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Integrated Data as the Foundation of Systems Engineering

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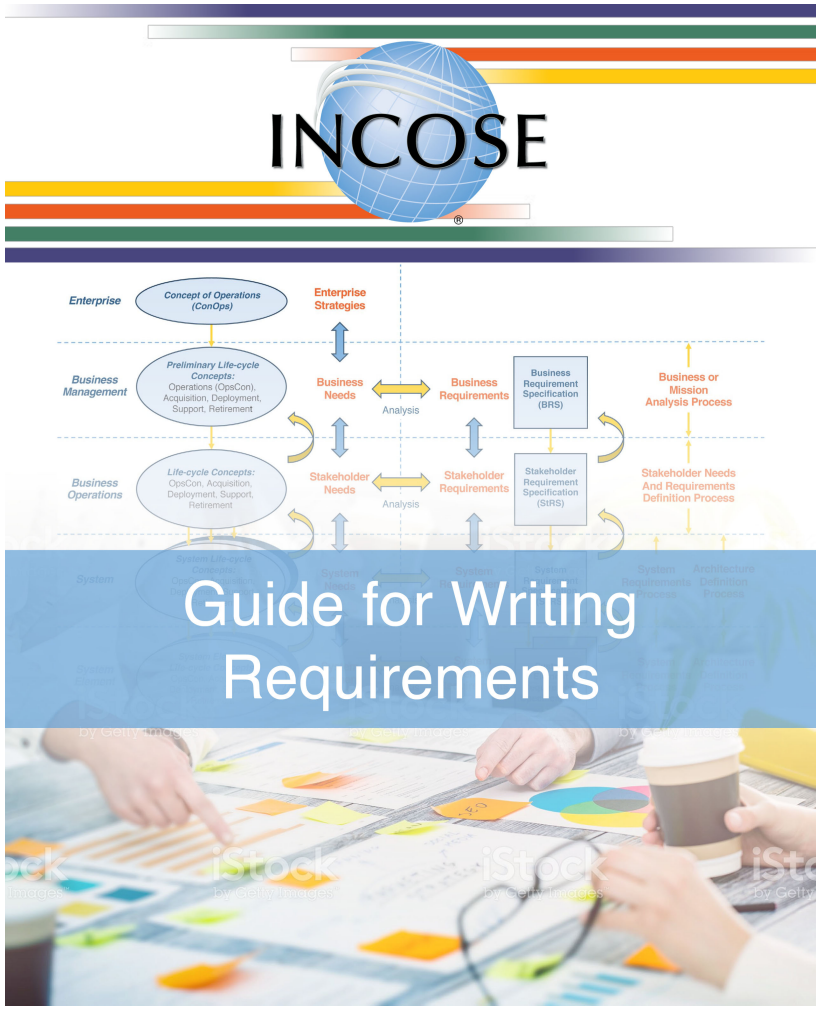
INCOSE
Enterprise
Concept of Operations (ConOps)
Enterprise Strategies
Business Management
Preliminary Life-cycle Concepts:
Operations (OpsCon), Acquisition, Deployment, Support, Retirement
Business Needs
Analysis
Business Requirements
Business Requirement Specification (BRS)
Business or Mission Analysis Process
Business Operations
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Stakeholder Needs
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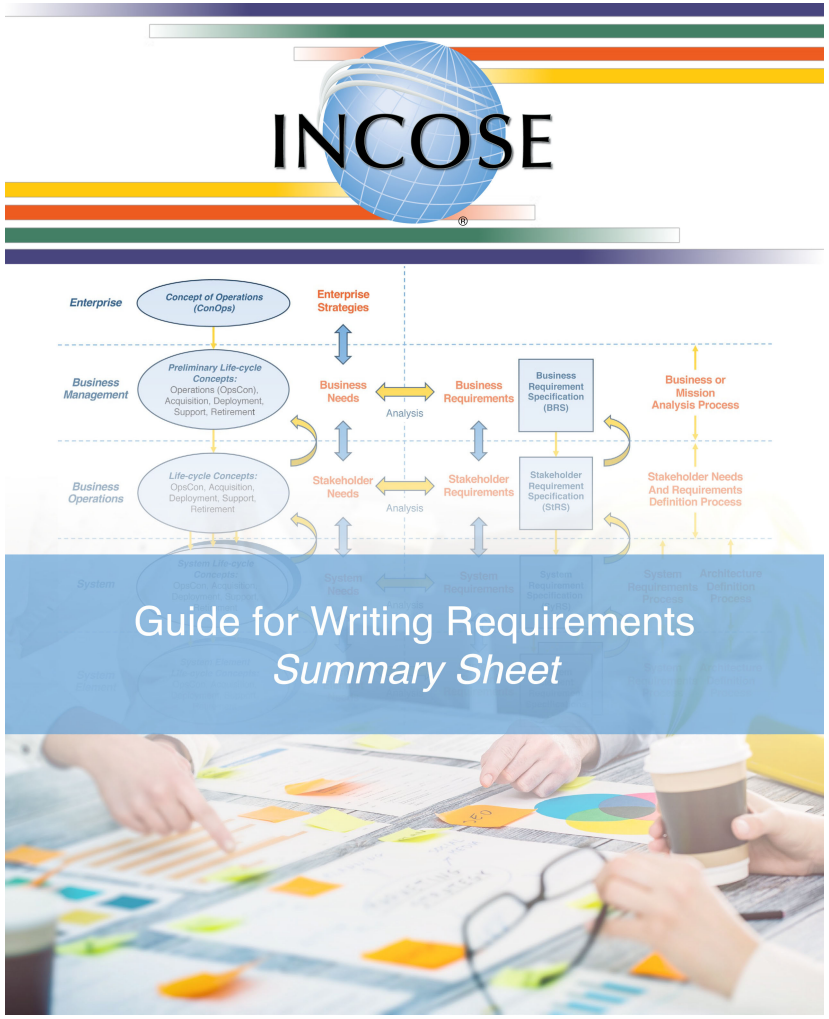
Stakeholder Requirement Specification (StRS)
Stakeholder Needs And Requirements Definition Process
System
Guide for Writing Requirements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Summary Sheet

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**

Purpose / Problem

- The basic premise of this paper is that:
  - SE is based on models, models are represented by data and information
  - Other Systems Engineering (SE) work products are either projections of the same data and information or represented by data and information generated from other SE lifecycle process activities
  - To effectively manage ever increasing complex systems of the future, this underlying data and information must be integrated into a common, project dataset
  - This common, integrated dataset is the foundation for Systems Engineering
  - The result is an information model that represents both
    - An integrated architectural model of the system under development
    - A model of the SE lifecycle process activities and resulting work products

Objectives / Goals

- Present a broader data-centric perspective of SE that meets the intent the MBSE initiative and help organizations to move towards INCOSE's Vision 2025
- Provide organizations an understanding that the integrated dataset is the foundation of SE
- Provide organizations guidance that can be used to successfully implement SE from a data-centric perspective

The overall goal is to help organizations implement the level of SE capability that best fits their needs.

Differing Perspectives of SE

- The practice of SE is often viewed from many perspectives
- SE cannot be effectively practiced when viewed from just one perspective (requirements, models, patterns, standards, industry specific application, etc.)
  - To successfully practice SE, wise systems engineers recognize and use each perspective as appropriate to the activity they are performing
- The perspective of this document addresses the intent of the MBSE Initiative by presenting a broader, data-centric view of SE
  - From this perspective, modeling and other activities and SE are not synonymous
  - There are many work products, including models, that are generated during the execution of the SE lifecycle process activities

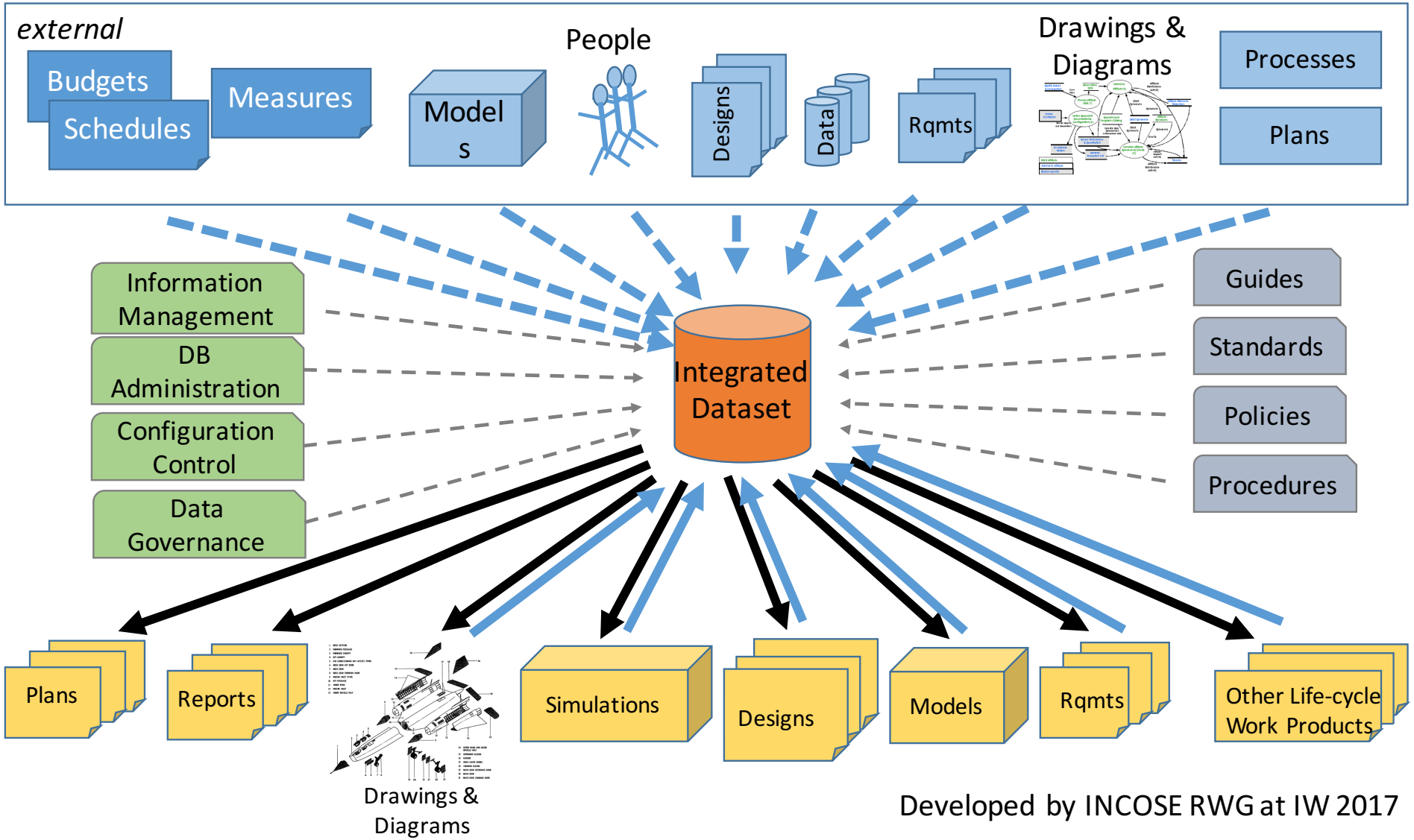
These work products are represented by their underlying data and information

Information Model

- SE tools used to generate and manage the various SE work products and underlying data and information provide context
- This context results in information
- This information represents an information model provides valuable rationale and insights developed while executing the SE lifecycle processes involved in engineering the system
- In practicing SE, the systems engineer's emphasis needs to be on the data and information shared across lifecycle processes rather than on the individual lifecycle process activities themselves
- Combining the systems engineer's experience and knowledge with the information contained in the integrated dataset enables the systems engineer to use their wisdom to successfully deliver winning products

Accepting this premise, **it is useful to view SE from a data-centric perspective**

Integrated Data View



SE from a Data-Centric Perspective defined:

"SE, from a data-centric perspective, involves the formalized application of a common, integrated dataset to represent the SE work products and their underlying data and information generated to support concept maturation, requirements development, design, analysis, and verification and validation activities throughout the system life cycle, from conceptual design to retirement."

Conclusions

- The integrated dataset is the foundation of all SE lifecycle activities
- The data-centric SE perspective focuses attention on the common, integrated dataset that underpins all SE activities, including
  - Modeling the system being developed
  - Modeling the SE lifecycle processes
  - Generation and management of all SE work products and their underlying data and information

Conclusions

- A data-centric SE perspective is essential to:
  - Manage the system development efforts across all lifecycles,
  - Address the challenges of increasingly complex systems,
  - Meet the intent of INCOSE's MBSE Initiative
  - Move towards INCOSE's Vision 2025.

References

- Dori, D., 2002, Object-Process Methodology: A Holistic System Paradigm. New York, NY, USA: Springer.
- Bellinger, G., 2004, Modeling & Simulation: An Introduction, http://www.systems-thinking.org/modsim/modsim.htm.
- Bellinger, G., Castro, D., Mills, A., 2004, “Data, Information, Knowledge, and Wisdom”, http://www.systems-thinking.org/dikw/dikw.htm .
- DoD 5000.59-M, 1998, DoD Modeling and Simulation – Glossary, Defense Modeling and Simulation Office.
- Friedenthal, S., Moore, A. and Steiner, R., 2008. A Practical Guide to SysML: Systems Modeling Language, Morgan Kaufmann Publishers, Inc.
- IEEE STD 610.12-1990. IEEE Standard Glossary of Software Engineering Terminology. superseded by ISO/IEC/IEEE 24765:2010, Systems and Software Engineering – Vocabulary. Washington, DC, 2010.
- INCOSE-TP-1995-002-01, 1995. “Metrics Guidebook for Integrated Systems and Product Development”, Wilbur, A., Towers, G., Sherman, T., Yasukawa, D. and Shreve, S.
- INCOSE-TP-2003-020-01, 2005, Technical Measurement, Version 1.0, 27 December 2005. Prepared by Roedler. G. and Jones, C.
- INCOSE-TP-2003-002-04, 2015, Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities. Version 4, Edited by Walden, David D., et al.
- INCOSE-TP-2004-004-02, Systems Engineering Vision 2020, Version 2.03, September 2007, http://www.incose.org/ProductsPubs/pdf/SEVision2020_20071003_v2_03.pdf.
- INCOSE-TP-2005-001-03, 2010, Systems Engineering Leading Indicators Guide, Version 2.0, January 29, 2010; available at http://seari.mit.edu/documents/SELI-Guide-Rev2.pdf . Edited by Roedler, G., Schimmoller, H., Jones, C. and Rhodes, D.
- INCOSE-TP-2010-005-02, 2010, Systems Engineering Measurement Primer: A Basic Introduction to Measurement Concepts and Use for Systems Engineering, INCOSE
- ISO/IEC/IEEE 15288, 2015, Systems and Software Engineering— System Life Cycle Processes. Geneva, Switzerland: International Organization for Standardization, 2015.
- Long, D., “One Model to Coordinate them All”, http://community.vitechcorp.com/home/post/One-Model-to-Coordinate-them-All.aspx Paper, Vitech Corp.
- Malone, R., Herrord, J., Friedland, B., Fogarty, D., 2016. “Paper Insights from Large Scale Model Based Systems Engineering at Boeing”. 26th Annual INCOSE International Symposium (IS 2016), Edinburgh, Scotland, UK, July 18 - 21, 2016.
- Novel Engineering, “An Introduction to Model-Based Systems Engineering”, Presentation, 2016.
- NASA, 2016, Expanded Guidance for NASA Systems Engineering: Volume 2: Crosscutting Topics, Special Topics, and Appendices, NASA Headquarters.
- Scott, Z., “Models and Views”, http://community.vitechcorp.com/home/post/Models-and-Views.aspx, Paper, Vitech Corp.

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Lou works with both government and industry clients. Lou has spoken at Project Management Institute (PMI) chapter meetings, INCOSE conferences and chapter meetings. Lou has had published and presented a multitude of papers on requirement RD&M topics for NASA's PM Challenge, INCOSE, INCOSE INSIGHT Magazine, and Crosstalk Magazine. Lou is a member of INCOSE, co-chair of the INCOSE Requirements Working Group, a member of PMI, the Software Engineering Institute (SEI), the World Futures Society, and the National Honor Society of Pi Alpha Alpha. Lou has a BS degree in Electrical Engineering from Oklahoma State University, an MA degree in Computer Information Systems from the University of Houston – Clear Lake, an MS degree in Environmental Management from the University of Houston – Clear Lake, and has completed the course work for an MS degree in Studies of the Future from the University of Houston – Clear Lake. Lou is the primary contributor to RE's blog on requirements best practices. The blog can be assessed at: http://www.reqexperts.com/blog .

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