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Nicolas Tremblay, Eng., M. Eng.

Implementing systems engineering and project management processes at CSiT, a Canadian company in the transit industry

Overview and Results Achieved

Agenda

- Who is CSiT?
- ISO/IEC 29110 Systems Engineering
- Implementation of ISO/IEC 29110 at CSiT
- Third Party Process Audit
- Benefits to CSiT
- Next steps
- Summary
- Question period

Who is CSiT?

- CSiT is a Canadian company
- Established in 2011 in Montreal
- Provides multi-modal solutions to the transit industry worldwide
  - Information Systems
  - Information Integration
  - Integrated Communications Systems
- Develops a line of product called TRANSIS
  - designed for Smart Cities
- Innovation with common system for
  - Control Center
  - Stations and Interactive Kiosks
  - Trains, Buses
  - Web, Mobile

TRANSIS in action

nn Station)

CSiT - Reasons to implement processes and quality system

Motivations

- Systematic work, disciplined and quantifiable, typical of engineering environments;
- Greater credibility to bid on tenders;
- Reduction of long-term production costs;
- Improved efficiency and business productivity;
- Formalization of the management of agreements with suppliers;
- Increase competitiveness

- Public transportation customers often require a CMMI® maturity level for system and sub-system suppliers
  - e.g. CMMI Level 2

- In 2012, CSiT was composed of 4 people
  - Implementing the CMMI® Level 2 Process Areas was too demanding at that time.

ISO/IEC 29110

- New sets of Standards and Guides
- Designed for Very Small Entities (VSEs)
- Available in 4 profiles (Entry, Basic, Intermediate, Advanced)
- Provides Deployment Packages to facilitate the implementation of a set of practices

Very Small Entity (VSE)

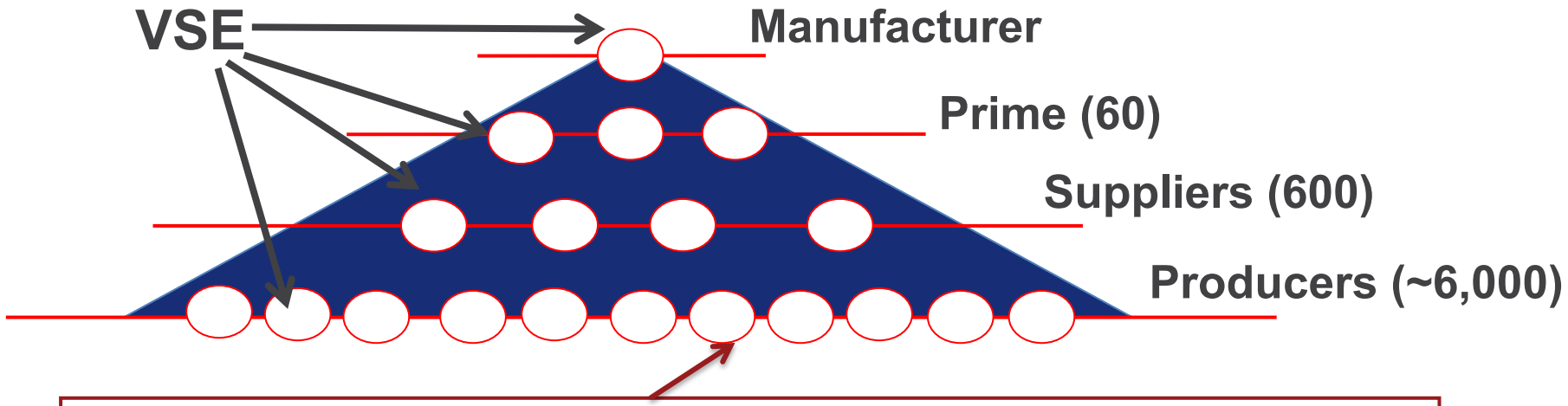
Enterprise, organization (e.g. public or non-profit organization), project or department having up to 25 people

Systems

Systems, in the context of ISO/IEC 29110, are typically composed of hardware and software components.

The Importance of VSEs in System Engineering

- Industry recognizes that VSEs make valuable products and services
- VSEs develop and maintain systems and software used in larger systems
- There is a need to recognize VSEs as suppliers of high quality systems and software



A defect from one of the producers went into a product and resulted in a loss of over $200 million by the manufacturer

There are VSEs in most organizations

Adapted from (Shintani 2006)

Size of Enterprises

European Union

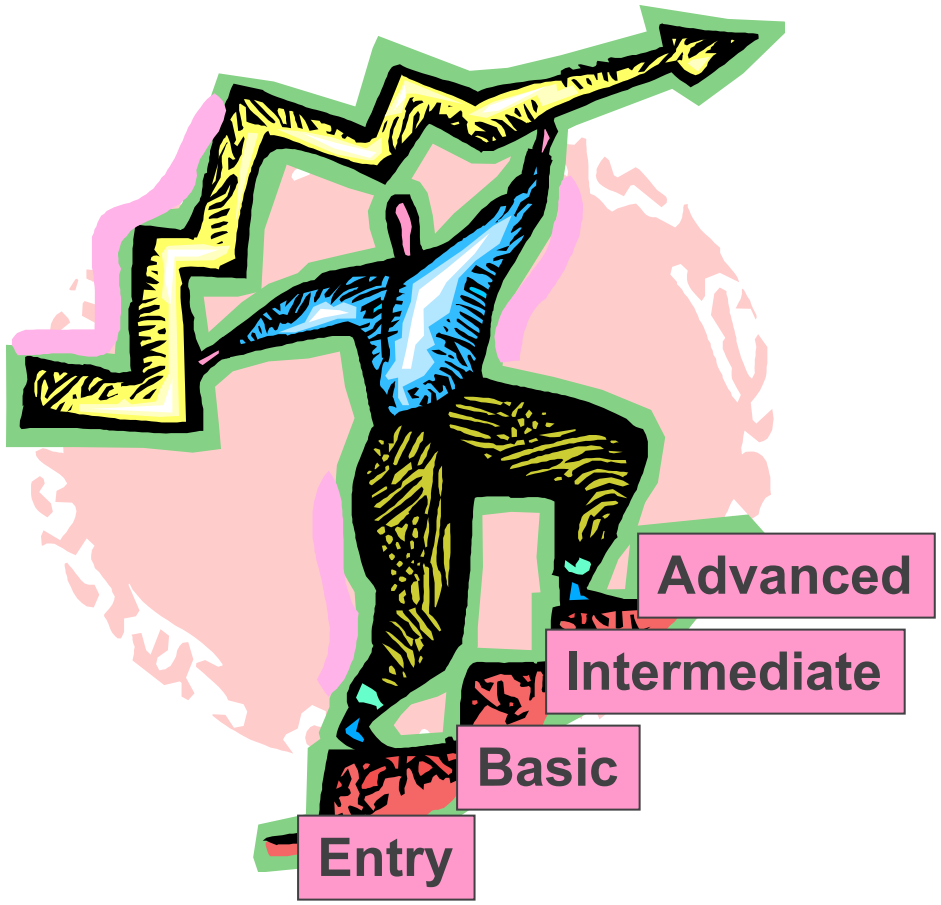
Type of enterprise	Number of employees	Annual turnover (EUR)	Number of enterprises (% of overall)	Number of enterprises
Micro-enterprises	1 - 9	≤ 2 million	92.2 %	19 968 000
Small enterprises	10 - 49	≤ 10 million	6.5 %	1 358 000
Medium enterprises	50 – 249	≤ 50 million	1.1 %	228 000
SMEs, total	87 100 000		99.8 %	21 544 000*
Large enterprises	> 250	> 50 million		
Large enterprises, total	42 900 000		0.2 %	43 000

* Independent companies only, excluding legally independent companies that are part of large enterprises.

- Micro-enterprises account for 70% to 90% of enterprises in OECD** countries (about 95% in USA***)

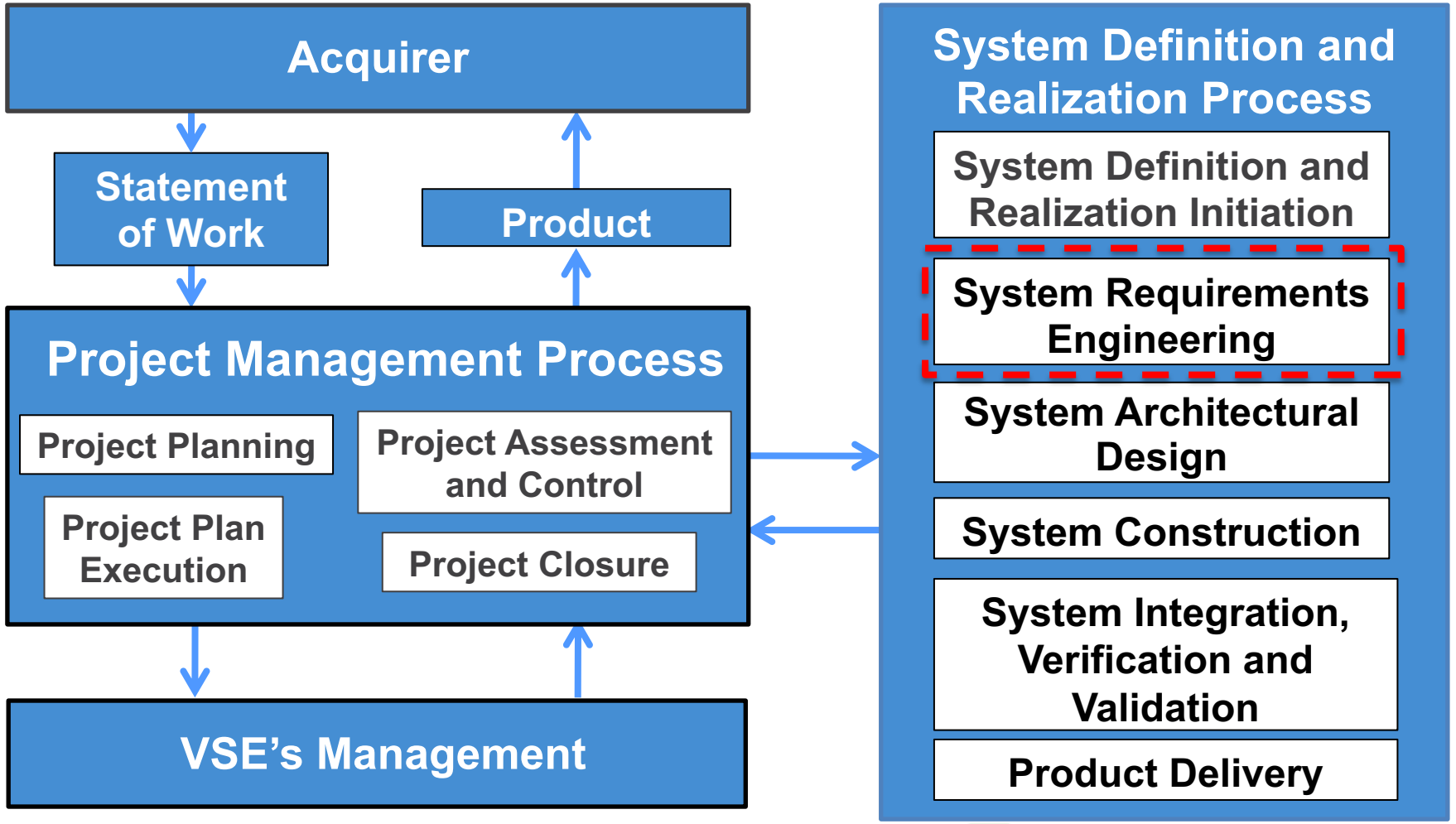
* Moll, R., Being prepared – A bird's eye view of SMEs and risk management, ISO Focus, February 2013
** OECD: Organisation for Economic Co-operation and Development
*** Statistics About Business Size (including Small Business). US Census Bureau(www.census.gov/econsmallbus.html).

ISO/IEC 29110 - The Generic Profile Group for Developers of System/Software



- **Advanced** – Targets VSEs which want to sustain and grow as an independent competitive system or software development business
- **Intermediate** – Targets VSEs involved in the development of more than one project in parallel with more than one work team
- **Basic** – Targets VSEs developing a single product by a single work team
- **Entry** - Targets VSEs typically developing 6 person-month projects or start-ups

ISO/IEC 29110 - System Engineering Basic Profile



ISO/IEC 29110 - One Task of the System Engineering Requirements Activity

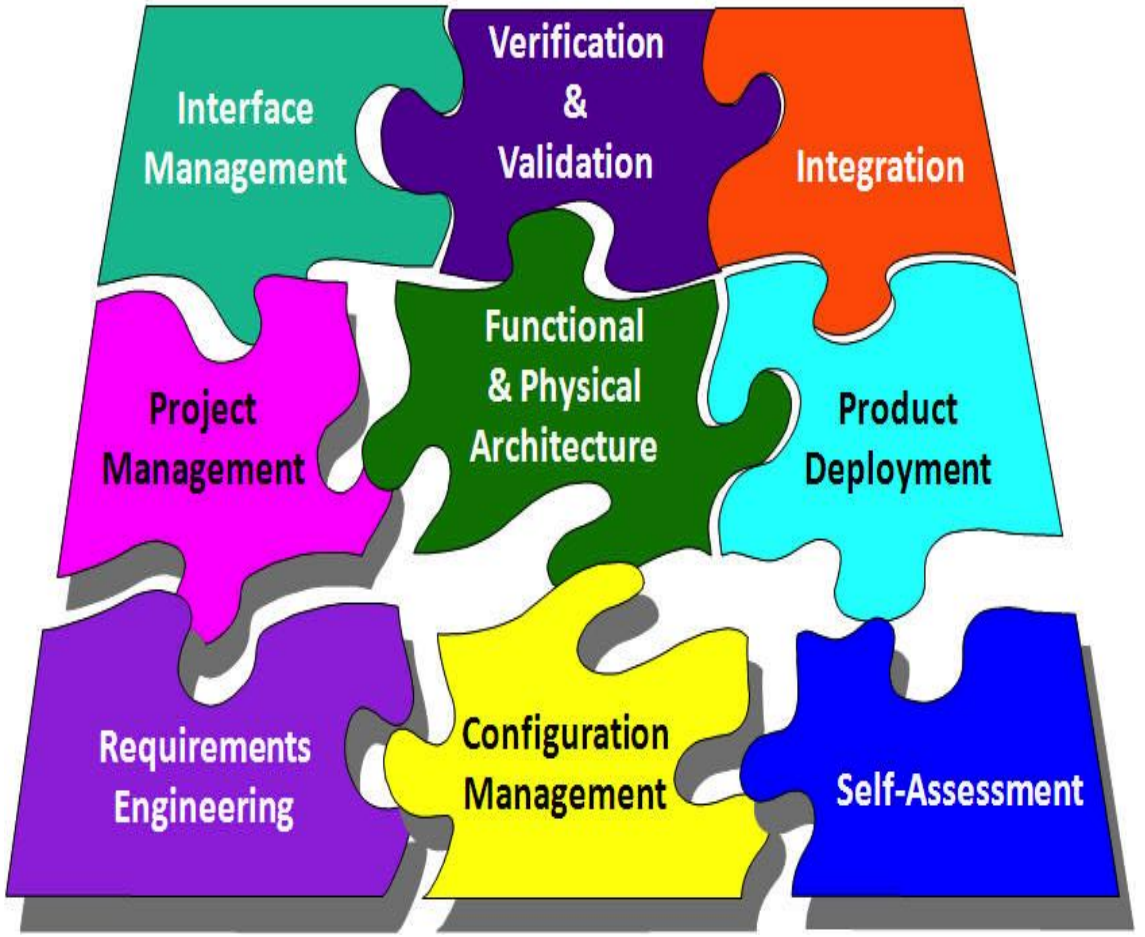
Role	Task	Input Products	Output Products
ACQ STK SYS	SR.2.7 Validate that System *Requirements Specifications* satisfies *Stakeholders Requirements Specifications*.	System Requirements Specifications [*verified*]	Validation Report • System Requirements Specifications [*published*]
	The results found are documented in a *Validation Report* and corrections are made until the document is approved by the SYS.	Stakeholders Requirements Specifications [*validated*]	System Requirements Specifications [*validated*]

ISO/IEC 29110 – Document Content

Name	Description	Source
Change Request	Identifies a Software, or documentation problem or desired improvement, and requests modifications. It ***may*** have the following characteristics: - Identifies purpose of change - Identifies request status - Identifies requester contact information - Impacted system(s) - Impact to operations of existing system(s) defined - Impact to associated documentation defined - Criticality of the request, date needed The applicable statuses are: *initiated, evaluated, and accepted*	Customer Project Management System Implementation

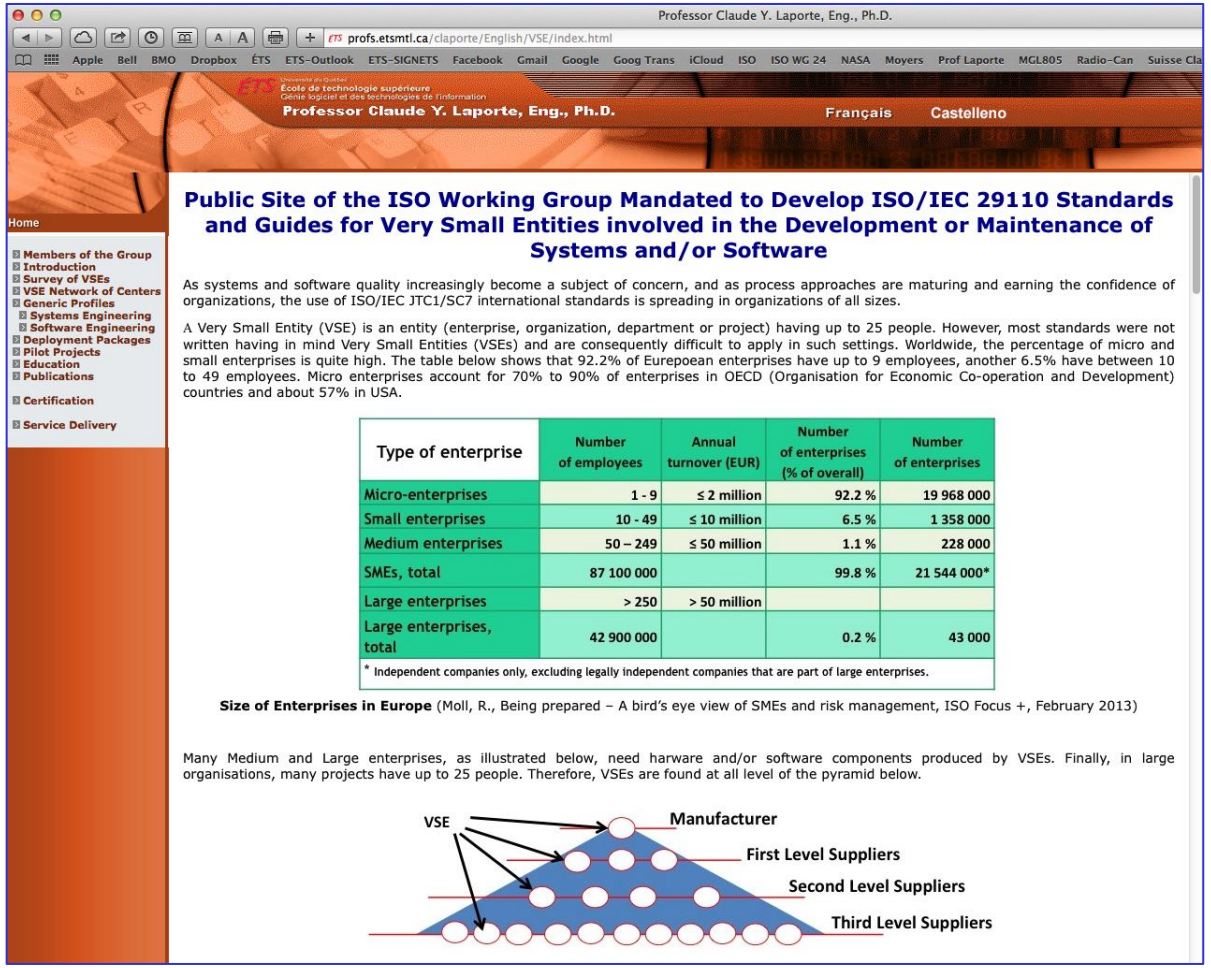
ISO 29110 – Deployment Packages for System Engineering

- The Deployment Packages have been developed to help implement the ISO 29110 processes
- Produced by members of INCOSE VSE Working Group



ISO 29110 Public Web Site

- Members of WG
- Introduction
- Survey of VSEs
- Network of Centers
- Generic Profiles
  - Systems engineering
  - Software engineering
- Deployment Packages
- Pilot Projects
- Education DPs
- Publications
- Certification
- Service Delivery



http://profs.logti.etsmtl.ca/claporte/English/VSE/index.html

– Strategy to implement ISO 29110

- Implement the Systems Engineering ISO 29110 Basic profile as a foundation
- Perform a gap analysis between CMMI-DEV Level 2 and the SE Basic Profile
- Structure practices to be in line with CMMI-DEV Level 2.

Guidelines for the Development of the processes

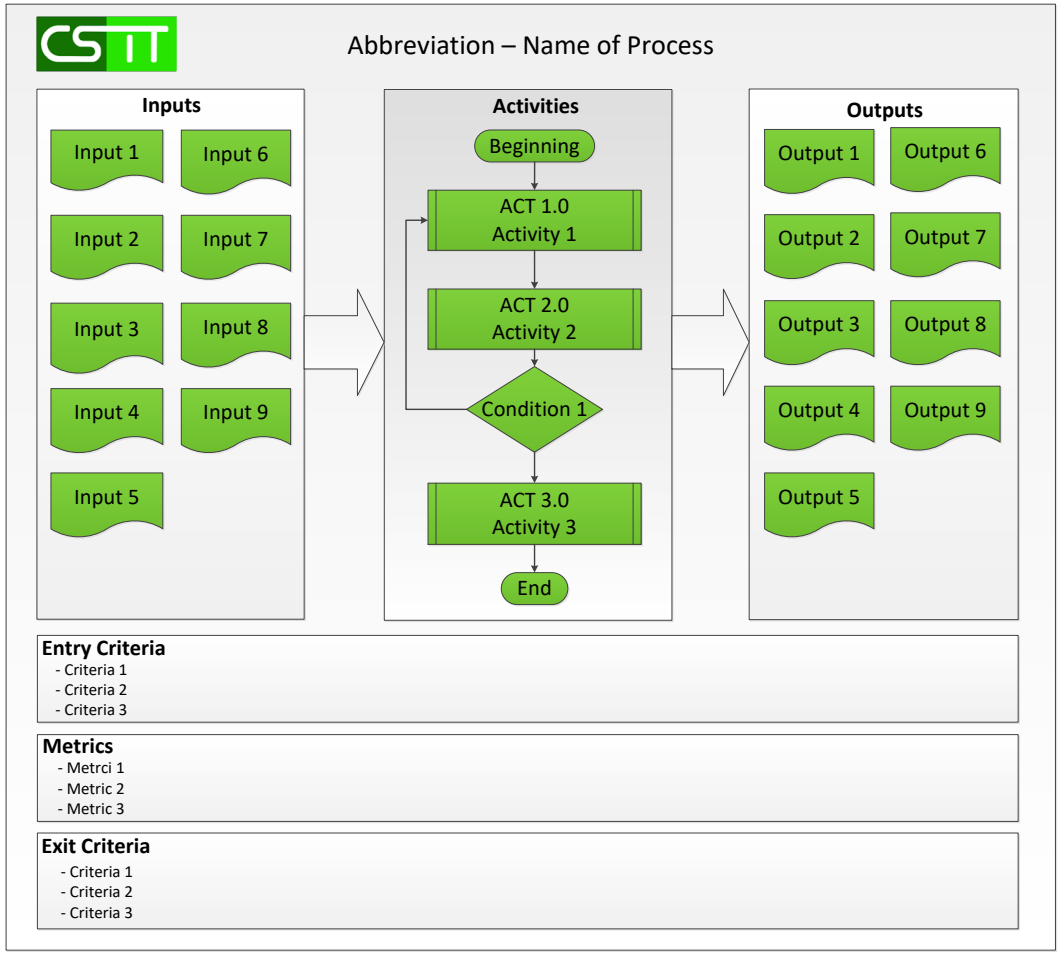
- To avoid producing too many documents, CSiT defined two sets of guidelines:

  - **Process guideline**
    - Add tasks, not described in the Basic profile, only if they add value to the context and projects of the company or if they provide an alignment with CMMI® level 2
      - Example: Supplier Agreement Management

  - **Document template guidelines**
    - Group different documents into one where this is possible
    - Each section of a template must be relevant and applicable

Graphical Documentation of Processes

- **Inputs/Outputs**
- **Entry/Exit Criteria**
- **Activities and Tasks**
- **Measures**



Textual Documentation of Processes

- Objective
- Rationale
- Role
- Inputs/Outputs
- Entry/Exit Criteria
- Activity and Task
- Measure

Name of Activity	
Objective:	
Rationale:	
Roles:	
Entry Criteria	•
	•
Inputs	
Outputs	
Exit Criteria	•
	•
Metrics	
Tasks	1. Task 1
	2. Task 2
	3. Task 3
	4. Task 4

Work Product V&V and Acceptance

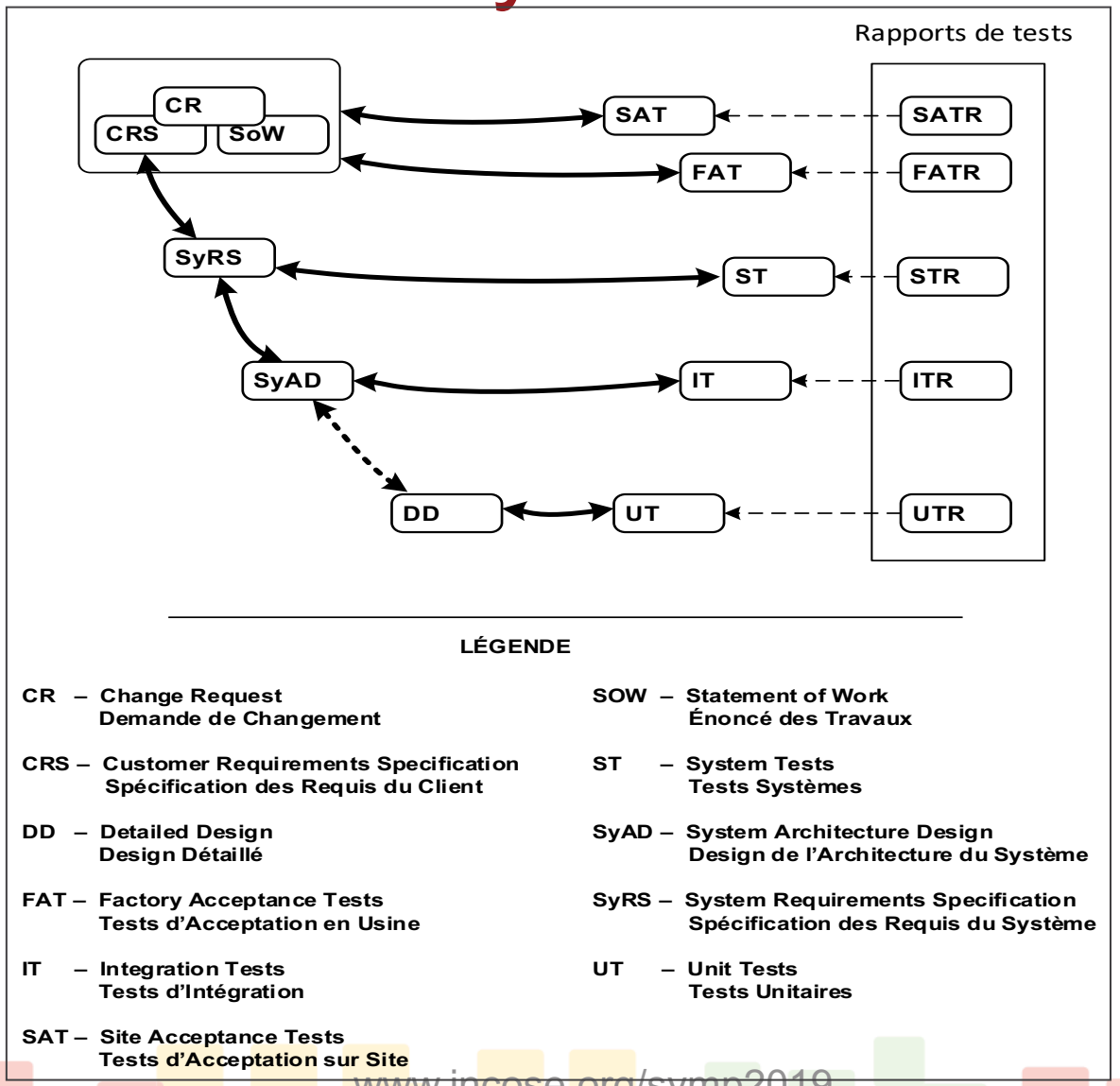
- Four types of reviews for internal work products and deliverables
  - Personal Review, Desk-Check, Walk-through, Inspection

	VERIFICATION					VALIDATION		ACCEPTANCE AND SIGNATURE		
Delivrables and Internal Work Products	**Peer Review**			**Tests**		**Tests**		**Acceptance**		
Description	**Peer Review ? (Y=Yes, N=No)**	**Type of Review (P=Personnal, D=Desk-Check, W=Walkthrough, I=Inspection)**	**Output Documents ANN = Annotations RR = Review Report MoM = Minutes of Meeting CHKL = Checklist**	**Type of Test U = Unit I = Integration S = System**	**Output Document UTR = Unit Test Report ITR = Integration Test Report STR = System Test Report**	**Type of Test F = Factory S = On Site**	**Output Document FTR = Factory Test Report STR = Site Test Report**	**Internal Approval (signature) (Y=Yes, N=No)**	**Delivered to Customer? (Y=Yes, N=No)**	**Acceptance required form Customer? (Y=Yes, N=No)**
Technical – System Requirement Specification	Y	D, W	RR then MoM	N/A	N/A	N/A	N/A	Y	Y	O
Technical – Software Requirement Specification	Y	D, W	RR then MoM	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – System Architecture Design	Y	D, W	RR then MoM	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – Software Architecture Design	Y	D, W	RR then MoM	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – Interface Control Document	Y	D	RR	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – Customer Requirements Specification	Y	D, W	RR then MoM	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – Factory Acceptance Test	Y	D	RR	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – Site Acceptance Test	Y	D	RR	N/A	N/A	N/A	N/A	Y	Y	Y
Technical – Drawing	Y	D	RR	N/A	N/A	N/A	N/A	N/Y	N/Y	N/N
...										
Project Management – Project Management Plan	Y	D	ANN and/or MoM	N/A	N/A	N/A	N/A	Y, First version	N/Y it depends	N
Project Management – Risk Register	Y	D	ANN and/or MoM	N/A	N/A	N/A	N/A	N	N	N
Project Management – Project Schedule	Y	W	MoM	N/A	N/A	N/A	N/A	N	N/Y	N/Y It depends
...										
User documentation – User Manual Installation	Y	D	RR	N/A	N/A	N/A	N/A	Y	Y	Y
User documentation – User Manual Operation	Y	D	RR	N/A	N/A	N/A	N/A	Y	Y	Y
User documentation – User Manual Maintenance	Y	D	RR	N/A	N/A	N/A	N/A	Y	Y	Y
...										
Product - Piece of software	Y	D	CHKL	U, I	UTR, ITR	N/A	N/A	N	N	N
Product - Piece of hardware	Y	D	CHKL	I	ITR	N/A	N/A	N	N	N
Product - System	Y	W, I	MoM	I, S	ITS, STR	F, S	FTR, STR	Y for UTR and STR	Y	Y

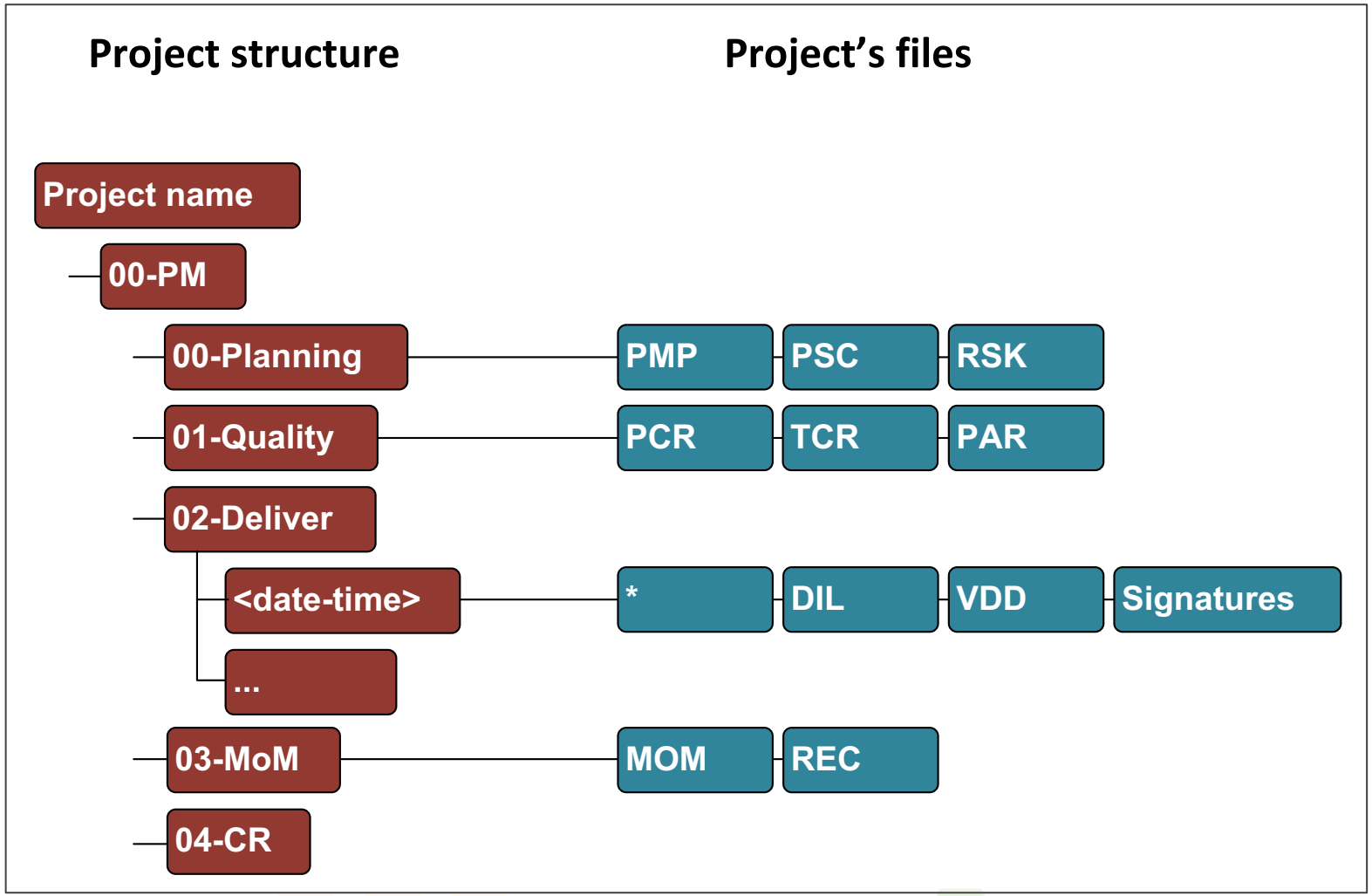
Selection and Definition of Measures

Measure ID	Measures	Reasons
MET-01	Number of errors detected by document type and by phase of the development cycle	To know the overall quality of each work product
MET-02	Number of hours worked for each phase of the system development cycle	To be able to use the performance of past projects to estimate new projects
MET-03	The cost of each project	
MET-04	The attributes of each project: • Number of change requests; • Level of risk; • Predominance hardware/software.	
MET-05	Distribution of effort related to the production, review and correction of deliverables	To be able to analyze the efficiency of processes on product quality
MET-06	Resources spent versus those that were planned in the project plan	To be able to analyze if the project is successful, to identify gaps and take the necessary remedial action

ISO 29110 Traceability Between Work Products



Documentation Structure in the CM Tool



Supplier Management Process

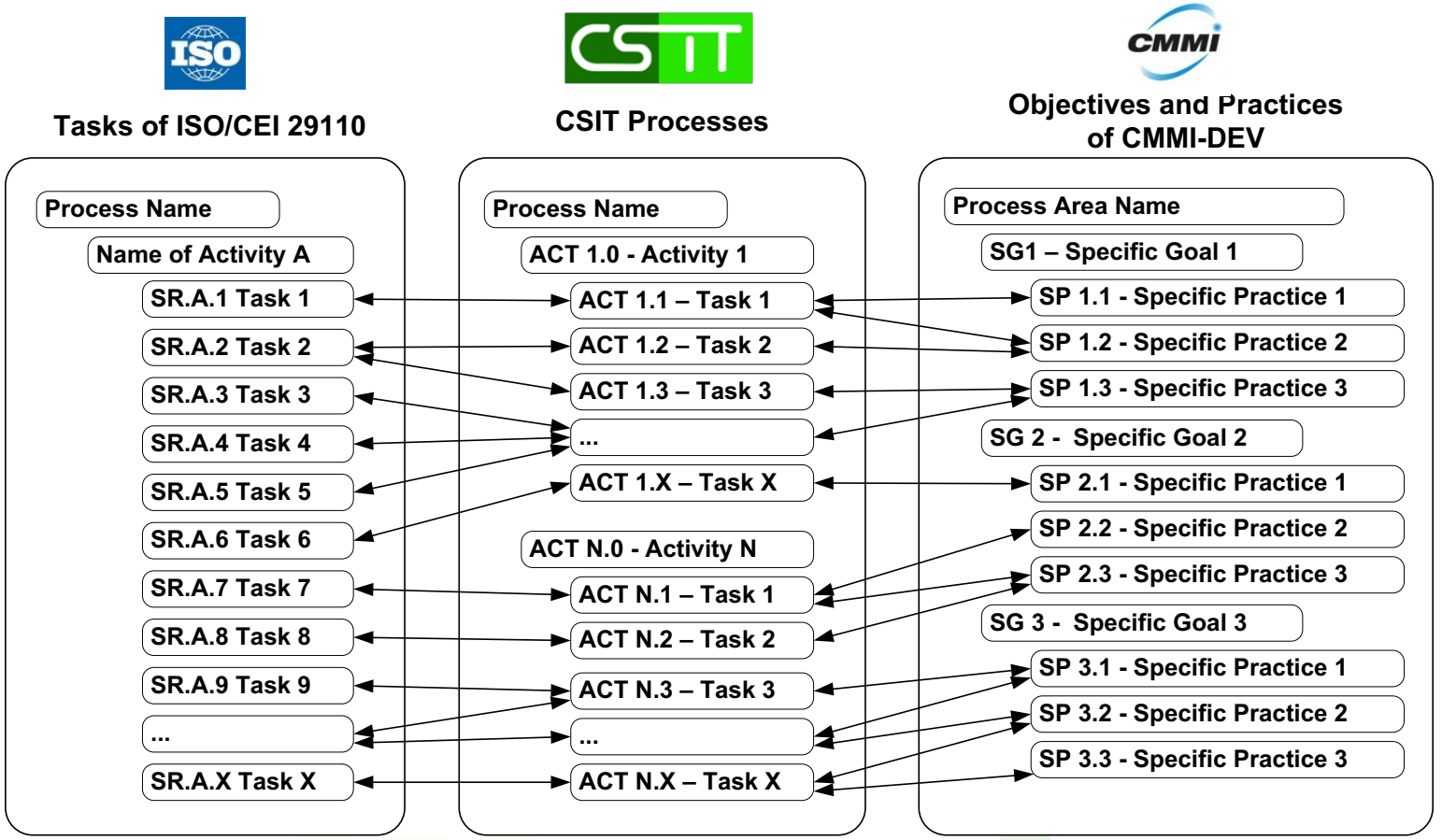
- ISO 29110 Systems engineering Basic Profile does not describe a Supplier Management process
  - This process is included in the Intermediate and Advanced profiles
- CSiT mostly integrates COTS hardware components
  - Supplier Management is key
- The supplier management process contains a detailed description about planning and managing acquisitions
  - New sections were added to the CSiT Project Plan
  - New templates were developed

Supplier Management Process

- New sections were added to Project Plan
  - List of acquisitions and potential suppliers
  - Acquisition plan/strategy
  - Supplier management plan
- Additional templates were created
  - Request For Proposal (RFP)
  - Supplier Selection Matrix
  - Purchase Order (PO)
  - Purchase Agreement

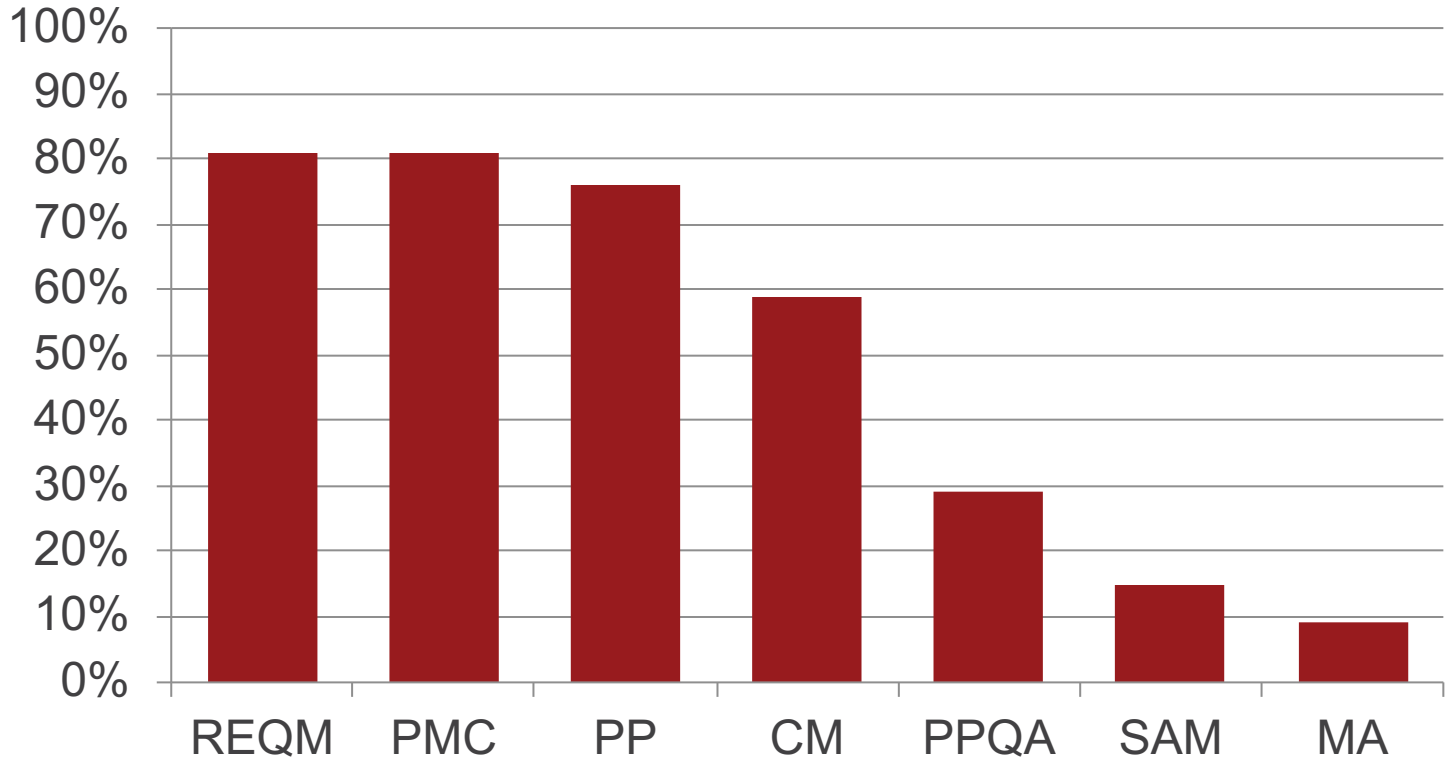
Mappings Between Frameworks

- Between ISO/IEC 29110 and CMMI-DEV



Mappings Between Frameworks

- Approximate coverage of CMMI-Dev Level 2 Specific Practices by ISO 29110 – Systems Engineering - Basic Profile

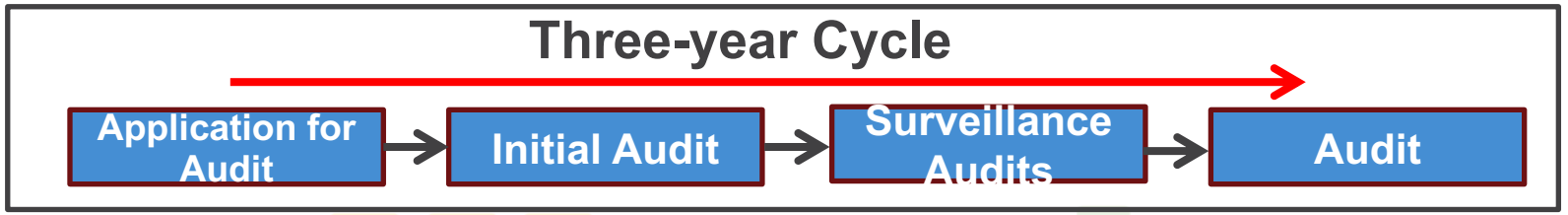


ISO/IEC 29110 Third Party Audit

- Audit requested by CSiT to obtain Letter of Conformity with ISO/IEC 29110 Systems Engineering Basic Profile

- Audit Steps
  - Initiation/revision and analysis of CSIT's process documentation by Auditor
  - Review of the documentation submitted by CSiT to the auditor
  - On-site audit was performed to review work product objective evidence by 2 auditors

- First CSiT Audit conducted successfully in Mid 2016
  - CSiT is audited every year since then



ISO 29110 Benefits

- **Day-to-day Benefits**
  - Standardized work and consistent deliverables across projects
  - Avoids ‘reinventing the wheel’ for each new project
  - Work is done in a systematic and disciplined way
  - Better quality of internal and external work products
  - Better project management and project monitoring
  - Reduction of project risks
  - Better communication within the team

- **Business Benefits**
  - Better credibility to bid on tenders
  - Access to markets that require demonstration of compliance to a process standard
  - Better recognition of the quality of work and products.
  - Better trust from customers and business partners
  - An important step towards a CMMI level 2

ISO 29110 Benefits

- **Holding a third-party audit <u>each year</u> allows CSiT to:**
  - Demonstrate the serious of the company's approach to its customers
  - Ensure constant discipline in the way of working
  - Improve the way of doing things based on the team's lessons learned as well as on the auditor's recommendations

- It has greatly helped CSiT to **become an <u>accredited suppliers</u> of goods and services** to one of the world's largest train operator (New York City Transit)

- It allowed CSiT to **bid on an RFP of a European customer** (Barcelona-based Transit Operator) that required certification from one of the 3 following standards: CMMI level 2, IEEE 15288 and ISO 29110

Next steps

- Take additional measures to improve decision-making
- Improve business processes
- Prepare for the next audit
- Develop process groups to meet the projects attributes such as the size and nature

Classification of CSiT processes

	Light Process	Standard Process	Full Process
Type of Project	Proof of Concept, Prototype Concept validation or Product Deployment at Customer Site **Small** Project	Typical Project Product intended to be installed at Customer Site **Medium** Project	Project when CMMI level 2 is required by a Customer Product Testing or Product Deployment at Customer Site **Large** Project
Framework to be used	ISO 29110 **Entry** Profile + CMMI - Supplier Agreement Management	ISO 29110 **Basic** Profile + CMMI - Supplier Agreement Management	**CMMI** (Level 2)

Summary

- ISO/IEC 29110 for SE Management and Engineering Guide is easy to understand and implement
  - Freely available from ISO
- A startup can apply proven engineering practices from ‘Big League’ standards (e.g. ISO 15288)
- ISO/IEC 29110 is a solid foundation for CMMI level 2
- CSiT has rapidly grown in maturity while preserving its agility
- VSEs developing systems should consider the adoption of ISO/IEC 29110


감사합니다
Natick
Grazie
Danke
Ευχαριστίες
Dalu
Obrigado
Thank You
Köszönöm
Tack
Спасибо
Dank
Gracias
谢谢
Merci
Seé
ありがとう

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