

Applying Systems Engineering from Startups to Grownups

Overview of the ISO/IEC 29110 and INCOSE SBSE Working Groups (SBSE-WG)

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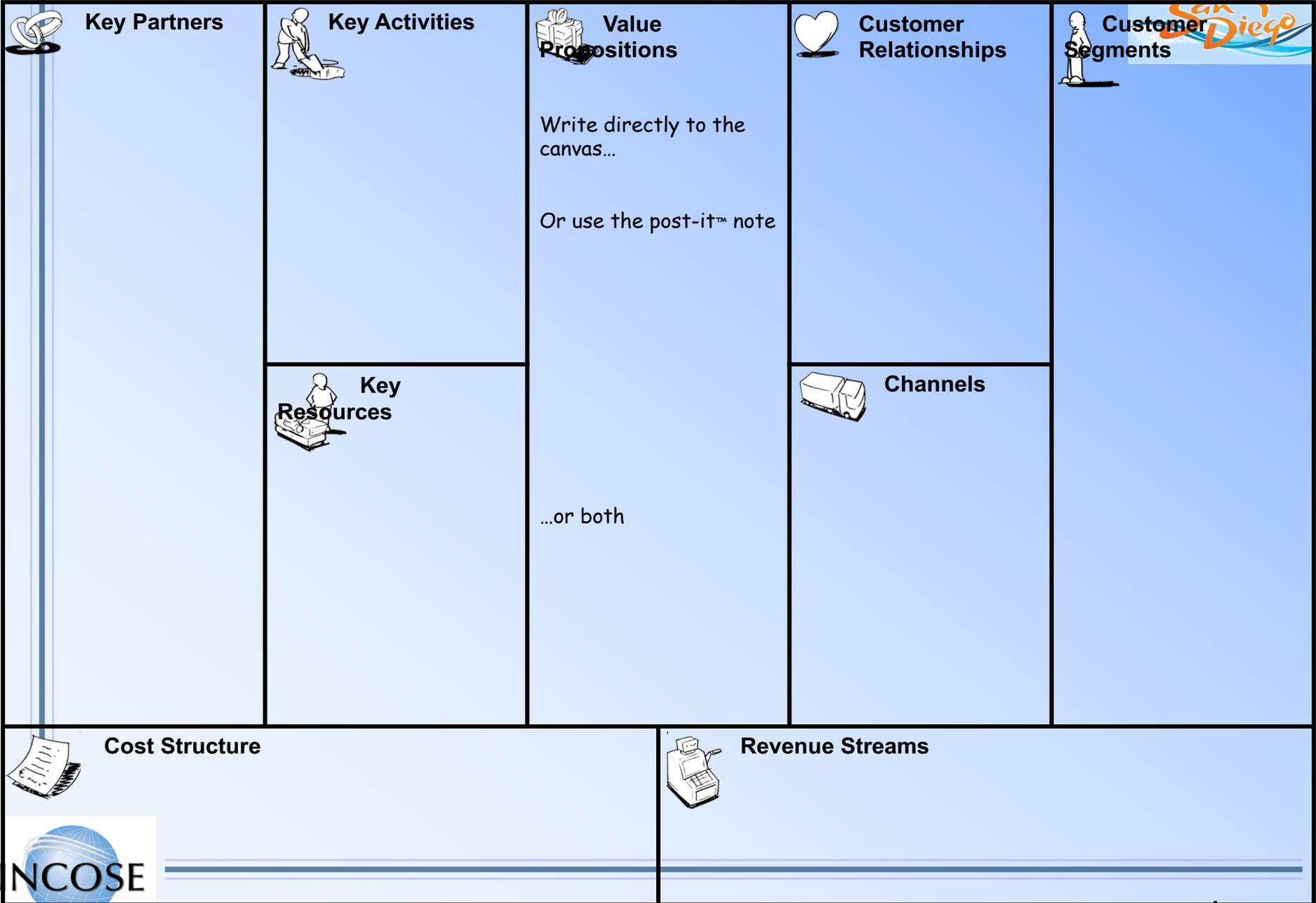


Outline

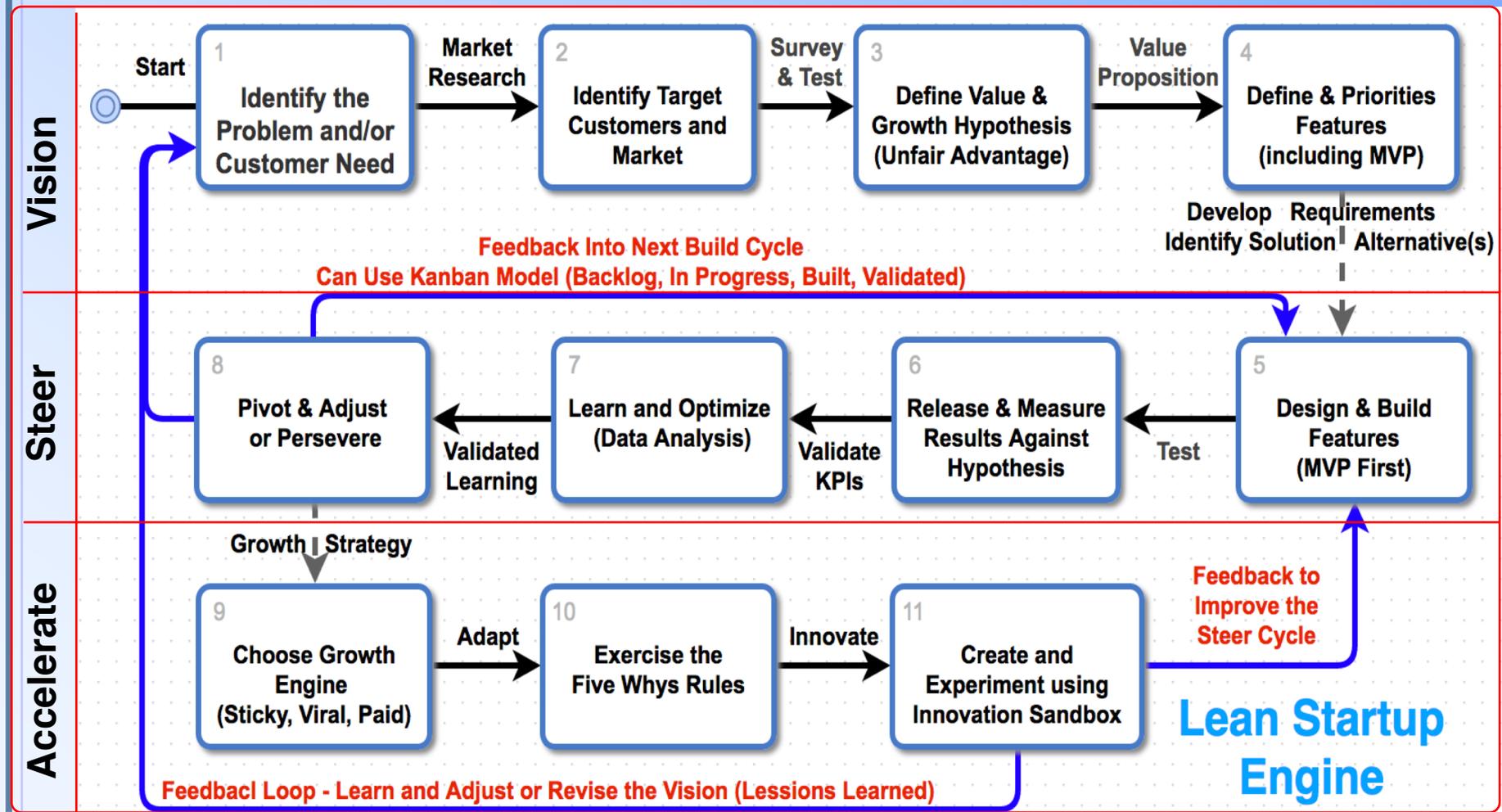
- **Startups and Their Processes**
- **What is a Very Small Entities(VSE)?**
- **VSEs and Their Processes**
- **Identify the Problem**
 - Recognize and Measure the Gap (Problem)
- **Solve the Problem**
 - Bridge the Gap
 - ISO/IEC 29110 History and Overview
 - INCOSE SBSE-WG History and Overview
- **Summary and Takeaways**
- **Q/A**

Startups and Their Processes

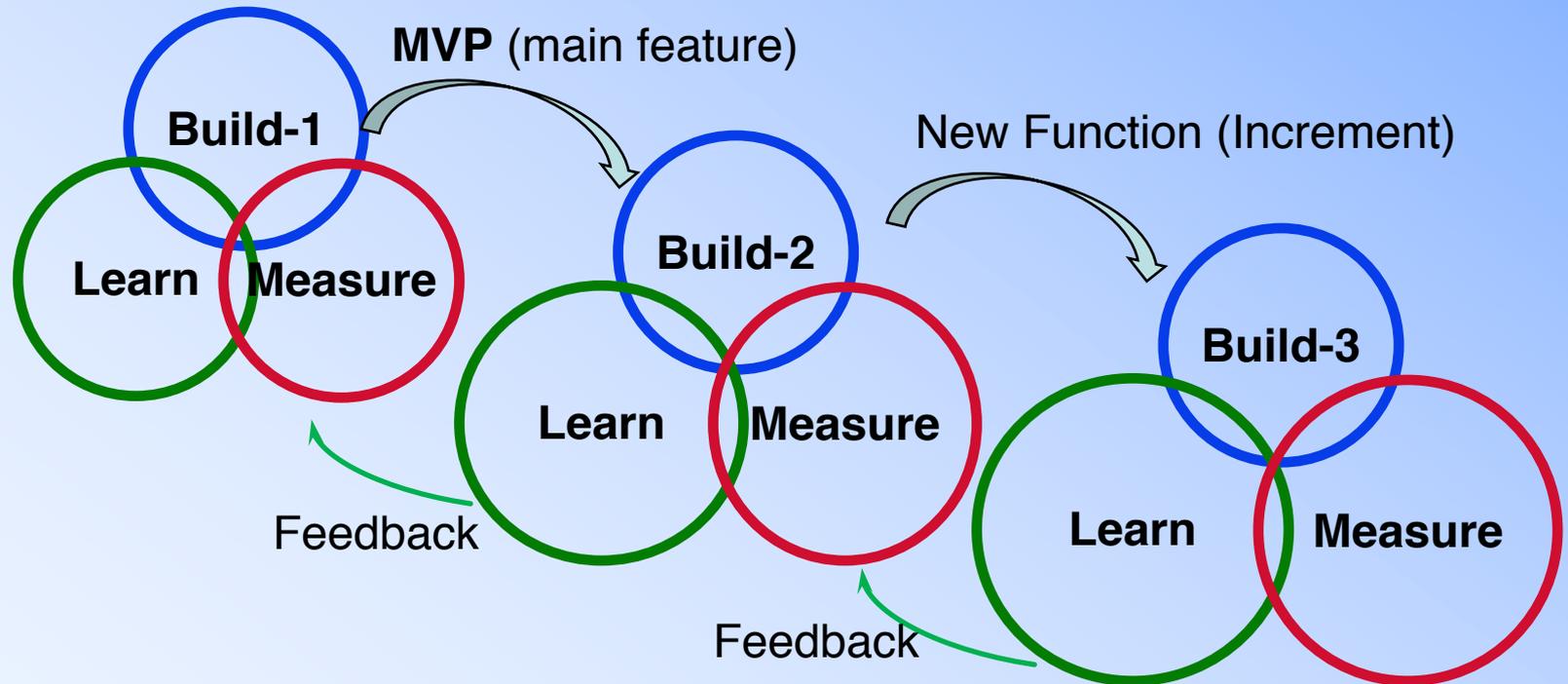
- Most startups use a quick (mostly undocumented) process in their market validation, design and development of their Most Viable Products (**MVP**).
- Startups do not have a well defined set of system/software **requirements** to start with. Then **how do they know what to produce?**
- There are many processes used by startups, a couple famous ones are:
 - Business Model Canvas process
 - Lean Startup Process



Lean Startup Process by Eric Ries



Iterative and Incremental Process

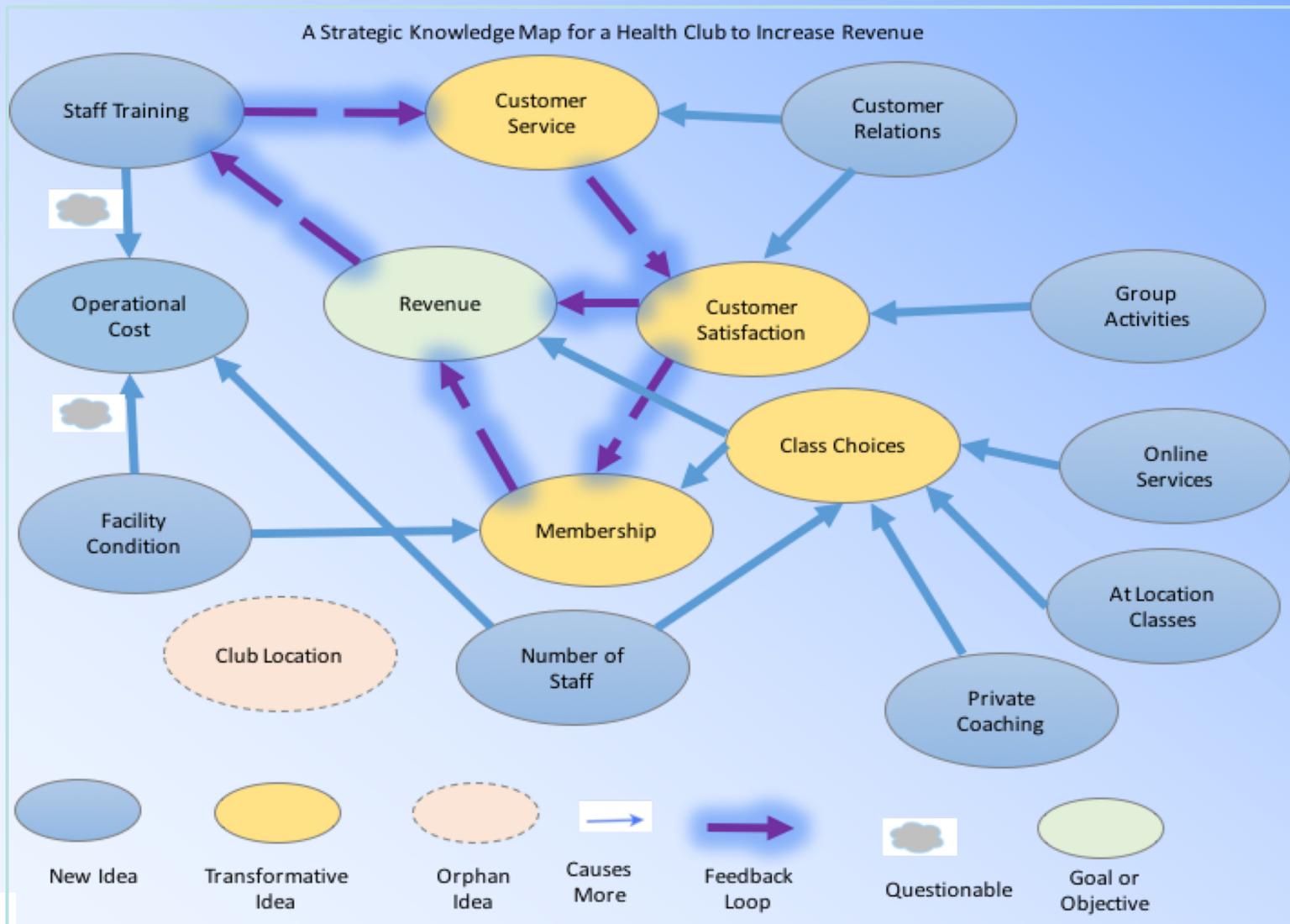


Build-Measure-Learn is a Lean and Agile Methodology

Does SE Apply to Startups?

- Although the traditional SE lifecycle may not apply to startups but someone with the SE vision can prepare the road ahead using expertise and tools such as:
 - System Thinking
 - Feasibility and Trade Studies
 - SWOT Analysis
 - Developing a **Strategic Knowledge Map (SKM)**
 - Risk analysis and mitigation
 - Verification, validation, deployment,..
 - Related documentations

Strategic Knowledge Map (SKM)



SKM can be used as a model to generate an executable strategic plan

What is a VSE?

- A few startups that survive through the series-A funding can become a Very Small Entity (VSE).
- According to the ISO/IEC 29110 Standards - VSE is considered as an enterprise, an organization, a department, or a project having up to 25 people.
- VSEs account for about 90% of European enterprises and about 57% in USA.

A large majority of organizations developing software and products worldwide are VSE

VSEs and Their Processes

- Most VSEs use a hybrid or a homegrown process that best fits their environment.
- VSEs often do not apply the ISO/IEC standards to their businesses due to:
 - Lack of knowledge and limited resources.
 - Realizing that standards require much bureaucracy, documentation, and costly to apply.
 - Assuming that standards are for large organizations.
- The above creates a major issue for VSEs as they become a more mature organization and **facing real-world challenges** and demands.

Identify the Problem

- Lack of standard processes will negatively impact VSE's growth and sustainability:
 - Because it creates a **gap** when VSEs transitioning to a more mature businesses (**grownups**).
 - VSEs may be **eliminated in source selection** because they cannot produce quality systems or software products or fail to meet customer needs.
 - Most VSEs play a **sub-contracting role** to major organizations that require some level of certification such a ISO and/or CMMI.

Recognize the Problem



***As VSEs move toward a more mature organization,
they should realize and measure the GAP
In order to sustain and grow their business***

Solve the Problem BY

BRIDGING



*VSEs should be proactive to apply the light-weighted
ISO/IEC 29110 Standards to get/be ahead of
completions...*

Brief ISO/IEC 29110 History

- During a worldwide survey of many different domain VSEs, it was verified that **existing ISO standards** were “**too complicated**” for use by VSEs.
- **In 2005**, the first meeting of ISO/IEC JTC1 SC7 Working Group (WG) 24 was held, and the work on **ISO/IEC 29110 series began and still continues**.
- These publication are based on and mapped to the **ISO/IEC-12207 & 15288** but tailored to a VSE product or project needs and requirements.
- Worldwide, **hundreds of VSEs have implemented** the ISO/IEC-29110 and been certified for the Basic Profile.
- The standards are also available in French, Portuguese, Spanish, and Czech.

ISO/IEC 29110 Set of Documents

29110 Overview (TR 29110-1)

29110 Profiles (IS)

Framework and Taxonomy (IS 29110-2)

Specifications of VSE Profiles (IS 29110-4)

Specification - VSE Profile Group m
(IS 29110-4-m)

29110 Guides (TR)

Assessment Guide (TR 29110-3)

Management and Engineering Guide (TR 29110-5)

Management and
Engineering Guide
VSE Profile m-n
(TR 29110-5-m-n)

This set of International Standards and Technical Reports is intended to be used by VSEs that do not have experience or expertise in adapting/tailoring ISO/IEC/IEEE 12207 or ISO/IEC/IEEE 15288 standards to the need of a specific project.

ISO/IEC 29110 Documents Tree

Generic Profile Group

TR 29110-1 Overview

IS 29110-2-1 Framework and Taxonomy
of standardized profile

TR 29110-2-2 Guide
for Domain Profiles

TR 29110-3-1
Assessment Guide

IS 29110-3-2 Conformity
Audit Guide

IS 29110-3-3 Capability for
Conformity assessment

TR 29110-3-4 Self Assessment

29110-4 Profile Specifications

IS 29110-4-1
Software
Engineering

IS 29110-4-2
Organizational
management

IS 29110-4-3
Service Delivery

IS 29110-4-4
Agile Development

IS 29110-4-5
DevOps

IS 29110-4-6
Systems
Engineering

29110-5 Profile Implementation Guidelines

TR 29110-5-1
Software Engineering
1. Entry Profile
2. Basic Profile
3. Intermediate Profile
4. Advanced Profile

TR 29110-5-2
Organisational
Management

TR 29110-5-3
Service Delivery

TR 29110-5-4
Agile Software
Development

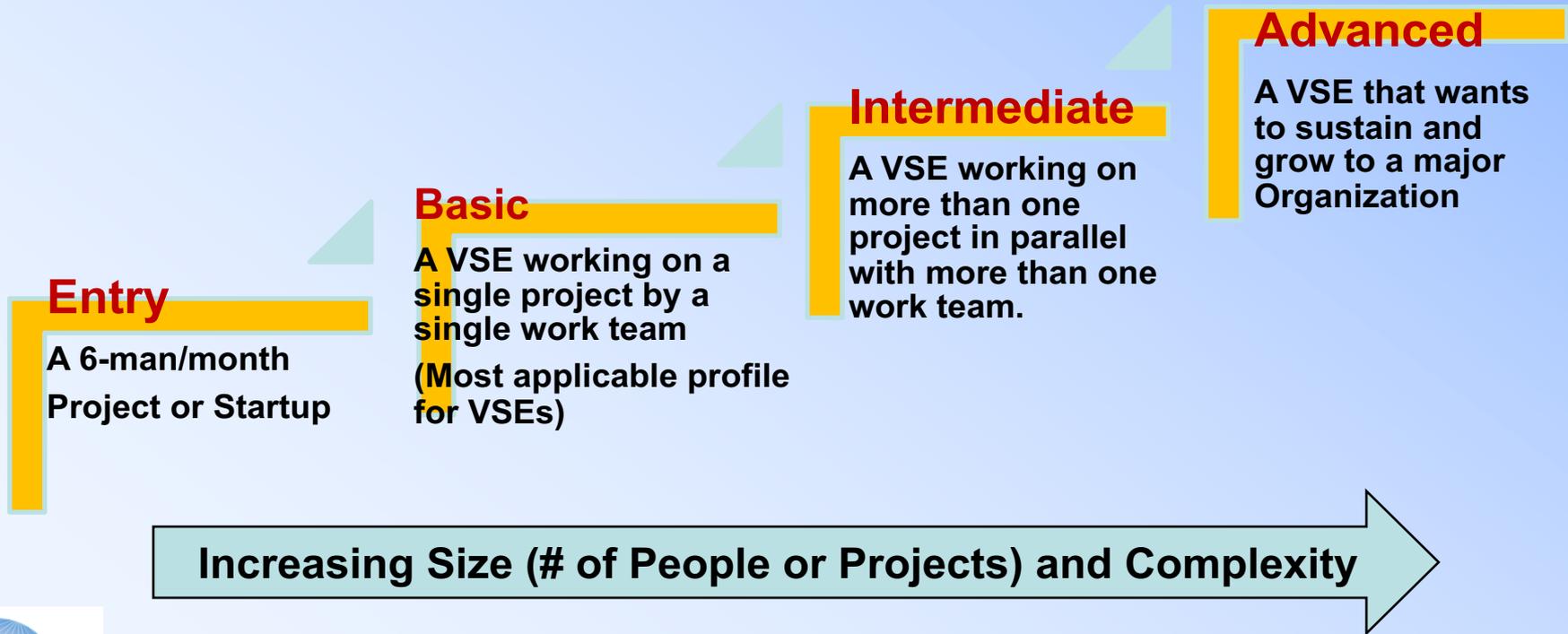
TR 29110-5-5
DevOps

TR 29110-5-6
Systems Engineering
1. Entry Profile
2. Basic Profile
3. Intermediate Profile
4. Advanced Profile

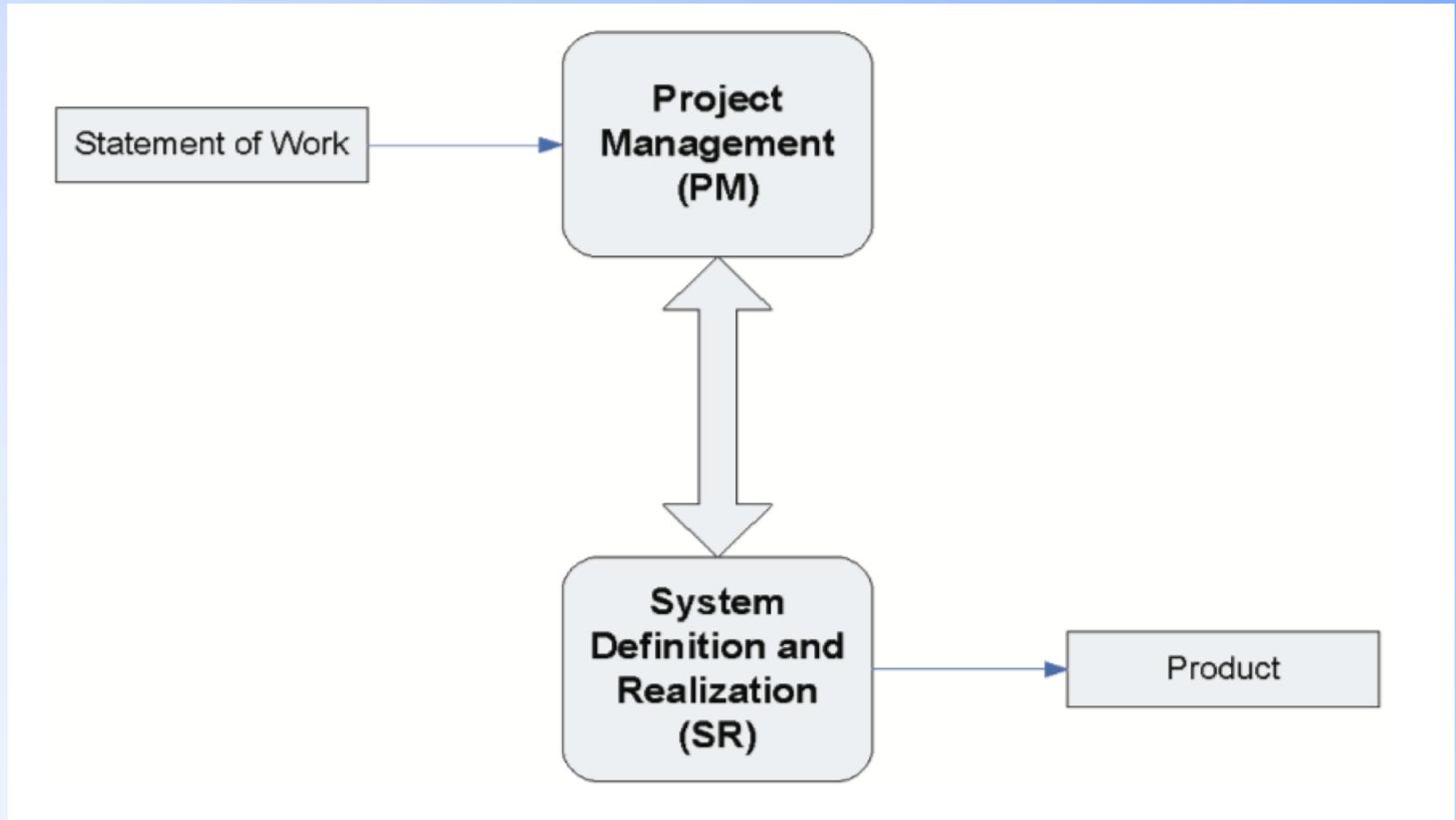
*ISO 29110 guides (i.e. Overview and Management and Engineering Guides are available at no cost from [ISO site](#)
Standard and Guide for the Space Domain are in development*

Software and System Profiles

- There are four different profiles for software and systems profiles of the Generic Profile Group:

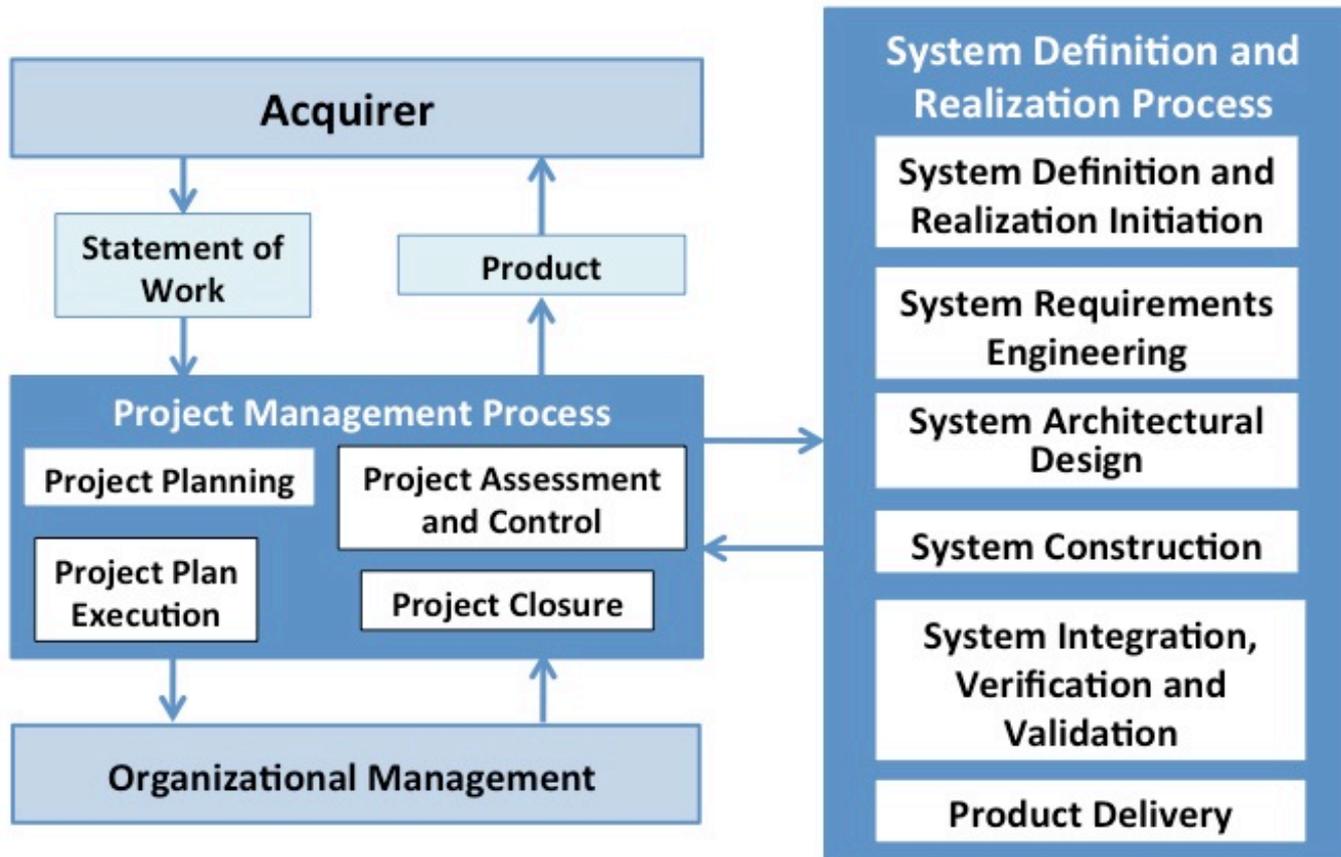


Basic Profile Guide Processes for SE ISO/IEC 29110-5-6-2



Basic Profile Guide Processes and Activities

ISO/IEC 29110-5-6-2



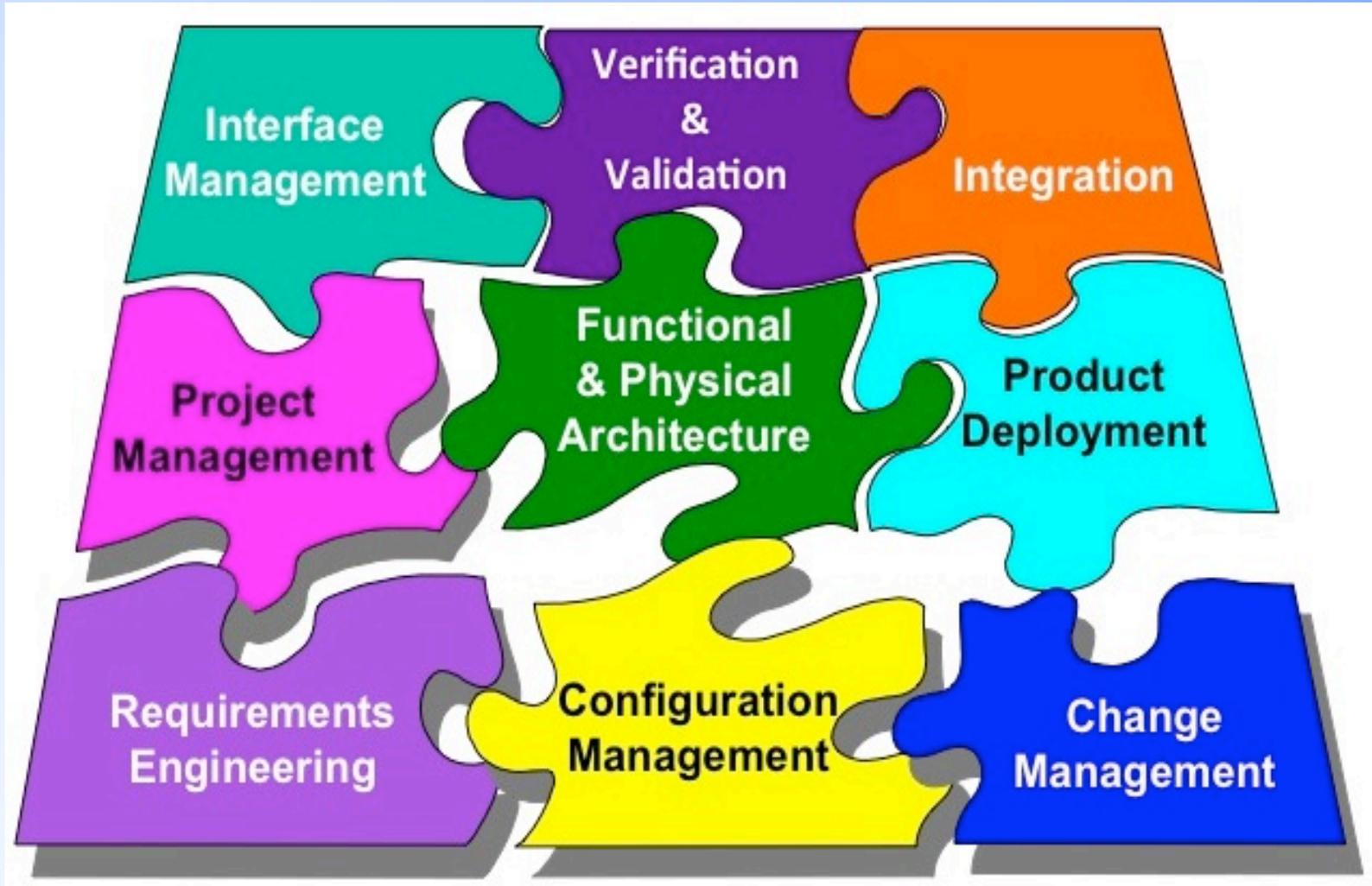
Adapted from (Varkoi 2010)

Deployment Packages

- Deployment Packages (DPs) are a set of artefacts to **facilitate the implementation** of a specific profile of the ISO/IEC 29110 Management and Engineering Guide.
- DPs are not intended to preclude the use of additional guidelines that VSEs find useful.
- A set of DPs have been developed by the INCOSE Small Business Systems Engineering – Working Group (SBSE-WG)

Many case studies of ISO/IEC 29110 implementations have proven the success and positive results for VSEs
See Reference-page at the end of this presentation

Deployment Packages



INCOSE SBSE-WG Support

INCOSE

Small Business Systems Engineering

Working Group

(SBSE-WG)

INCOSE SBSE-WG History

- **In 2009**, INCOSE and the Association Française d'Ingénierie Système (AFIS) (French INCOSE Chapter) established the SE for Very Small and Micro Enterprises (VSMEs) WG.
- I met with members of the SBSE-WG during the **IW-2019** and attended their meetings.
- The members meet at major INCOSE events and have periodic conference calls for updates.

INCOSE SBSE-WG Charter

- The SBSE-WG (formerly VSE-WG) continues working on the Deployment Packages (DPs) for the benefit of and critical to VSEs success.
- These DPs provide:
 - Systems Engineering process information **tailored and scaled** for use by the VSEs.
 - Systems Engineering **tasks and activities** for quick and efficient implementation.
- DPs are derived from ISO Standards (15288, 29110, 12207) and the INCOSE SE Handbook.

INCOSE SBSE-WG Goals

- SBSE-WG Major goals are:
 - To improve and make **product development** within Small Business' **more efficient** by using Systems Engineering concepts.
 - Elaborate tailored guidance to apply, in the context of either a **prime or subcontractor** role to small projects.
 - To contribute to **standardization** in the context of Systems Engineering.

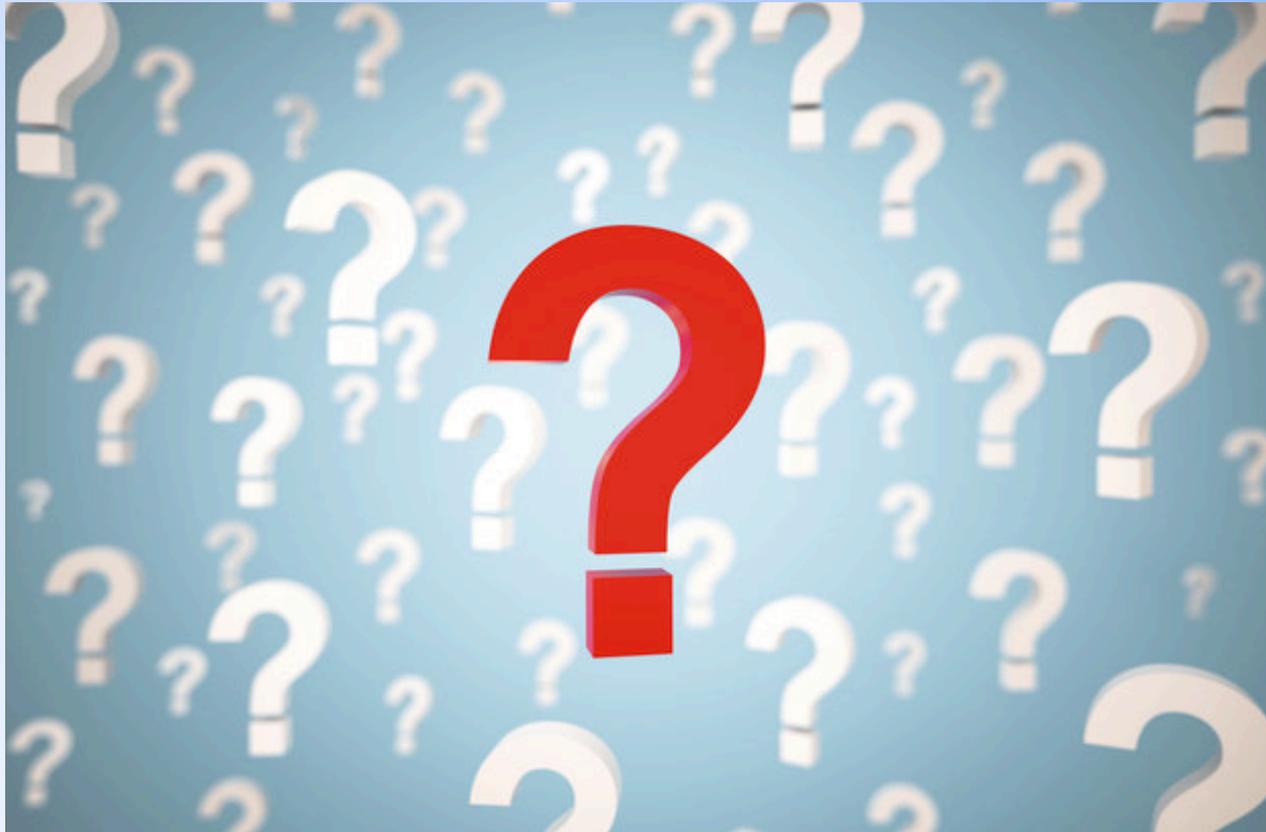
Summary

- **VSEs are on the rise today more than ever** as we experience and digital transformation, robotics evolution, cybersecurity threats, artificial intelligences, location based services, to just name a few.
- **Its time to reduce the gap** between what the industry and government need and what VSEs can produce.
- **Early adoption** of the ISO/IEC 29110 and collaboration among industry, academia, and government is critical to **close the above gap**.
- **Its time to promote and accelerate adoption and implementation** of the ISO/IEC 29110 by **thousands of VSEs worldwide** that develop systems or software products to meet today's challenges and technologies.

References and Additional Resources

- Applying Software Engineering Standards in Very Small Entities
 - Claude Y. Laporte, Mirna Munoz, Jezreel Mejia Miranda, and Rory V. O'Connor
- [INCOSE SBSE-WG Site](#)
- [WWW.ISO.ORG](#)
- [Self Study Modules](#)
- [Professor Claude Y. Laporte Website](#) (ISO 29110 Editor)
 - The above site includes many case studies and examples of VSEs adapting the ISO/IEC 29110 and their success stories.
- Various online articles and resources

Questions



Backup Slides

**Sample projects and Additional references
Compiled by Prof. Claude Laporte**



The Organization

- CSiT was established in 2011 in Montréal
- CSiT provides multi-modal Integrated Communications Systems and Information Integration for Transit Systems



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MTA



Background and Strategy

- 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 (10 people presently)
 - Implementing the CMMI® Level 2 Process Areas was too demanding at that time.
- **Strategy**
 - Implement the draft version of Systems Engineering ISO 29110 Basic profile as a foundation
 - Used other frameworks to complete process descriptions
 - e.g. INCOSE Handbook, PMBOK® Guide (PMI) and CMMI®
 - Perform a gap analysis between CMMI® level 2 and the SE Basic Profile
 - Implement practices needed for a successful CMMI® level 2 assessment





Classification of Processes

	Light Process	Standard Process	Full Process
Type of Project	Proof of Concept, Prototype Concept validation or Product Deployment at Customer Site <u>Small</u> Project	Typical Project Product intended to be installed at Customer Site <u>Medium</u> Project	Project when CMMI level 2 is required by a Customer Product Testing or Product Deployment at Customer Site <u>Large</u> Project
Framework to be used	ISO/IEC TR 29110-5-6-1 - <u>Entry</u> Profile + CMMI - Supplier Agreement Management	ISO/IEC TR 29110-5-6-2 - <u>Basic</u> Profile + CMMI - Supplier Agreement Management	<u>CMMI</u> (Level 2)

Small project less than 1M\$ – Medium project >1M\$ and <10M\$ - Large project > 10M\$



Young Transportation Enterprise

- 2016 INCOSE International Symposium
 - 16-page paper
- Edinburgh, July 16-21, 2016

http://profs.etsmtl.ca/claporte/Publications/Publications/Setting%20up%20process%20at%20CSiT_INCOSE_2016.pdf

26th Annual INCOSE International Symposium
Edinburgh, UK, July 18-21, 2016

Developing and implementing systems engineering and project management processes at CSiT - A small Canadian company in public transportation

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Abstract. A project was created to define and implement project management and systems engineering processes at CSinTrans Inc. (CSiT), a Canadian company, founded in 2011. CSiT specializes in the integration of communication and security systems in transit industry such as trains, subways and buses as well as railway stations, subway stations and bus stops. ISO/IEC 29110 standard and guides for systems engineering have been used as the main reference for the development of these processes.

The project's history, purpose and rationale that prompted CSiT to adopt this recently published standard are presented. The implementation of the standard is described. The reflections and decisions made during the implementation are presented. The lessons learned are discussed. Recommendations and advice for organizations wanting to implement ISO/IEC 29110 are described.

Connecting Business Development and Systems Engineering with ISO/IEC 29110 Standard in Small and Medium Enterprises of France

Stéphane Galinier, Claude Y Laporte

4th IEEE International Symposium on Systems Engineering
October 1-3, 2018, Rome, Italy





SMEs-VSEs Selected for the Pilot

Domain	Size (Number of people)	Main product or service	Year established
Space	70	Spacecraft structural subsystems	1994
Agriculture	10	Farming robotics	2016
Nuclear	150	Electricity and ventilation engineering	2007
Aeronautics	20	Drone inspection services	2015
Nuclear	10	Nuclear dismantling simulation	2010
Automotive	20	Embedded electronic systems	2003



Observed Benefits for the SMEs-VSEs

- « The development of SE facilitated the integration of the product evolution with a regular production of versions, less incidents and a better adhesion of the contributors. »
- « The implementation of SE has a structuring effect. Its implementation makes it possible to discern the importance of minor issues and to consider the growth of the workforce more serenely. »
- « SE is clearly a valued know-how with our clients and partners in our contracts, but also with our shareholders in the case of mergers/acquisitions. »
- « The introduction of the SE has clearly resulted in a significant reduction in costs associated with late detection of problems. »
- « Linking requirements and causes makes our products more responsive to market expectations. »



4th IEEE INTERNATIONAL SYMPOSIUM ON
SYSTEMS ENGINEERING
 October 1-3, 2018 | Rome Marriott Park Hotel | Rome, Italy



• **Key figures**

- 18-month project
 - December 2017 to October 2018
- About 50 K€ funded by AFIS and French Government
- **6 SMEs selected**
 - Space (70 people), Agriculture (10 p), Nuclear (200 p), Aeronautics (10 p), Nuclear (20 p), Automobile (50 p)
- 8 experts acted as coaches

• Based on **Basic Profile of ISO 29110**

<https://www.researchgate.net/publication/328047970> Connecting Business Development and Systems Engineering with ISO/IEC 29110 Standard in Small and Medium Enterprises of France

4th IEEE International Symposium on Systems Engineering
 October 1-3, 2018, Rome, Italy
 Pre-Publication version

Connecting Business Development and Systems Engineering with ISO/IEC 29110 Standard in Small and Medium Enterprises of France

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Abstract— As systems are getting larger, customers as well as systems integrators need to work with more performing and innovative small and medium-size suppliers. To stay in the game, these small and medium enterprises (SMEs) have to face new challenges in order to develop their strategic positioning. The authors propose that many of these business development challenges can be addressed by SMEs by using a Systems Engineering framework, such as the ISO/IEC 29110. AFIS, the French Systems Engineering association (French INCOSE chapter), and French government funded a 24-month project where a team of 8 experts, members of the AFIS and INCOSE, helped 6 enterprises, located in the south of France, in implementing Systems Engineering processes, using the engineering and management processes of the ISO/IEC 29110 framework, and measured the effectiveness of their actions. The selected enterprises are operating in a wide range of domains such as automotive, space and agriculture, and their size ranges from 10 to 150 people. The lessons learned show how these processes helped the SMEs to understand the benefits of Systems Engineering for their business development, to embrace a bigger point of view and understand how their business environment changes. Finally, the authors show how close the profiles of business developer and systems engineer are, based on systems thinking abilities.

Keywords— systems engineering, business development, ISO/IEC 29110, small enterprises, standards, processes, very small entities (VSE)

I. INTRODUCTION
 Small and medium enterprises (SMEs) developing systems are facing increasing challenges. New systems are getting more complex, larger, require interdisciplinarity, constantly higher safety and security performances. The authors make the idea emerge that these Business Development challenges can be clearly addressed at SME level with a Systems Engineering dedicated approach such as ISO/IEC 29110 (ISO 29110 hereon). It took about 18 months to write and publish a book in French that describes these issues [1].

A 24-month pilot project was initiated early 2017, in the south of France to implement the engineering and management processes of ISO 29110 in 6 enterprises regarding their own business objectives. These SMEs develop services, products, subsystems or systems, directly specified for a customer or for a market by self-specification. The objective of AFIS (Association Française d'Ingénierie Système, INCOSE French chapter) is to take advantage of the synergy of the skills of companies to enrich and improve the recognized systems engineering (SE) practices in the implementation of SE processes, methods and tools [2]. The AFIS and French government funded the project where a team of 8 experts, members of the AFIS, helped the 6 enterprises in implementing systems engineering processes and measured the effectiveness of their actions.

II. OVERVIEW OF ISO/IEC 29110 SERIES
 ISO 29110 defines a Very Small Entity (VSE) as an enterprise, an organization (e.g. a public organization or a non-profit organization), a department or a project having up to 25 people [3]. Worldwide, a large majority of organizations are VSEs. In Europe, for instance over 92% of enterprises, called micro-enterprises, have up to 9 employees and another 6.5% have between 10 and 49 employees [4]. In France for instance, there are over 134,000 SMEs employing 4,000,000 workers. About 11,000 SMEs have engineering activities.

From studies conducted, most VSEs do not have the resources in terms of expertise and money to adopt heavyweight engineering standards, such as ISO/IEC/IEEE 15288 system life-cycle processes standard [5], to meet their needs. The ISO 29110 set of standards and guides was developed to address the needs of VSEs.

A four-stage roadmap, called Generic profile group, has been developed for VSEs that do not develop critical products [6]. Entry, Basic, Intermediate and Advanced profiles. VSEs targeted by the Entry profile are those working on small projects (e.g. at most six-person months of effort) and for





Background



- Prime Solutions Group (PSG) is a VSE of 20 people
- Areas of Expertise
 - Radar Signal Processing Algorithm developments in advanced Intelligence
 - Surveillance and Reconnaissance systems
 - Software Command and Control
- Primary Customers
 - US Government and its Defense contractors
 - Provides critical support for ground system architectural reviews, ground system design reviews, interface design reviews, hardware and software integration and test activities, anomaly resolutions, and program management tasks.
- Application of ISO 29110 SE Deployment Packages (DPs)
 - Internal company uses and customer uses

Tailored DP Approach to Research Proposals



- Tailored the set of ISO 29110 DPs to provide a repeatable process for developing proposals for the SBIR program and implementing the project if it is selected for award
 - Tailoring of DPs is continuously reviewed on a project by project basis
- The value for PSG as a VSE
 - Have a starting point on each proposal and project
 - This approach provides a checklist for addressing project components that can make a difference on selection or non-selection of the proposal for funding

Application of DPs to Engineering Services



- Engineering services provide direct support to customers
- Prime contractors in the supply chain want to see evidence that processes exist
 - Change Management, Configuration Control, Design Review Process, Retention of Quality Records, Safety
- Prime contractors may request processes as attachments in proposals and contracts
- To answer due diligence process audits
 - PSG leveraged details presented in the ISO 29110 DPs and incorporated that content into Standard Operating Procedures (SOPs)



- A SE VSE Company Use Case
- 27th Annual INCOSE International Symposium
- Adelaide, Australia, July 15-20, 2017

<https://onlinelibrary.wiley.com/doi/full/10.1002/j.2334-5837.2017.00402.x>

http://profs.etsmtl.ca/claporte/Publications/Publications/A%20S%20VSE%20Company%20Use%20Case_INCOSE_2017.pdf

27th Annual INCOSE International Symposium (IS 2017)

Adelaide, Australia, July 15-20, 2017

A SE VSE Company Use Case

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Abstract. Prime Solutions Group, Incorporated (PSG) is a systems engineering company and Very Small Entity that has benefited from association with INCOSE and specifically the Very Small Entity Working Group. This paper presents the company's use of the INCOSE Very Small Entity Working Group Deployment Packages for research projects, engineering services and software development. Further tailoring of the Very Small Entity Working Group Deployment Packages derived from ISO/IEC Technical Report 29110 into a System of Research & Development Innovation is discussed. Finally, the current INCOSE Technical Operations policy review and update activity is presented as an example of applying Very Small Entity systems engineering process on INCOSE. The objective of the paper is to describe the application of an INCOSE technical product in the small business world.

Introduction

PSG is a systems engineering Small and Medium Enterprise (SME) and a Very Small Entity (VSE). In our case, we are a small company of 20 people. Process, structure, and approaches are important to us because it represents how we do business accomplish success on projects and demonstrate our competency for current and our next customer(s). Indeed, every small and large business as well as associations such as INCOSE needs to address process or face frustration or perhaps extinction. In this paper, we talk about our specific use case as a VSE and the types of processes we have developed and explored. Included is a description of a related process and policy review in our very own INCOSE.

Participation in the INCOSE VSE WG has direct application to PSG's mission and focus and elevates our confidence as a VSE in pursuit of business opportunities in systems engineering. In the U.S.A., VSEs have been responsible for creating many innovations through non-diluted funding of the Small Business Innovative Research/Scientific Technology Transfer (SBIR/STTR) programs. The success stories are many and include innovative products and organizations which got their start as SBIR/STTR projects. These include Google and GoreTex. Our interests are in innovative research that help solve complex defense systems through systems and software engineering research. Early in our lifecycle, we had to come to grips with that as our mission statement and be careful to codify