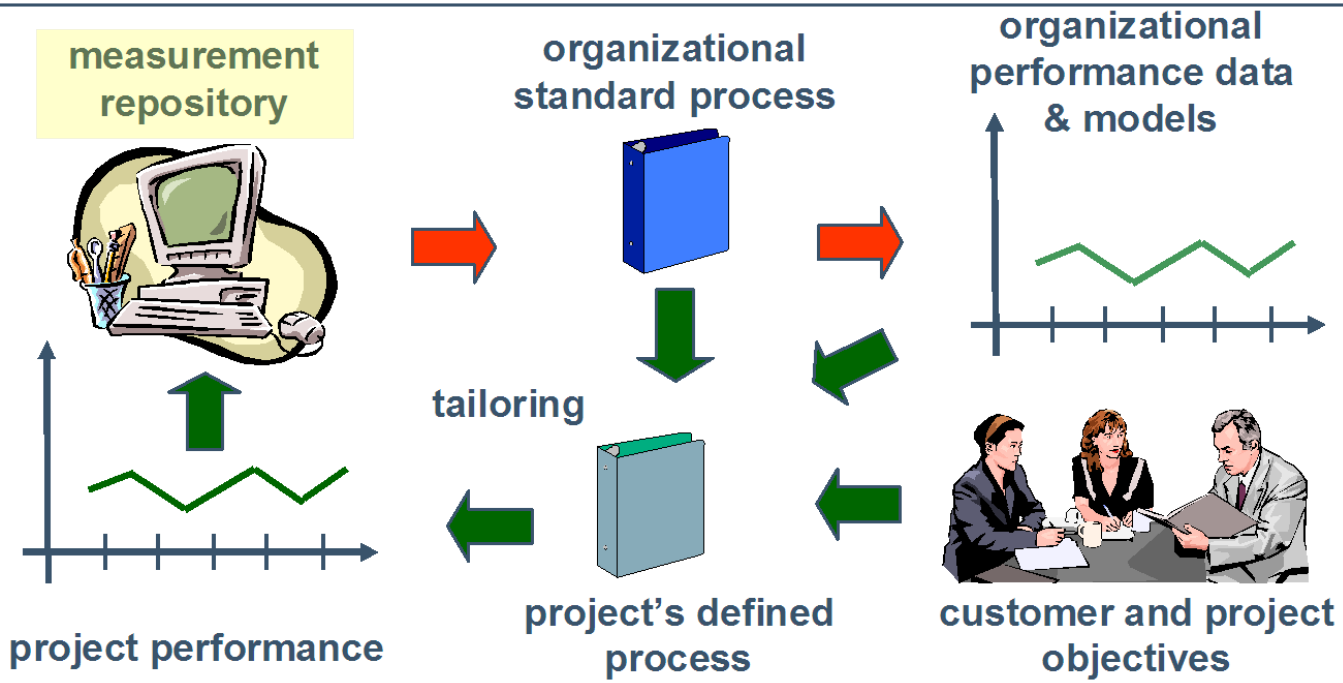
CMMI to TL 9000

- A CMMI Maturity Level 3 Apprised **software** organization will meet ISO 9001 / TL 9000 requirements with gaps in the following areas:
  - Post deployment support
  - Customer satisfaction surveys
  - Quality partnering
- TL 9000 hardware (H) adders are not addressed in CMMI

Isn't CMMI Level 3 good enough?

Organizational Process Performance

- Establishes a quantitative understanding of the performance of the organization's set of standard processes



Quantitative Project Management

- Quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.

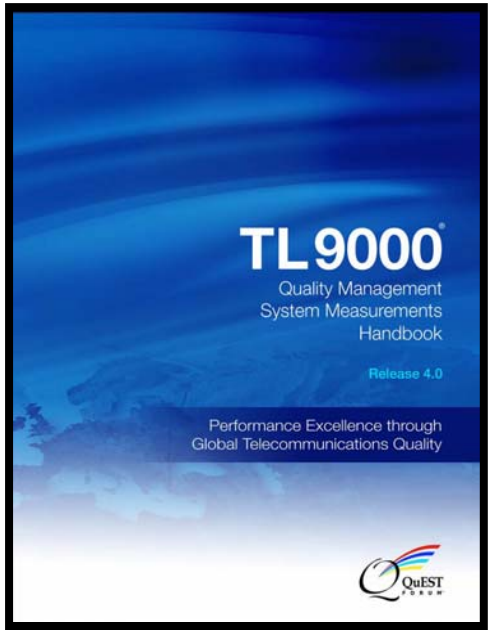
Measurements

Bottom Line

- Process improvement for its own sake will soon die,
- Process improvement should be done to help the business

"In God we trust,
All others bring data."

W. Edwards Deming

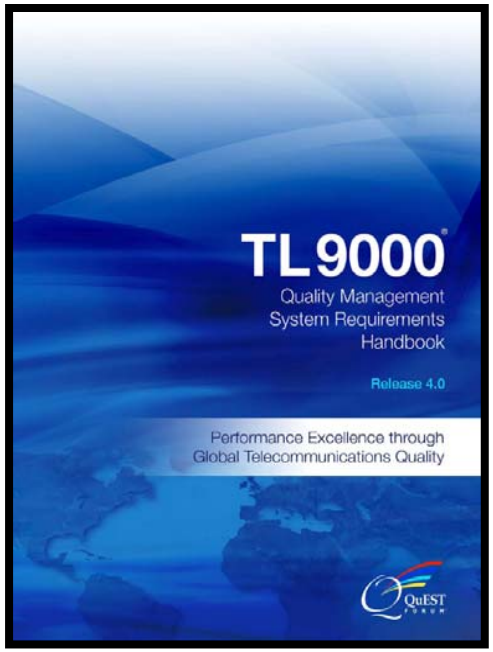


TL 9000 Model

Measurement Collection and Reporting System

Hardware Measurements	Software Measurements	Services Measurements

Common TL 9000 Measurements

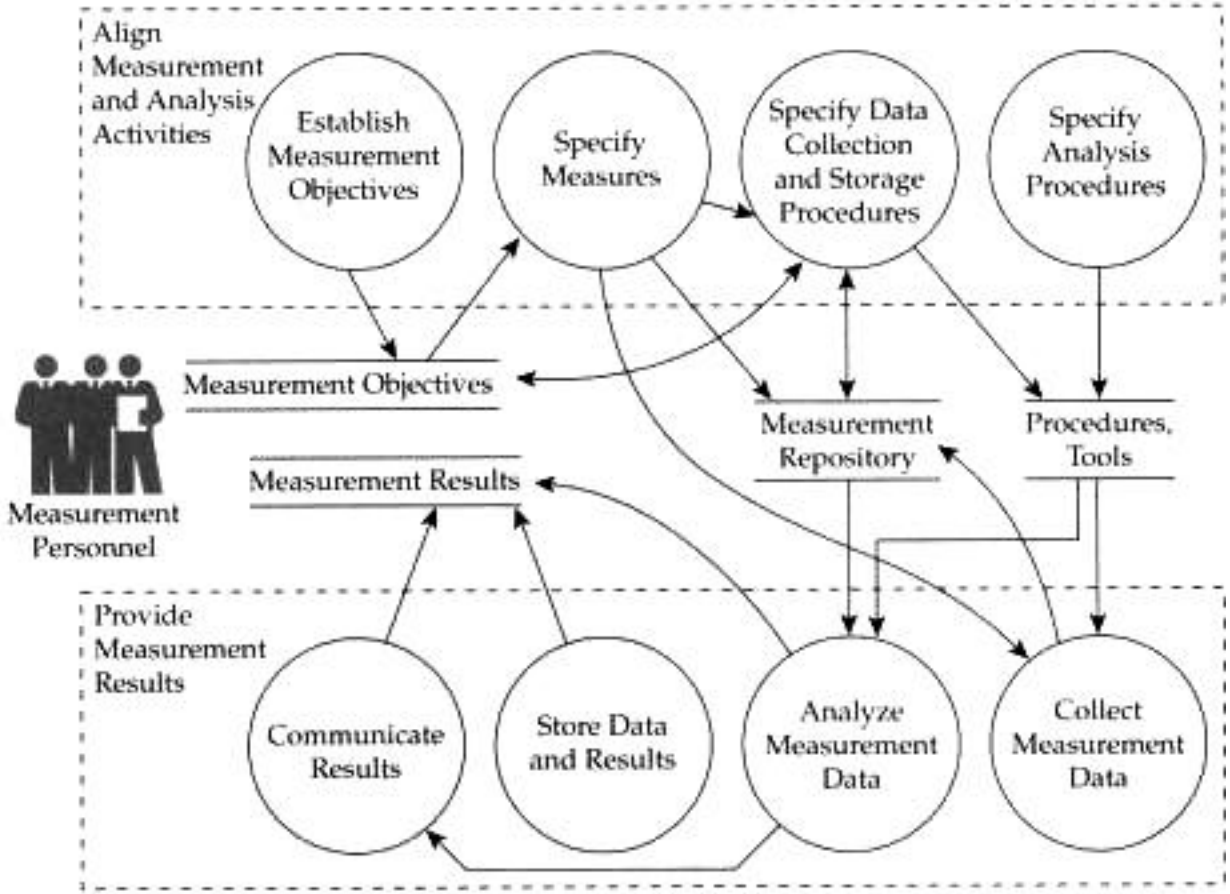


Hardware-Specific Requirements	Software-Specific Requirements	Services-Specific Requirements

Common TL 9000 Requirements

International Standard ISO 9001:2000

Measures and Analysis Process Area



Product vs. Process Measurements

- Product Measurements
  - Shared with Customers
  - Benchmarked with industry
- Process Measurements
  - Not shared, nor benchmarked
  - Predictors of Product Measures
  - Impacted by Suppliers Product Measurements
  - Input to Lean & Six Sigma techniques

Process Measurements

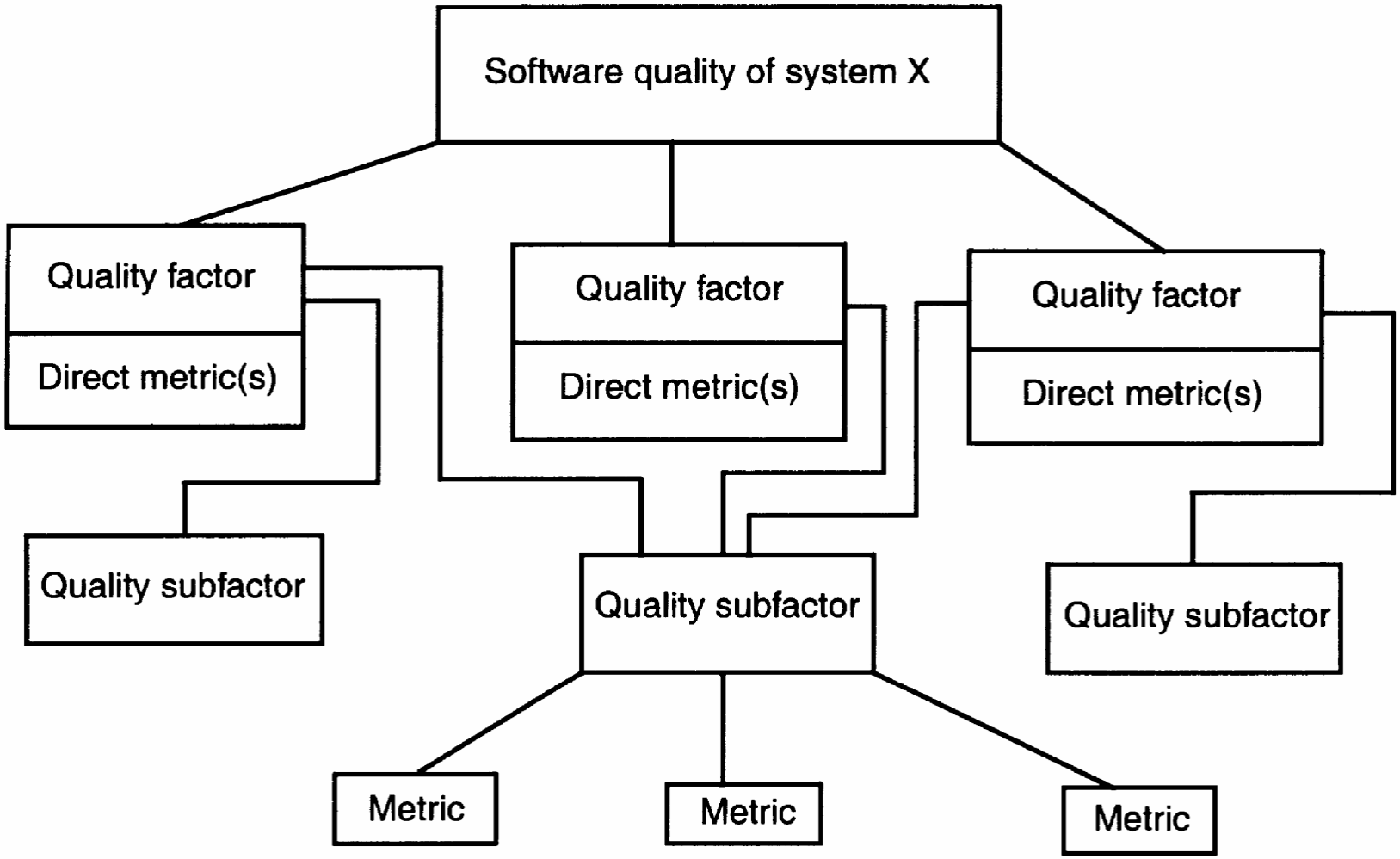
TL 9000 Requirements Release 4.0

- **8.2.3 Monitoring and measurement of processes**
  - The organization shall apply suitable methods for monitoring and, where applicable, measurement of the quality management system processes.
  - These methods shall demonstrate the ability of the processes to achieve planned results.
  - When planned results are not achieved, correction and corrective action shall be taken, as appropriate, to ensure conformity of the product.
- **8.2.3.C.1 Process measurement**
  - Expanded: to include appropriate design process measurements and require performance targets or control limits for key process measurements.
- **7.2.3.HS.2 Design and Development Process Quality Measurements Data Reporting**
  - New: Provide design and development process measurements when requested by the customer
- **7.3.1.HS.2 Design and Development Process Quality Measurement Planning and Implementation**
  - New: Planning during the design and development phase to select and report appropriate design and development process quality measures

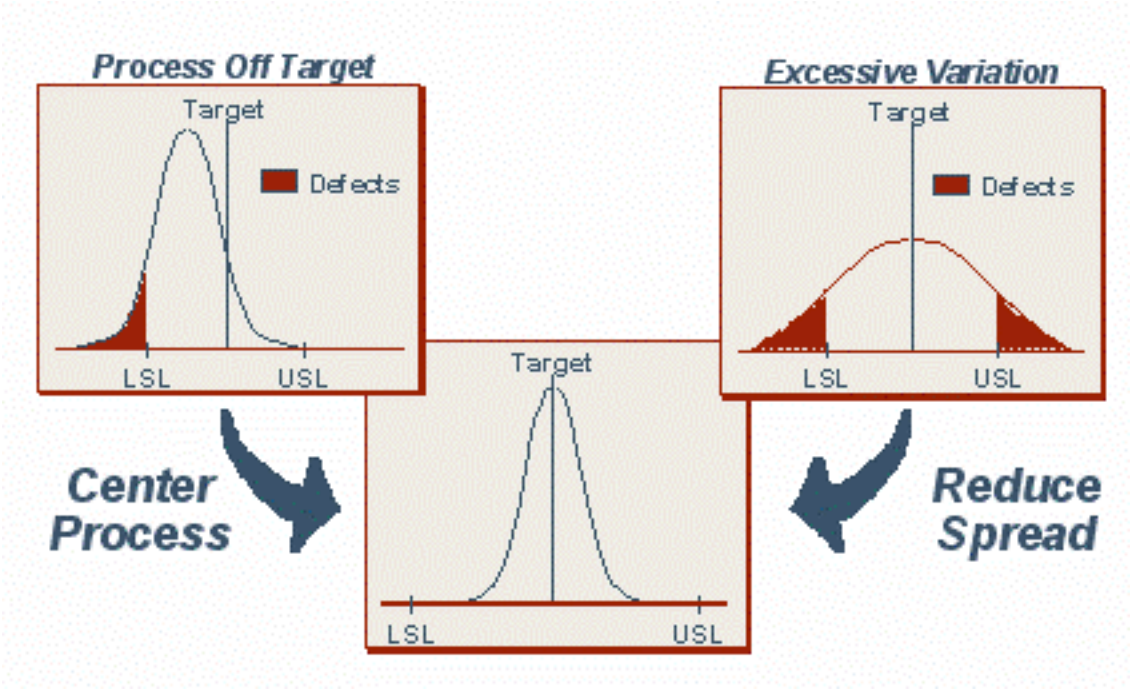
Typical Process Measures

- Defects
  - Received & Detected
  - Created & Detected
  - Missed and found later
- Cycle time
  - Calendar
  - Actual
- Costs
  - Total effort
  - Computer resources utilization
  - Rework
- Project Milestones
  - Targets achieved
  - Deviation from targets
- Controls
  - Conformance
  - Risk detection
  - Rework
  - Exceptions approved

Hierarchy of software quality measure framework, IEEE 1061



Statistical Thinking



Lean

Lean Principles

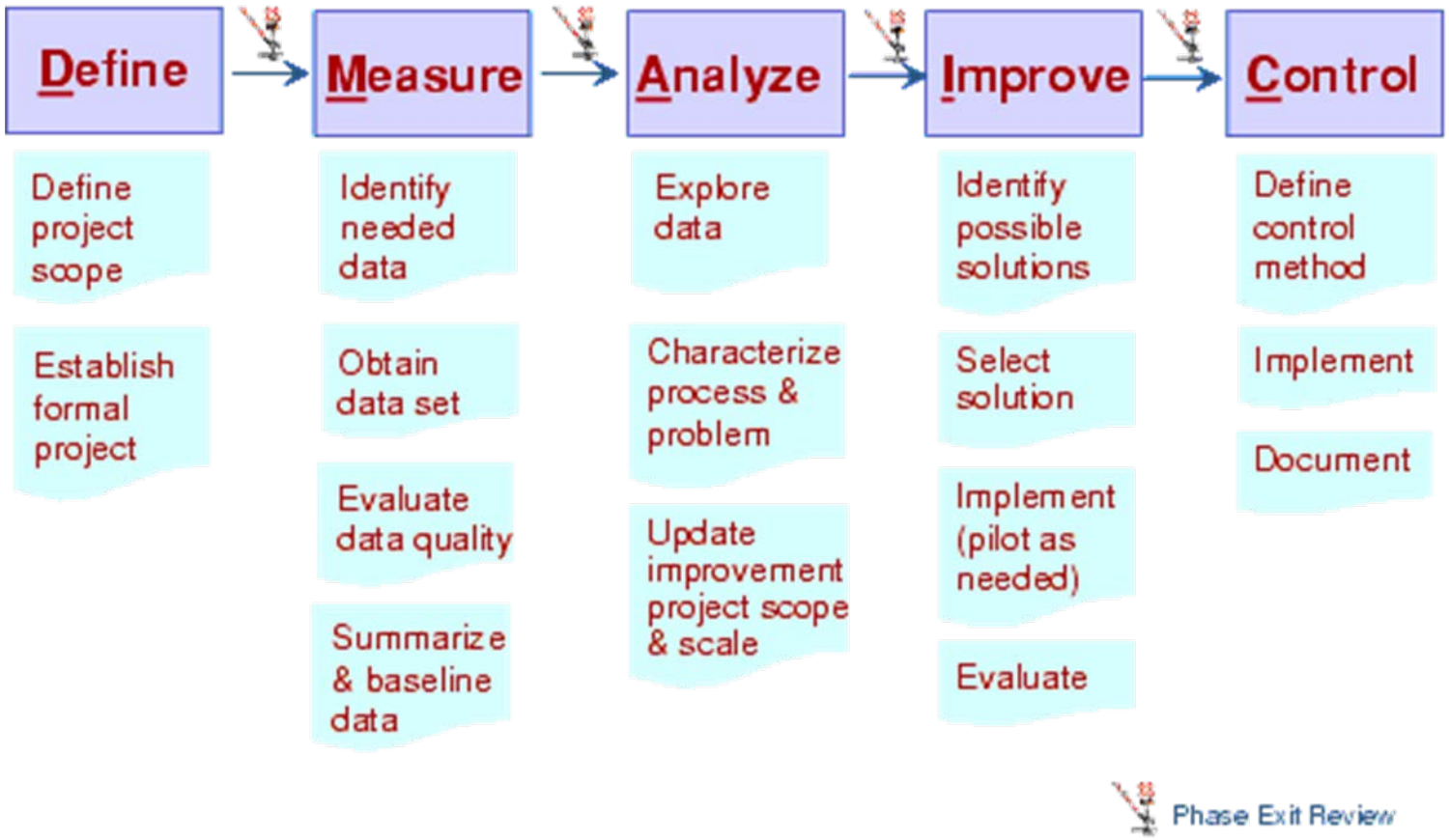
- Lean Manufacturing Processes
  - Helps eliminate production waste, introduce value-added measurements, and push for continuous improvements
- Continuous pursuit of improving the processes
- Philosophy of eliminating all non-value adding activities & reducing waste within the organization
  - Uncover and reduce waste.
    - Engineering defects
    - Wasted time and effort
  - A new way of thinking
  - Whole systems approach
- Lean concept of value flow, or the uninterrupted value flow at the pull of the customer
- Closely associated with "Kaizen", which means “Continuous Improvement”
- Lean implementation **precedes** Six Sigma

Six Sigma

Six Sigma

- **A measurement standard in product variation**
  - A statistical concept measures a process in terms of defects
- **DMAIC method**
  - Define, Measure, Analyze, Improve, and Control
- **Continuous improvement methodology**
  - To improve business processes and products
  - Forces organizations to define their vision of quality in numerical terms.
  - Offers phases, tools, and techniques that help an organization improve their processes
  - Uses data and statistical analysis tools to identify, track and reduce problem areas and defects in products and services
  - Defects are isolated and eliminated and thereby lower the overall costs of rework during production and post production maintenance

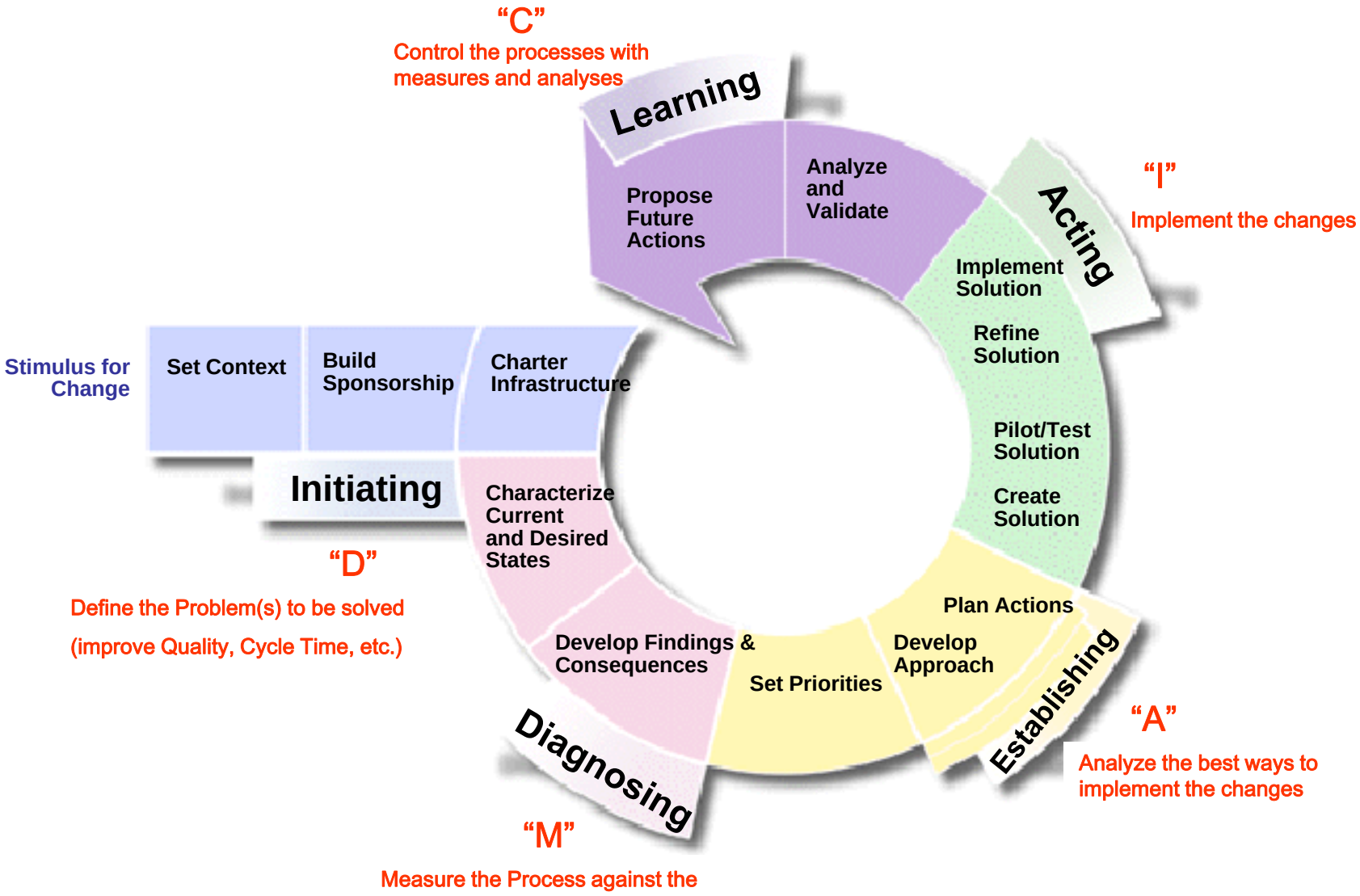
DMAIC Roadmap



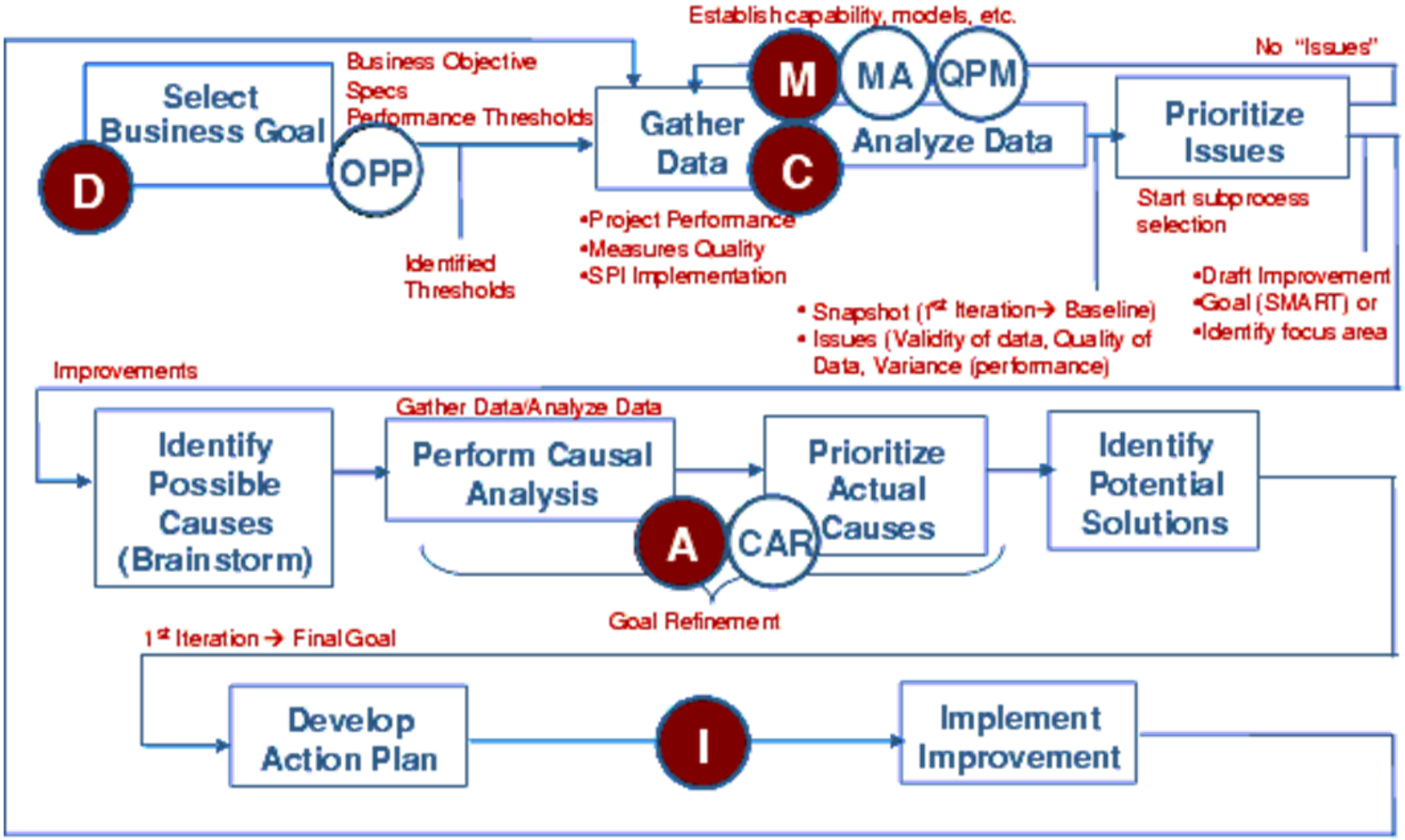
Focus on tools?

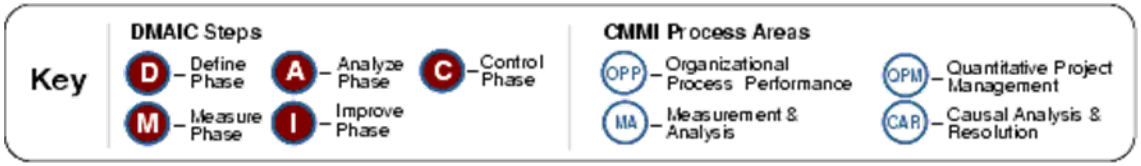
- Its not about CMMI or Lean or Six Sigma,
  its all about Business Improvement.
  CMMI and Six Sigma are not ends in themselves but are simply important techniques for leveraging more effective Business Performance.
- The successful use of CMMI, Lean, Six Sigma by various industries is challenging the traditional mantra of being able to use one method only
- Lean and Six Sigma, with CMMI can be used as complimentary set of improvement methods to provide a lower risk and faster approach, Otherwise:
  - CMMI can yield behavior changes without benefit
  - Six Sigma improvements based solely on data, may miss innovative improvements (assumes a local optimum)

SEI's IDEAL℠ Approach (and Six Sigma *DMAIC*)



CMMI Process Areas & DMAIC Steps





Lean Six Sigma

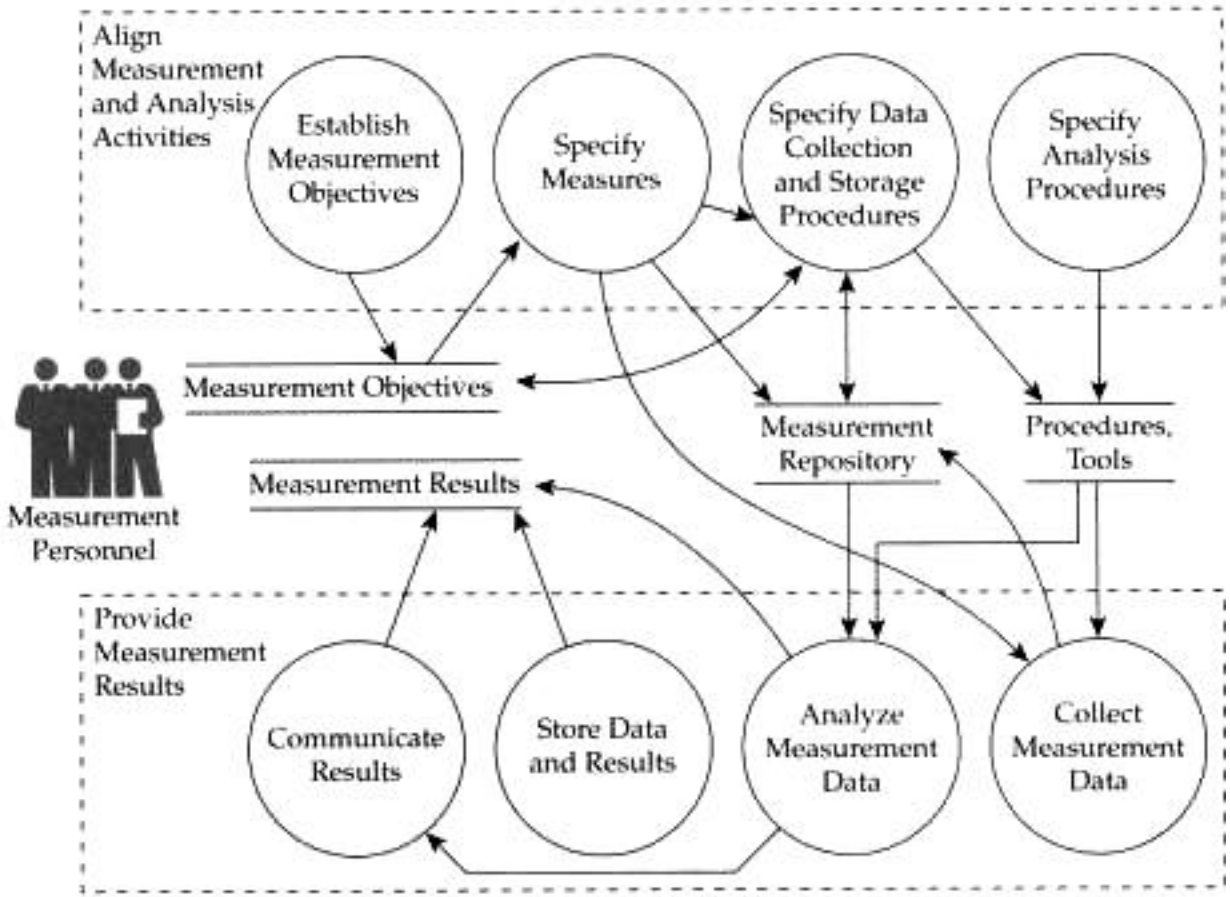
Lean Six Sigma (LSS)

- Combines of two complementary techniques, Lean and Six Sigma:
  - Lean
    - increasing the speed of a process,
    - elimination of any non-value added process steps / activities
  - Six Sigma
    - more on quality than speed
  - Lean
    - customer value flow
  - Six Sigma
    - value continues to flow smoothly and to improve.
- LSS Fundamentals
  - Delight your Customers
  - Base Decisions on Data & Facts
  - Work Together for Maximum Gain
  - Improve Your Processes
- LSS
  - does not provide processes or process descriptions
  - emphasizes that speed is directly related to process excellence
  - uses data to identify and eliminate process problems
- Combines general quality guidance with a process-based management approach, describing the criteria that the processes should support

Robust Management System Foundation

- LSS requires first:
  - robust management,
  - sound engineering practices, &
  - process measurement system foundation
  - **prior** to Lean, Six Sigma, or combined Lean Six Sigma
- Robust management system foundation:
  - ISO 9001,
  - TL 9000, or
  - CMMI-DEV
- Process improvement by
  - set of organizationally adopted processes to be applied by all of their projects, and
  - improving the "set" on the basis of **project's experiences**
- **Project's "experience"** is factored by
  - Lean principles and
  - Six Sigma principles
- Lean Six Sigma specific improvement techniques
  - Validate specific process changes to be deployed across the organization
  - Quantify savings
  - Encourage future investments

Measures and Analysis: What & How



CMMI: ***what*** should be done, not ***how*** to do it.

Lean Six Sigma: ***how*** to do it – a *performance-based* methodology for applying measurement and analysis to problem solving and project management

LSS Implementation

- Both Lean and Six Sigma techniques address and change similar
  - management and
  - technical staff behaviors
- Organizational change management approach
  - quicker and less costly than a sequential approach
  - result in changes to:
    - participant's skills,
    - their tools, and
    - their work processes and artifacts
- Top management has the responsibility providing:
  - overall direction,
  - resources, and
  - control framework

Resources for Improvements

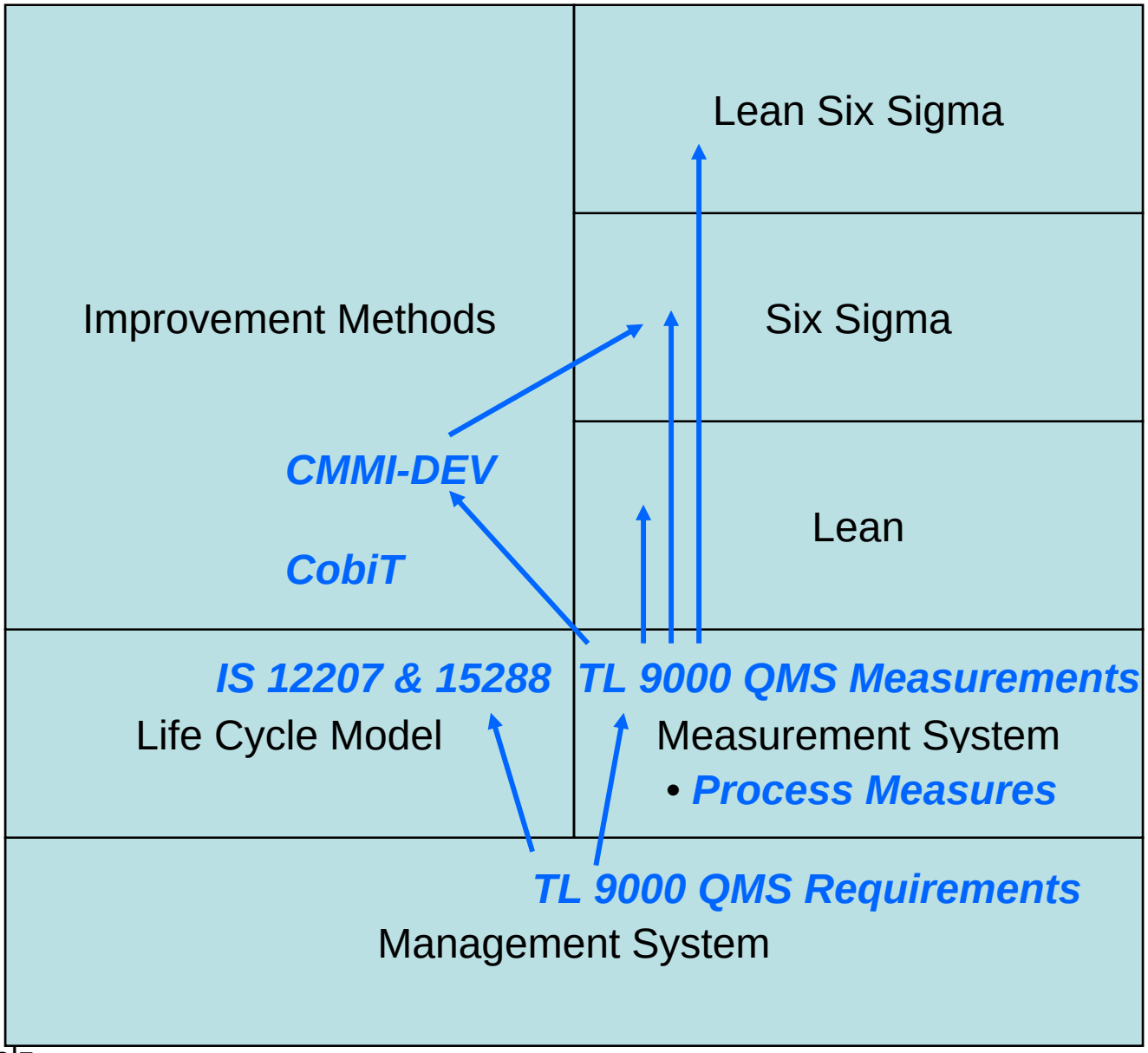
- Whenever objective experiences demonstrate the need for changes to processes and artifacts,
- Then the appropriate IEEE software & system engineering standards can be selected and analyzed for their best practices to be incorporated into
  - processes,
  - internal plans,
  - procedures, and
  - other artifacts,
- to support of Lean Six Sigma implementation.

Conclusions

1st Foundation, 2nd Improvement

- **Foundation**
  - Management System
  - Life cycle models, Software & system engineering, Service, etc.
  - Measurement System
    - Process measures
- **Improvement**
  - Trim the waste and increase overall production value and product quality
    - Lean
    - Six Sigma
    - Lean Six Sigma
  - Alternate ☹
    - *improving an undocumented 'fuzzy' process,*
      which means making assumptions about what the process is,
      hoping the participants of the next iteration understand and continue the changes

Building for Business Success



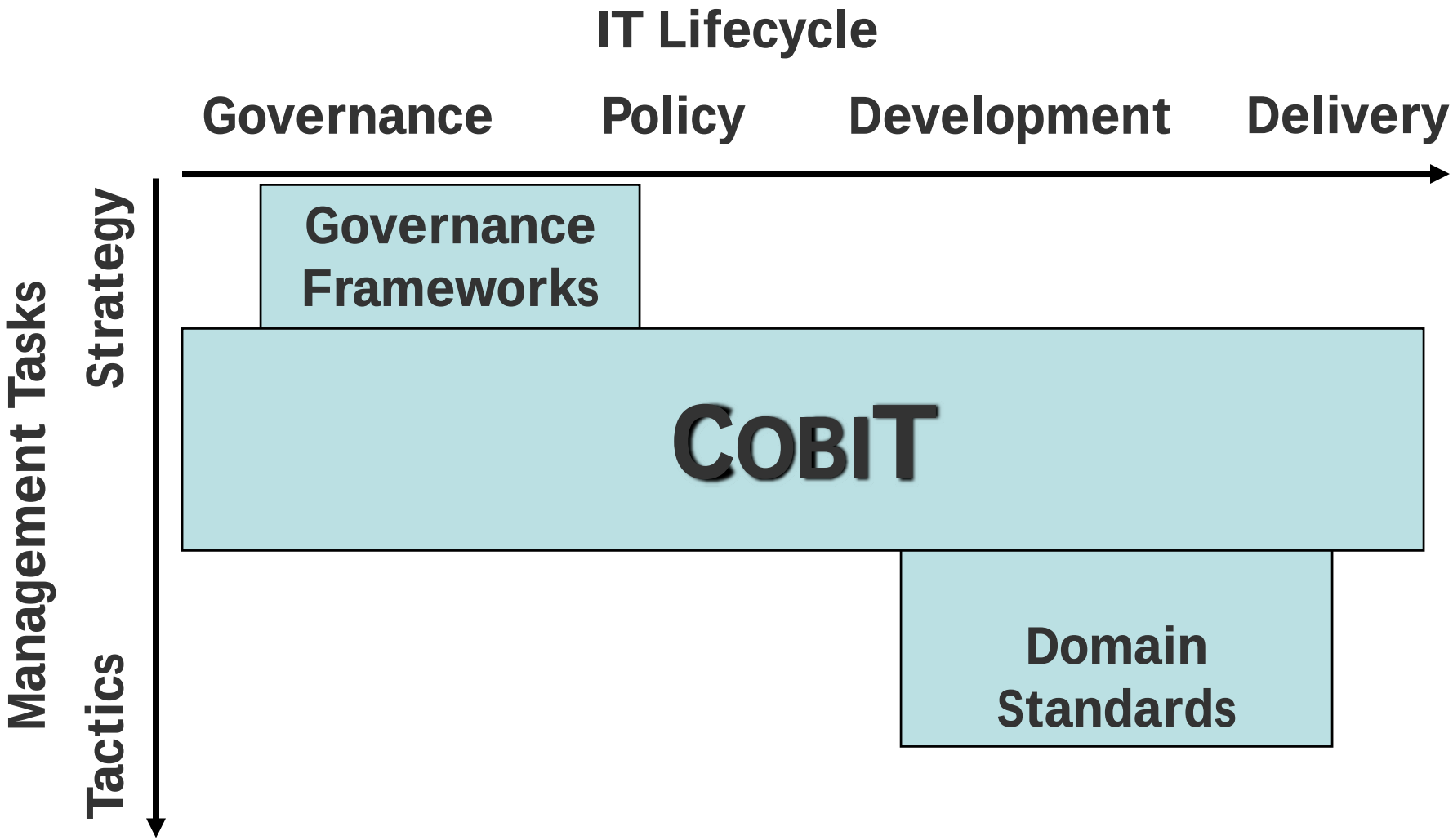
Questions?

Backup

ISO 9001 Quality Management System

- **Quality management principles**
  - **Customer focus**
  - **Leadership**
  - **Involvement of people**
  - **Process approach**
  - **System approach to management**
  - **Continual improvement**
  - **Factual approach to decision making**
  - **Mutually beneficial supplier relationships**

Where CobiT fits…

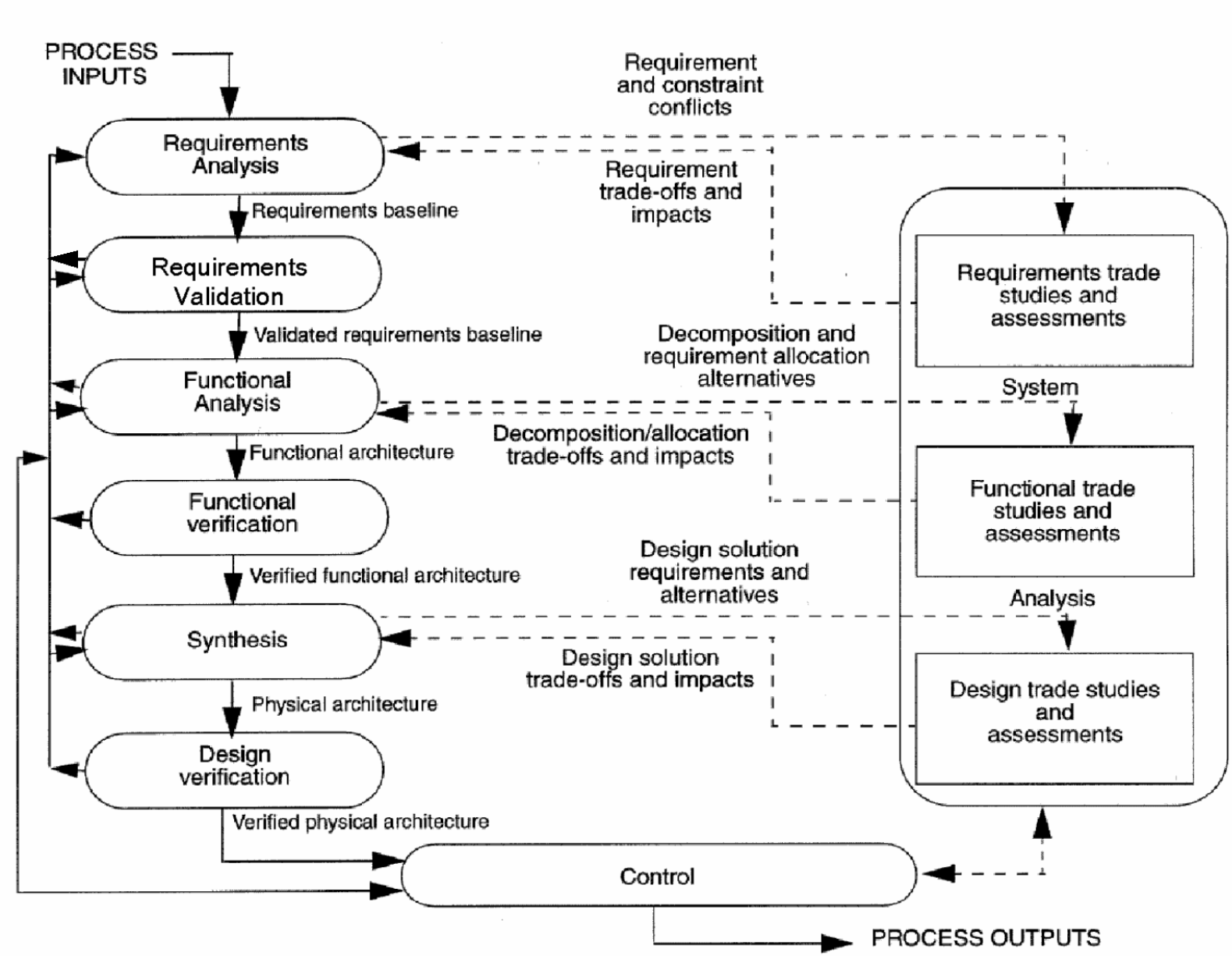


Debbie Lew, CISA, Ernst & Young, LLP
[Member, CobiT Steering Committee]

Development Life Cycle Model steps, IEEE 1074

- Selection of Development Life Cycle Model
- Tailoring of existing software & system engineering processes to create Project Development Life Cycle
- Development of project schedules of major artifacts and project roles
- Project members assigned to roles
- Project members create, review, revise, and transmit project artifacts to other project members or stakeholders. The work products or artifacts can be:
  - Process & product records, as simple as process start and end dates
  - Documents to share or review with team members or the customer
  - Final artifacts are customer deliverables, installations, and / or training
- Project artifacts are stored and managed as part of the project configuration management system
- Engineering processes & associated artifacts can be assessed

IEEE 1220 Systems engineering process



CMMI-DEV Product Suite

- Provides a set of best practices structured around the concept of a capability maturity model for organizations which produce products
- Set of appraisal methods
- Training courses.
- Provide a framework for organizations striving to improve their product development capabilities.
- Applicable to the development of products which contain one or more of the following elements – hardware, software, firmware and people.

CMMI-DEV

- *Process areas (or PAs)*
  - The primary structural element of a CMMI model
  - Composed of best practices which, when implemented result in satisfaction of associated goals for that process area.
  - Structure is common and includes required, expected and informative components
- *Capability Levels*
  - Each of the six capability levels represents a plateau of capability associated with a particular process area
- *Maturity Levels*
  - Each of the five maturity levels represents a plateau of organizational capability for developing products
- *Institutionalization*
  - Ingrained way of doing business that an organization follows routinely as part of its corporate culture
    - **The process is ingrained in the way the work is performed and there is commitment and consistency to performing the process.**
  - Generic Practices (GP) describe activities that address these aspects of institutionalization.
  - Progression of process institutionalization

CMMI-DEV Appraisal

- Examination of product development processes
- By a trained team of engineering professionals
- Using CMMI-DEV process reference model
- Reviews and/or collects objective evidence
- Determines of extent of practice implementation
- For identifying process strengths and weaknesses

CMMI Appraisals Published

Software Engineering Institute | Carnegie Mellon

Published Appraisal Results

Click the column header to sort by Organization, Organizational Unit, Team Leader, Sponsor, End Date, or Maturity Level.
Click the Maturity Level or Appraisal Year to filter the list.

Filter
Maturity Level: All MLs ML 2 ML 3 ML 4 ML 5 not given
Appraisal Year: All Years 2003 2004 2005 2006 2007

Organization - Organizational Unit	Team Leader - Sponsor	Appraisal End Date	Maturity Level - Representation
WIPRO Corporation - Wipro Infotech: Business Solutions Division	SanthanakrishnanSrinivasan - Rajat Mathur	Aug 14, 2003	ML: 5 - Staged
Wipro Technologies - Wipro Technologies Limited, SJPR Road, Bangalore	KrishnamurthyKothandaraman - Sambuddha Deb	Dec 22, 2006	ML: 5 - Staged
WISCO Engineering Technology Group Auto Co. Ltd. - WISCO Engineering & Technology Group Automation Company, Ltd.	RalphBowden - Bo Huang	May 30, 2006	ML: 3 - Staged
WISCOM SYSTEM CO.,LTD. - Wiscom System CO.,LTD.	WanJuyong - Chao Guo	Dec 15, 2006	ML: 3 - Staged
Wistron Information Technology and Services (Beijing), Inc. - Wuhan Software Development Center	EmanuelBaker - Yu Yang	Jan 28, 2005	ML: 3 - Staged
Wolters Kluwer - Corporate Legal Services - CT Corporation & CCH CORSEARCH	MichaelD'Ambrosa - Chris Jutkiewicz	Sep 30, 2005	ML: 2 - Staged
Wolters Kluwer - Corporate Legal Services - UCC Direct Services	MichaelD'Ambrosa - Chris Jutkiewicz	Nov 14, 2006	ML: 2 - Staged
Woori Finance Information System (WFIS) - Woori Finance Information System (WFIS)	SoowanLee - Jong Shik Kim	Nov 24, 2006	ML: 3 - Staged
World Information Technology -	SeshadriVenkatesan -	[illegible]	ML: 2 -

SEI Appraisal Program http://sas.sei.cmu.edu/pars/pars.aspx