27th annual INCOSE international symposium

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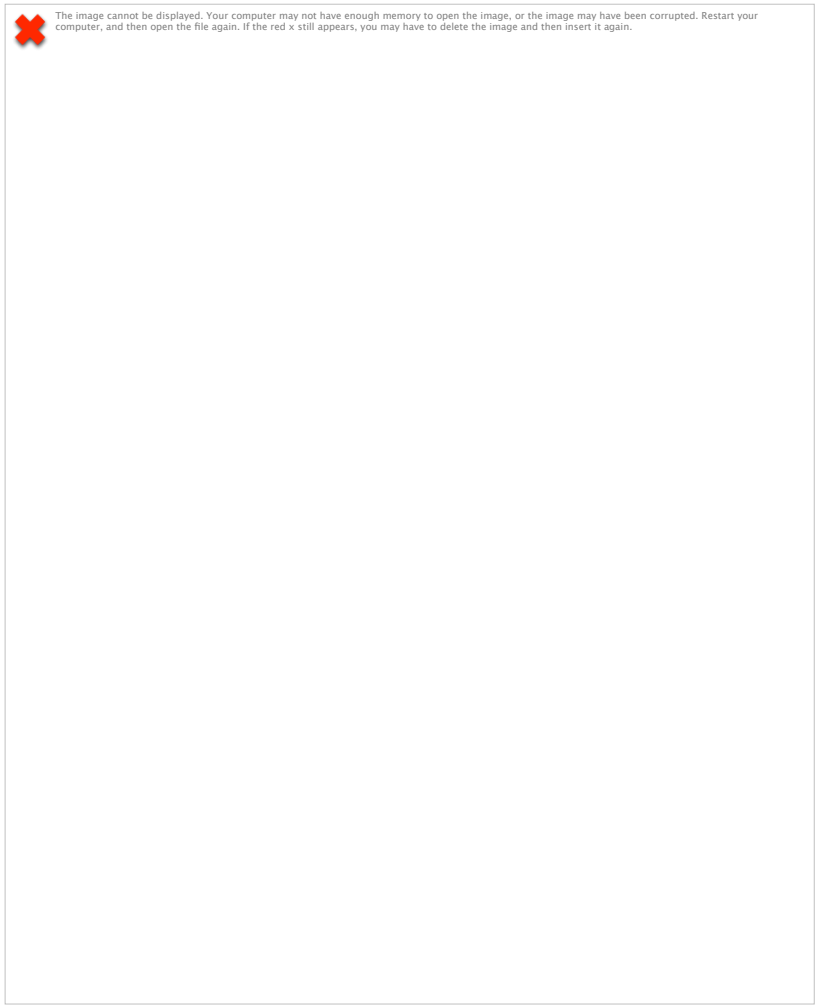
Developing A Systems Engineering Capability That Meets the Needs of Your Organization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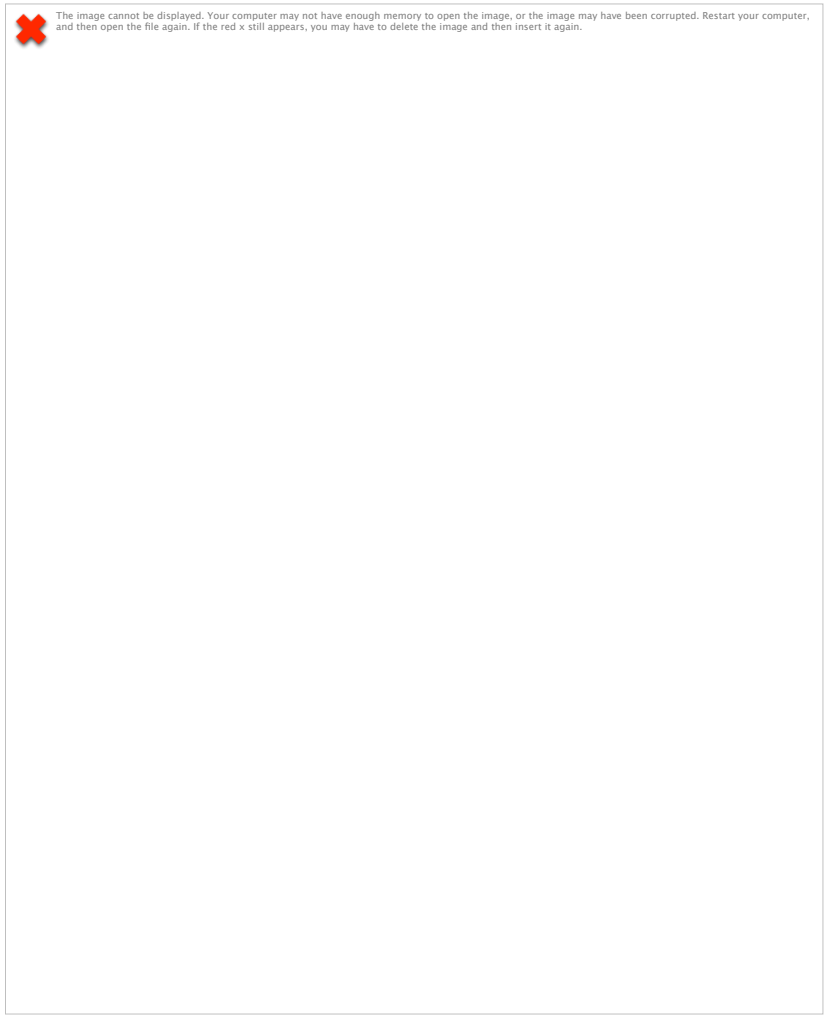
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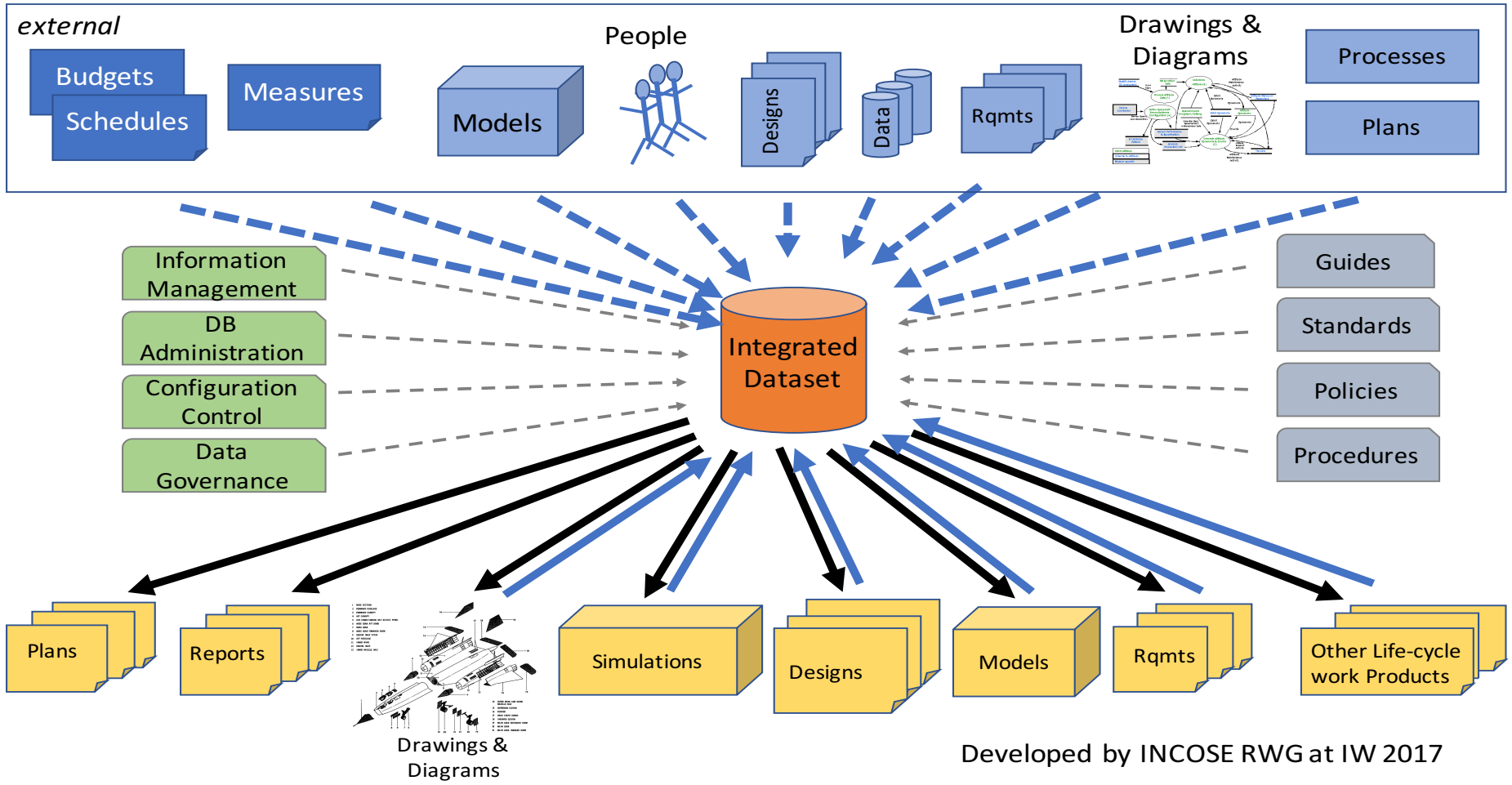
INCOSE Oil & Gas WG

- The INCOSE Oil & Gas WG, in collaboration with the RWG, have developed a requirement development and management (RDM) Capability Maturity Assessment Survey.
- The survey aims to quantitatively benchmark the application of RDM across the industry and confirm the importance of having a well-defined RDM process.
- You can access the survey at: **https://www.surveymonkey.com/r/INCOSE-OandG-Survey**

Introduction

- Managing projects and SE lifecycle activities using different tools and databases can result in “stovepipes” within the developing organization and especially between external organizations where artifacts generated by one group or organization using a specific tool are either not made available to those involved in the other lifecycle processes or the tools used and resulting datasets are not compatible.
- For today’s increasingly complex systems, these issues need to be addressed. Organizations need to be able to establish and maintain the “ground truth” as well as remove “stovepipes” and integrate artifacts and datasets across disciplines and system development lifecycle processes. A primary outcome of implementing data-centric SE within an organization is to breakdown the stovepipes and integrate these artifacts and the data and information that represents them into a common, **integrated dataset**.

Integrated data set



Success Starts at the Top

- To successfully practice SE from a data-centric perspective, the levels of the enterprise above the project level need to address process, tools, and people:
  - Processes need to be defined at the enterprise, business management, and business operations levels that support the chosen level of SE from a data-centric perspective capability;
  - SE tools and information technology (IT) infrastructure appropriate to the level of SE capability chosen needs to be provided by the IT organization at the business operations level; and
  - People within the projects need the training, knowledge, and experience appropriate to the level of SE capability being implemented by the organization consistent with type and complexity of systems being developed and the SE toolset adopted by the enterprise.

Management

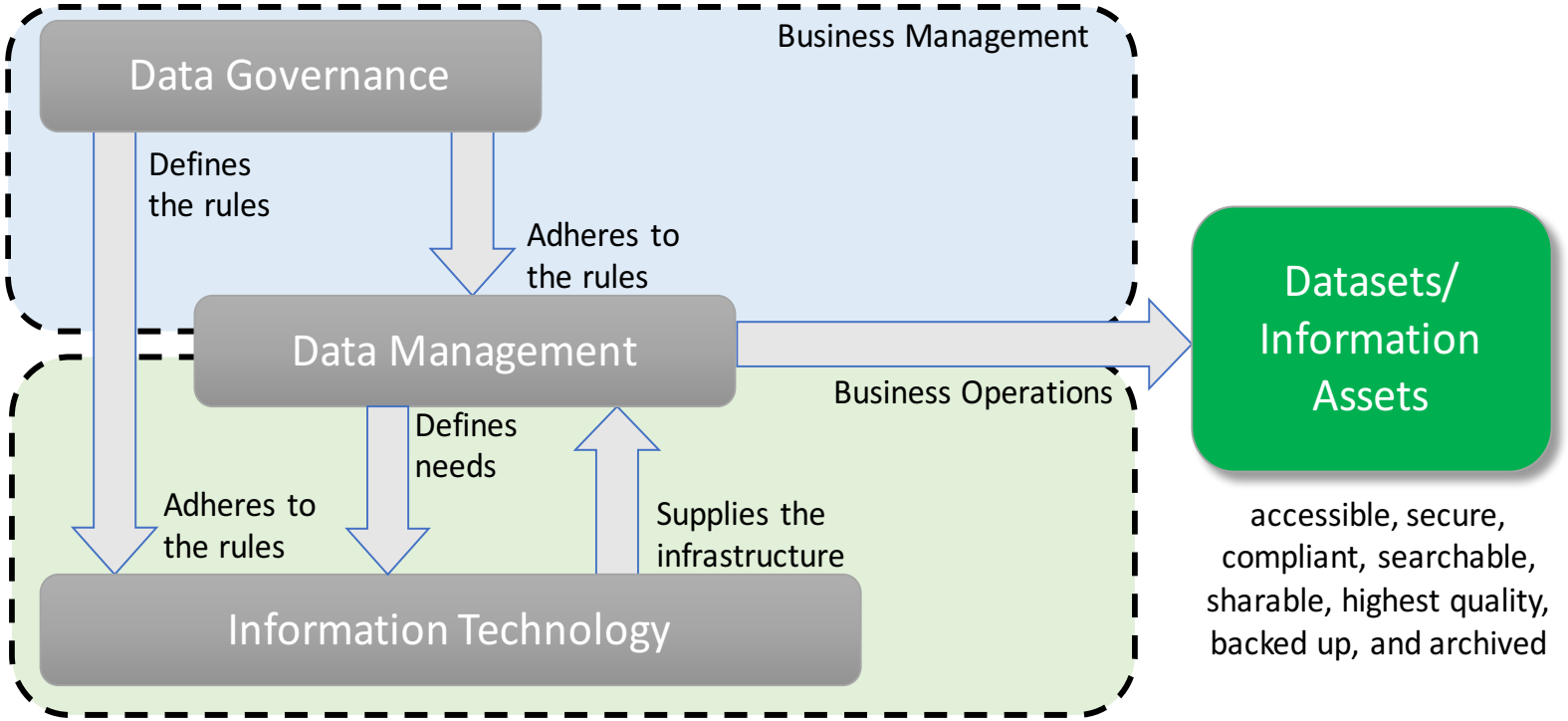
- At the **enterprise level,** strategies are defined that will guide its future. Leadership communicates their intentions regarding the operation of the organization—in terms of existing systems, processes, and systems.
- At the **business management level** the concepts, needs, resulting requirements are documented that will result in an infrastructure that enables the enterprise to adopt SE from a data-centric perspective. This includes choosing the level of SE capability appropriate to the projects, defining data governance and information management policies and plans, and developing the information technology (IT) architecture requirements tailored to the needs of the projects, product lines, and culture of the enterprise. Configuration management (CM) policy is defined at this level.
- …

Management

- …
- At the **business operations level** where the projects operate, the infrastructure is put in place to allow projects to develop and manage systems. This involves defining an organization standard ontology, operating procedures, work instructions, processes, etc.; acquiring the IT infrastructure, defining a master schema for the project databases and file management systems.

Data governance

Data Governance (DG) is the formulation of policy to optimize, secure, manage, and leverage data and information as an enterprise asset.



Data Governance defines the rules “what”. Data Management and Information Technology adhere to the rules “how”. Data Management defines the needs and requirements for the information technology infrastructure. Information Technology supplies and maintains that infrastructure.

Data governance

The following basic principles of DG need to be established at the enterprise level. These basic principles guide all enterprise activities:

- Data and information are assets – are the life-blood of the enterprise, with high value that must be managed accordingly.
- Data and information must be able to be trusted – therefore the data and information must be correct, consistent, of high quality, and managed.
- Data and information must be secure – protected from unauthorized use and disclosure.
- Data and information risk must be recognized and mitigated – this risk also can represent a liability if data and information is compromised or misused.
- …

Data governance

- …
- Data and information must be accessible and shareable – so that users can perform their duties; therefore, data and information must be sharable across the enterprise functions and organizations that have a need for the data and information.
- Data and information have an owner and steward – each data element and information has a data owner accountable for proper management, access, and usage of the data and information and a steward accountable for data and information quality.
- A Common Vocabulary (ontology and schema) must be defined - All data and information must be clearly defined consistently throughout the enterprise with the definitions understandable and available to all stakeholders.

For a data-centric project to be successful, the following actions must be completed

- The senior management has agreed to implement SE from a data-centric perspective, and there is an enterprise level “champion”.
- Data governance and information management policies have been defined.
- The level of data-centric SE capability consistent with the needs of the project has been agreed to.
- An IT infrastructure has been put into place that meets the needs of the project.
- An SE toolset consistent with the needs of the project has been procured and licenses put in place.
- …

For a data-centric project to be successful, the following actions must be completed

- …
- The project has a defined ontology and master schema for the project's integrated dataset.
- Plans, processes, procedures, and work instructions have been defined by the program/project (plans include: Project Management Plan (PMP), Systems Engineering Management Plan (SEMP), and Information Management Plan (IMP)).
- Project team members are trained in practicing SE from a data-centric perspective, the SE tools, defined schema, plans, processes, procedures, and work instructions.

Proposed levels of SE Capability

- To help in the journey to implement SE from a data-centric perspective, it is useful to define different levels of SE “capability”. What specific SE capabilities a project needs depends on their product line, its complexity, issues they are having and want to address, workforce knowledge and experience, the SE toolset being used, and the organization’s processes, standard operating procedures, and work instructions.
- Each level assumes the previous level has been experienced and surpassed. As the organization progresses through the levels, their SE capability level increases. As the SCL increases, the organization is getting closer to realizing the intent of the MBSE Initiative and will be moving closer to realizing INCOSE’s Vision 2025. The journey ends when the organization has reached the SCL that meets the needs of the organization

SCL 0, Legacy systems

- The various SE lifecycle process are divided across organizational units operating in stovepipes. The enterprise has no documented data and information governance policy. There is no defined master ontology for the enterprise nor projects. The primary toolset used by the projects is common office applications: word-processing, spreadsheets, presentations, and basic drawing and diagraming tools. The primary focus of a project is on hardcopy, printed documents, design description documents, ICDs, CAD drawings, etc.
- Unfortunately, this level represents many legacy system development processes and associated shortcomings seen in today's world of more complex systems.

SCL 1, Stove piped models

- The SE lifecycle process are divided across stovepiped organizational units. No data and information governance policy exists. There is no master ontology. Projects have no data management in their PMP's nor SEMPs and have no IMP, no master schemas for the databases representing the projects' work products, nor common, integrated project datasets.
- Some work products may be linked within the lifecycle stovepipe, but not across lifecycle stages. For example, allocation, traceability, parent/child, and interface requirement relationships are managed within the RMT, but the requirements are not linked to diagrams, models, design, systems verification, nor system validation work products. Models focus on functionality, performance, and interfaces, but do not reflect quality, design and construction standards, nor physical attributes of the system.

SCL 2, Monolithic data sets

- Stovepipes are mostly gone, but some still exist. The enterprise has not yet documented and implemented a data and information governance policy. However, a master ontology for projects has been defined. A project has included data management concepts in their PMP and SEMP and has an IMP. Projects have started to establish a common, integrated dataset with a master schema defined and uses this integrated dataset to manage work products and their underlying data across all lifecycle processes.
- While the projects have developed master schema for their integrated dataset, many of the SE tools store the data either as electronic files or in their own proprietary database using a proprietary schema. Because of the use of SE tools with proprietary schema, the data and information in these individual databases is not compatible - making it difficult to share data between tools and organizations.

SCL 3, Ground truth

- The enterprise has data and information governance policy and a master ontology. Projects have data management concepts in their PMPs and SEMPs and have IMPs. Most, but not all, of the underlying data representing the lifecycle products are included in the integrated dataset.
- There is only one “ground truth” for the project−the integrated dataset. The project’s data and information in the integrated dataset is under strict configuration control and therefore represents the baseline state of the project at any given time. The work products and underlying data and information are developed, analyzed, and managed holistically as an integrated system made possible because of the existence of a common, integrated dataset. Any “visualizations” of the data and information in the integrated dataset represent the current state of the project.

SCL 4, Interoperable tools

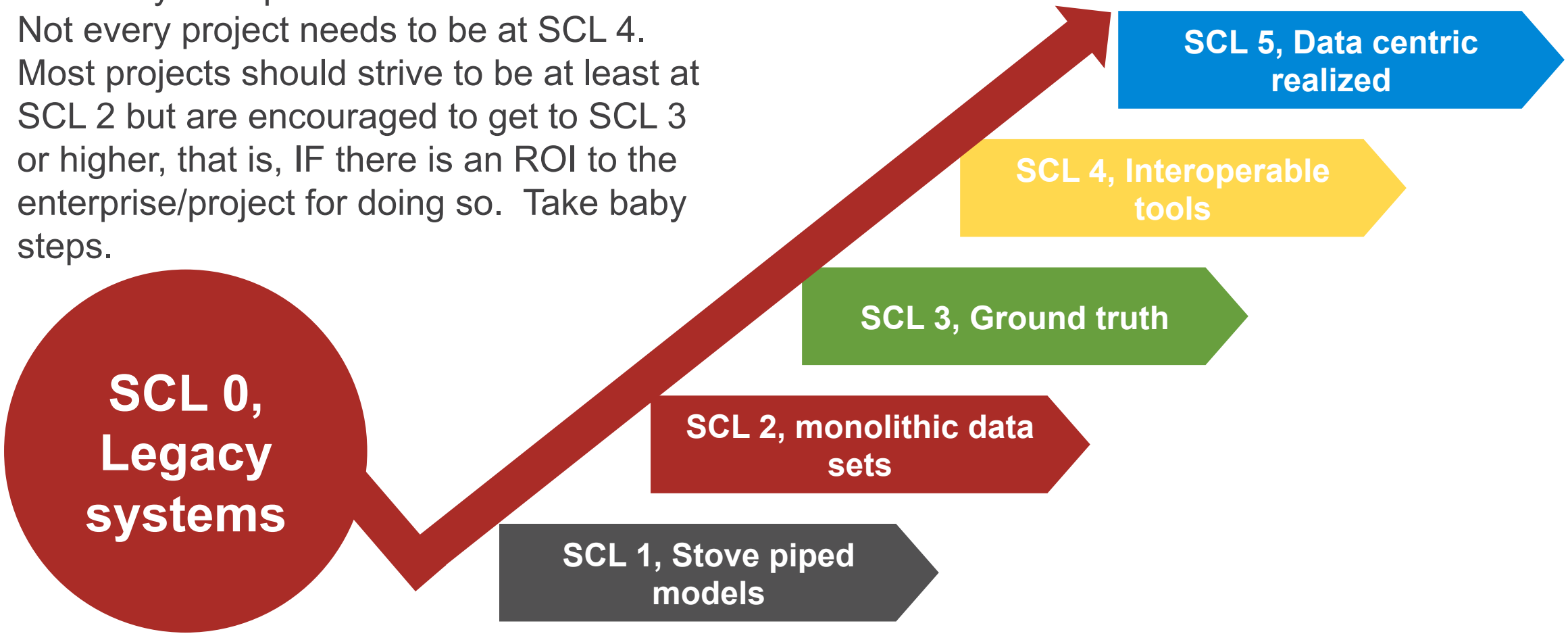
- All the underlying data representing the SE lifecycle work products is included in the project's common, integrated dataset. All PM and SE work products and underlying data and information are developed using SE tools that conform to interoperability standards and store the data and information in a database whose schema is consistent with the project's master schema.
- This allows all SE tool databases to be included directly as part of the project's integrated dataset, enabling all SE tools to share data and data to be shared with other organizations. All the work products are linked not only within a lifecycle stage, but also across lifecycle stages.

SCL 5, Data centric realized

- The enterprise has an enterprise level ontology defined and documented. The enterprise has defined and documented an enterprise level data and information governance policy and plans.
- The enterprise has developed an enterprise level IMP. Two or more projects within the enterprise are operating at SCL 4.

Journey to implement data-centric SE

Not every enterprise needs to be at SCL 5.
Not every project needs to be at SCL 4.
Most projects should strive to be at least at SCL 2 but are encouraged to get to SCL 3 or higher, that is, IF there is an ROI to the enterprise/project for doing so. Take baby steps.



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