

CZ3002 -

Advanced Software Engineering

2nd Half of the Semester

Capability Maturity Model Integration (CMMI)

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Introduction: Lesson Objectives

At the end of the lesson, you should be able to:

- ▶ Identify the **newer direction** of software engineering discipline: a focus of **processes**
- ▶ Identify **models** of processes and quality used in software engineering
- ▶ CMMI
 - ❖ Outline the **history** of Capability Maturity Model Integration (CMMI)
 - ❖ Describe the **composition** of CMMI
 - ❖ Understand the **definition** of CMMI
 - ❖ Explain the purpose of CMMI and its **benefits**
 - ❖ Describe the **maturity level characteristics**



Background on software engineering processes

- ▶ Emergence of Process-based Software Engineering (versus technical focused)
- ▶ Begin from study of **software processes** to establish the foundations of continuous **improvement** of such processes (Gilb, 1988; Humphrey, 1989 etc.) and of ordinal **scales** for measuring their maturity as the results of improvement
 - ❖ Principles of Software Engineering Management. Tom Gilb. Addison -Wesley, Jan 1, 1988
 - ❖ Managing the **Software Process**. Watts S. Humphrey. January 11, 1989
- ▶ Grow into formal models of **software engineering process maturities/capabilities** with definitions of key actions or measurement categories to advance: CMM & ISO 9000 marks as a new discipline (also known as process-based software engineering)

CMM Model

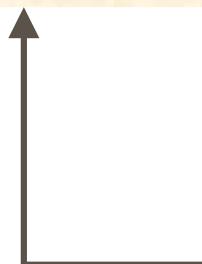
- SEI
- 18 key practice areas
- Correspondingly 5-level process capability scale

ISO 9001/ ISO 9000-3 Model

- International Organisation for Standardisation (ISO)
- Requirements for QM, QA systems
- 20 areas, 177 management issues

BOOTSTRAP Model

- BOOTSTRAP Institute
- **Extension** of CMM, 3 categories, 201 quality system attributes



ISO/ IEC 15504 (SPICE) Model

- ISO/IEC
- Separate **process** dimension from **capability** dimensional
- 5 categories, 35 processes, 201 base practices

SEP RM: Software Engineering Process Reference Model

- Complete process reference model

History of CMMI and SEI

Characterising the software Process: A Maturity Framework" Watts Humphrey. IEEE Software

Managing the Software Process
Watts Humphrey

Key Practices of the Capability Maturity Model for Software V1.1
Paul et al.

SEI-93-TR-25

Key Practices of the Capability Maturity Model for Software V1.0
Weber et al., CMU/ SEI-91-TR-25

Key Practices of the Capability Maturity Model for Software V1.1
Book Form

1987

1989

1990

1991

1993

1995

1996

2000

2002

Software Process
Assessment method commercialised

Software Capability Evaluation published

Systems Engineering CMM published (EIA 731)

CMM-Based Appraisal method published

SW-CMM V2 release delayed for CMMI effort

Acquisition CMM published

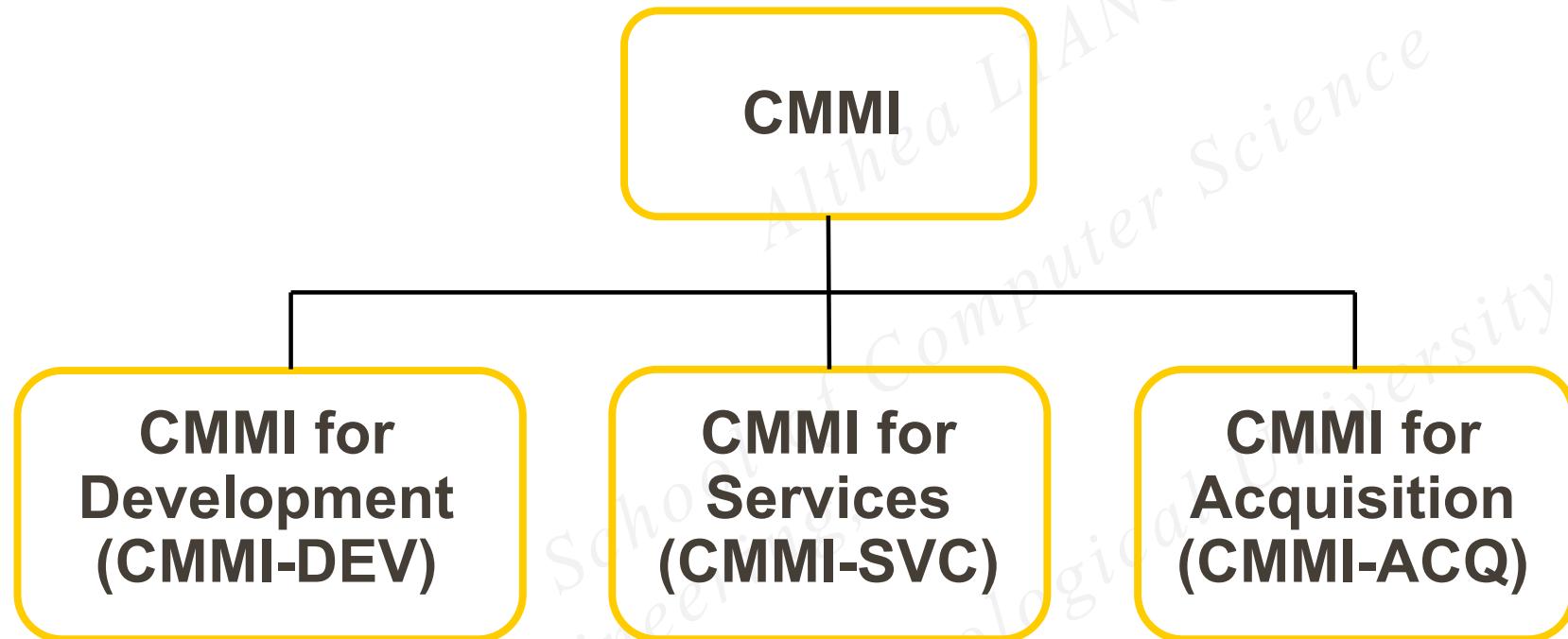
CMMI V1.0

CMMI V1.1
Sunset SW-CMM

Highlights of History

- ▶ First one was initially just called CMM; then called “CMM for Software” (SW-CMM); now called CMMI (CMM Integration) V1.3
- ▶ By 2013, Transferred from SEI to CMMI Institute at Carnegie Mellon University
- ▶ Other SEI Capability Maturity Models:
 - ❖ SE-CMM (Systems Engineering)
 - ❖ SSE-CMM (Security Systems Engineering)
 - ❖ SA-CMM (System Architecture)
 - ❖ P-CMM (People)
 - ❖ Team-CMM
 - ❖ Other CMM models

CMMI Composition -1



CMMI Composition -2

CMMI-DEV

- Product and service development

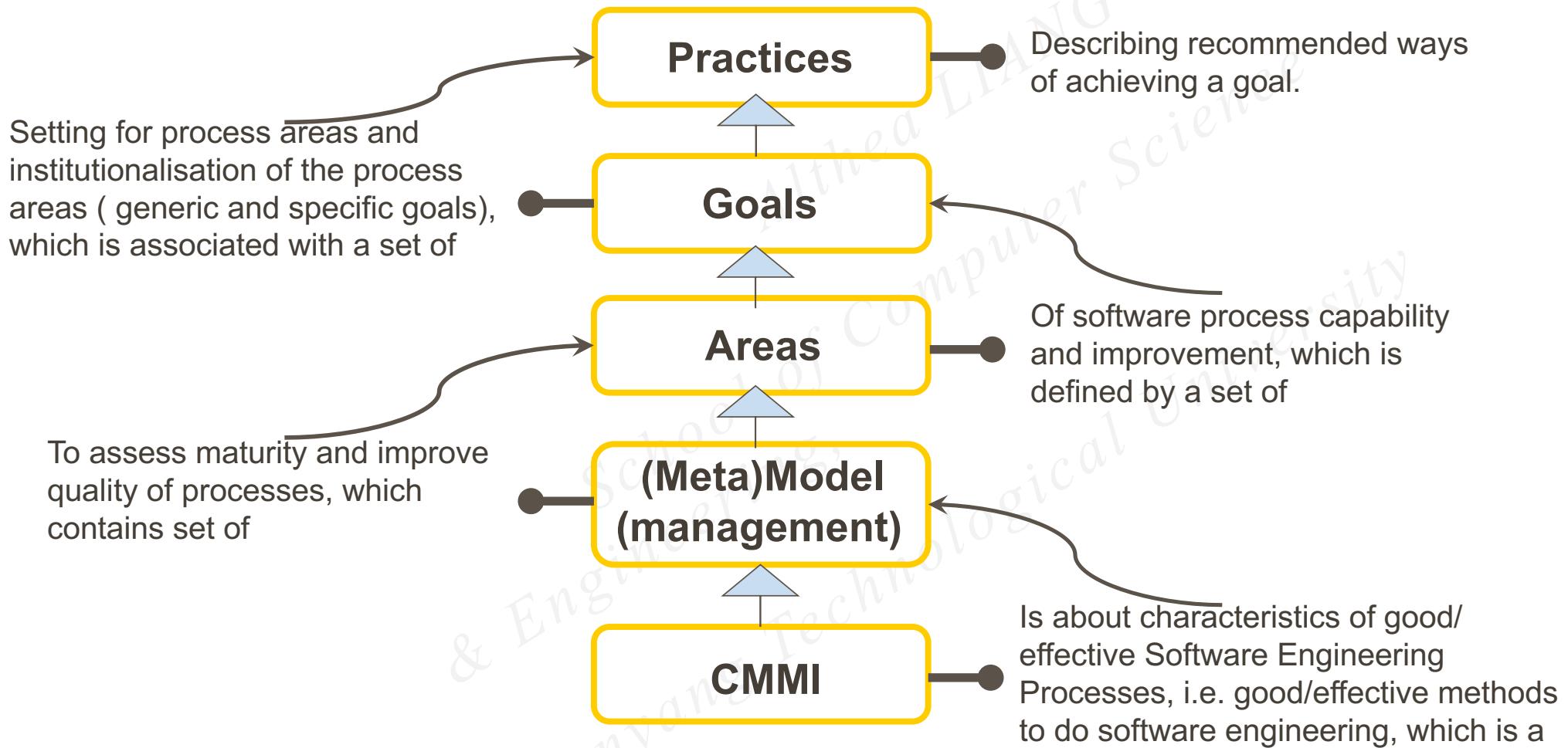
CMMI-SVC

- Service establishment, management

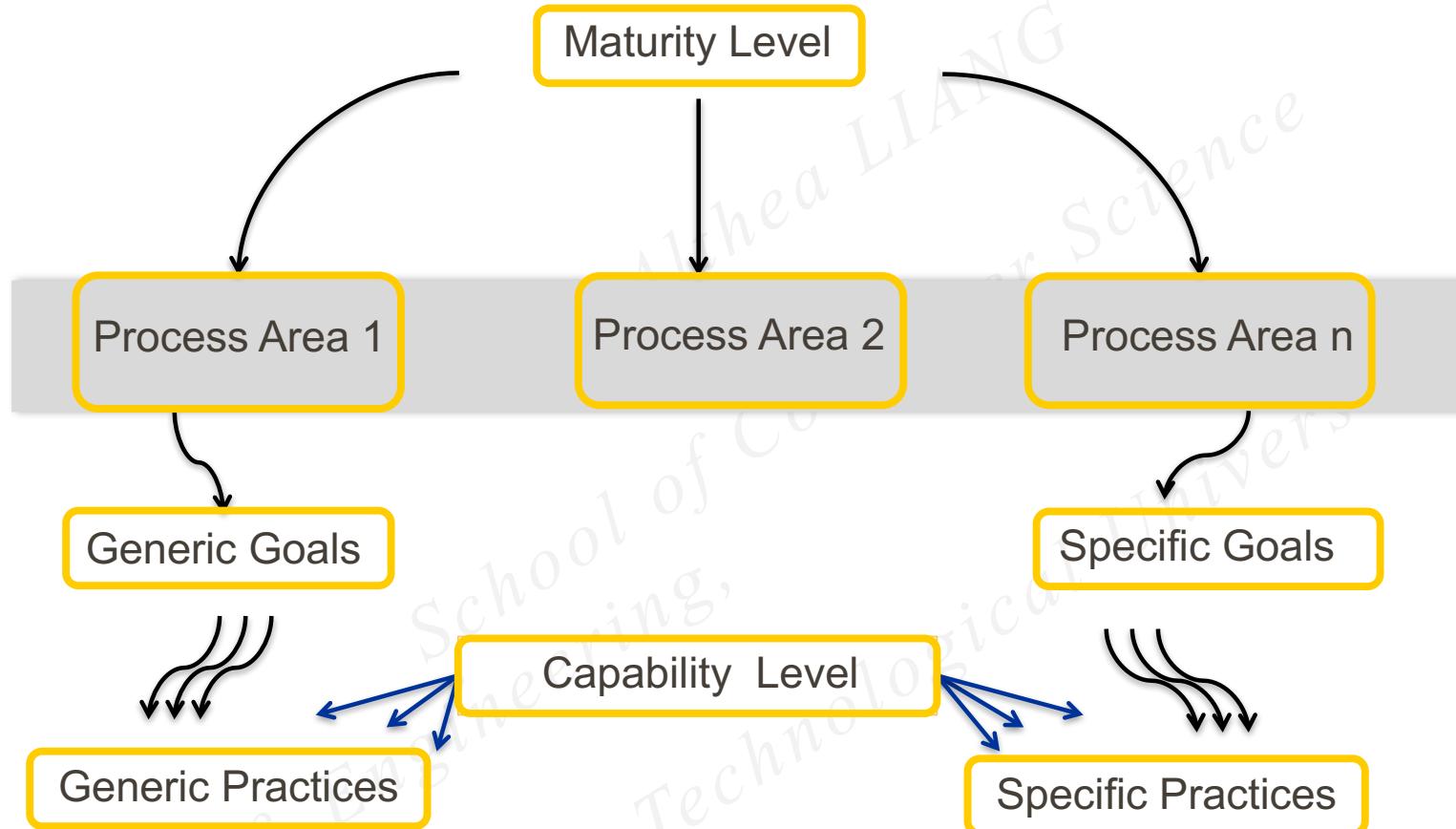
CMMI-ACQ

- Product and service acquisition

Definition of CMMI -1



Definition of CMMI - 2



Categories of Process Areas (V1.3)

Category	Process Areas
Process Management	Organisational Process Focus Organisational Process Definition Organisational Training Organisational Process Performance Organisational Innovation and Deployment
Project Management	Project Planning Project Monitoring and Control Supplier Agreement Management Integrated Project Management for IPPD Risk Management Integrated Teaming Integrated Supplier 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 Organisational Environment for Integration Causal Analysis and Resolution

Why is CMMI Useful ? -1

- ▶ “All models are wrong, but some are useful”
 - ❖ George Edward Pelham Box (October 18, 1919 – March 28, 2013) was a British mathematician and professor of statistics at the University of Wisconsin, and a pioneer in the areas of quality control, time series analysis, design of experiments and Bayesian inference.
- ▶ CMMI useful: Nature of good processes
 - ❖ Standard
 - ❖ Repeatable or managed
 - ❖ Defined
 - ❖ Quantitatively managed
 - ❖ Optimizing

Why is CMMI Useful ? Organisational Maturity

- ▶ From Good Processes to Mature Organisations
 - ❖ Work carried out according to **planned** process
 - ❖ Clearly defined **roles and responsibilities**
 - ❖ **Managers monitor** quality of software products and customer satisfaction
 - ❖ **Quantitative basis** for judging quality and analysing problems
 - ❖ Schedules & budgets based on past performance
 - ❖ Performance **measures** usually achieved

Benefits of CMMI

► Improvement

- ❖ Moving from Level 1 to Levels 2 and 3
 - Estimated vs. Actual Cost and Schedule have been shown to get very close at Level 3
 - Productivity improvement can be 100 - 200%
 - Post-release defects can be reduced by 10% - 94%
- ❖ Can take 1-2+ years to move up a Level

► Appraisal

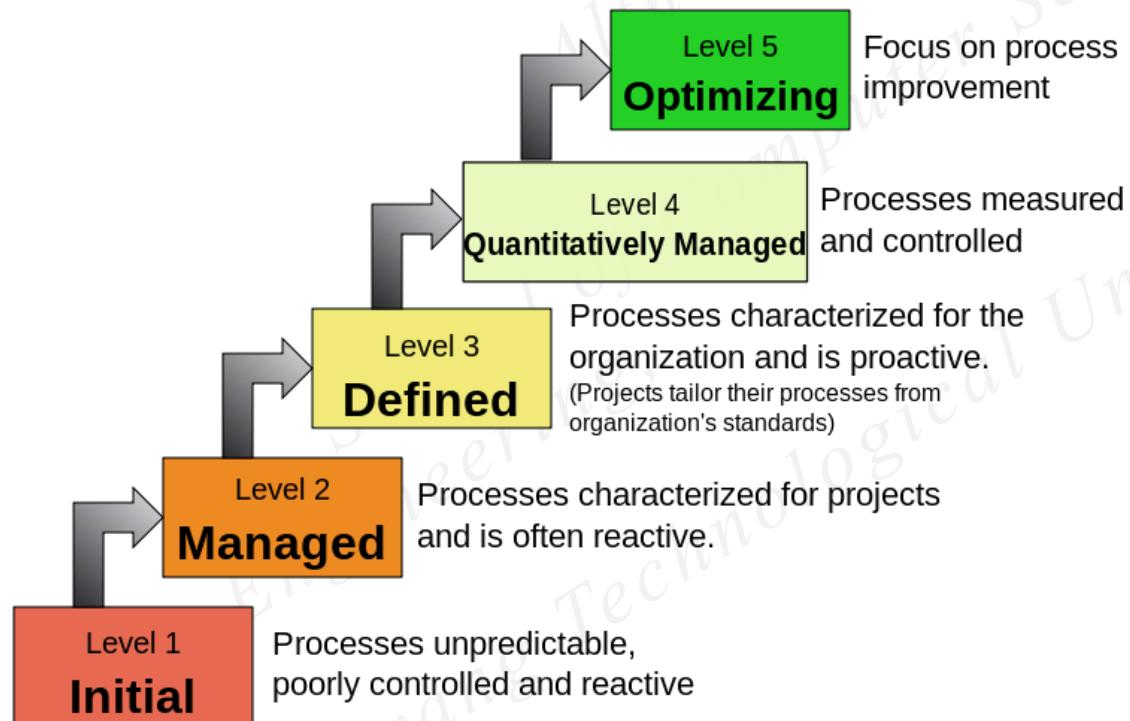
CMMI Maturity Level Overview

LEVEL	CHARACTERISTIC	KEY PROCESS AREA	RESULTS
5 Optimizing	Improvement fed back into process	Process change management Technology innovation Defect prevention	Productivity and quality
4 Managed	(Quantitative) Measured process	Quality management Process measurement & analysis	
3 Defined	(Qualitative) Process defined and institutionalized	Peer reviews Intergroup coordination Software product engineering Integrated software management Training program Organization process definition Organization process focus	
2 Repeatable	(Intuitive) Process dependent on individuals	Software configuration management Software quality assurance Software project tracking & oversight Software subcontract management Software project planning Requirements management	
1 Initial	(Ad hoc/chaotic)	Survival	

CMMI Maturity Level Characteristics

- ▶ [Sally Godfrey (2008) What is CMMI ?. NASA presentation]

Characteristics of the Maturity levels



CMMI Maturity Levels in Industry

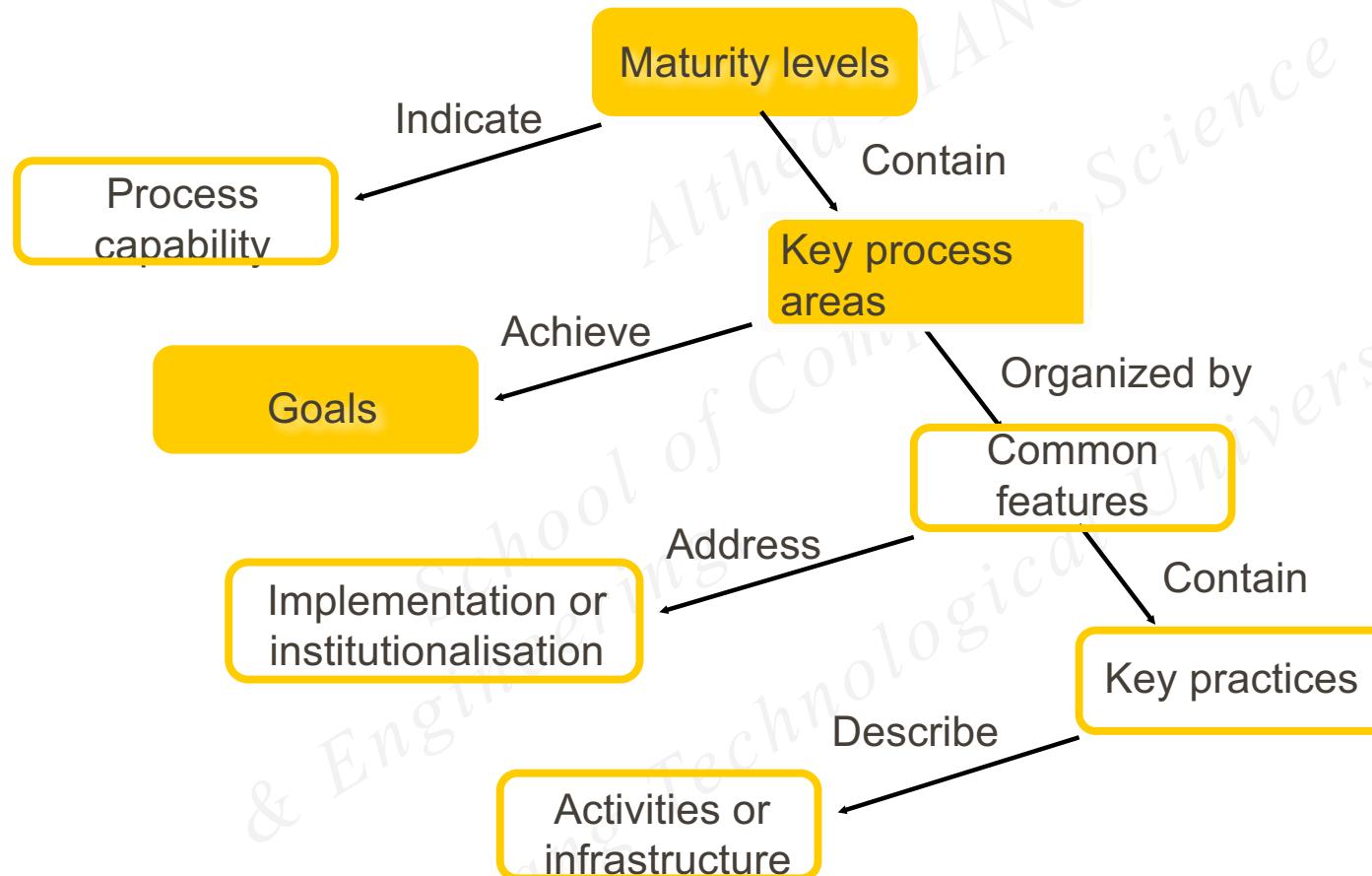
~73 - 80% at Level 1
~10-15% at Level 2 & 3
~1-3% at Levels 4 or 5

- ▶ Often, an organization's processes are at different maturity levels.
- ▶ Often, different projects within the organization are at different levels.
- ▶ A specific Level (other than 1) cannot be attached to an organization until all key process areas are stable at that particular level.

Eight-Step Process Improvement Model

- 1 • Define the problem
- 2 • Identify, analyze, and document process
- 3 • Measure current performance
- 4 • Understand why process is performing as is
- 5 • Develop alternative solutions and select best
- 6 • Develop strategy for implementation and implement chosen solution
- 7 • Evaluate results of new process
- 8 • Commit to continuous improvement of process

Defining your CMMI Level for your project in Labs



Common Features

- ▶ **Commitment to Perform** (e.g. organisational policies, senior management sponsorship)
- ▶ **Ability to Perform** (e.g. resources, training, organisational structures, tools)
- ▶ **Activities Performed** (e.g. plans & procedures, performing the work, tracking it, taking corrective action as necessary)
- ▶ **Measurement and Analysis** (e.g. examples of the measurements that could be taken to determine status and effectiveness of the activities performed feature)
- ▶ **Verifying Implementation** (e.g. reviews and audits by management and SQA)

Extra Reading Slides on Process Areas for Individual Maturity Levels

Summary

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Special Thanks to Kydon during the TEL Efforts of the Lecture

End of CMMI

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