Exploring Model-Based System Engineering(MBSE) /Model-Based Development (MBD) in the Life-Cycle Development for Civil Aircrafts

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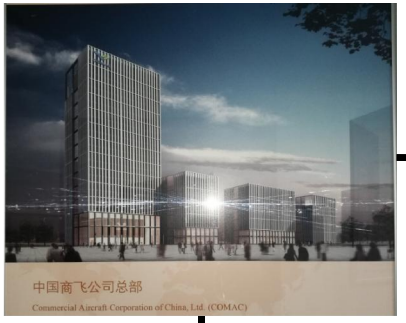
COMAC In A Glance



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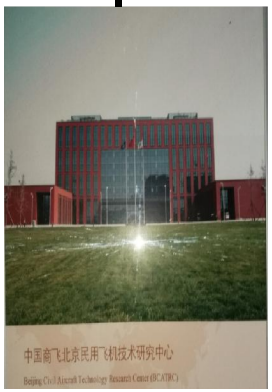

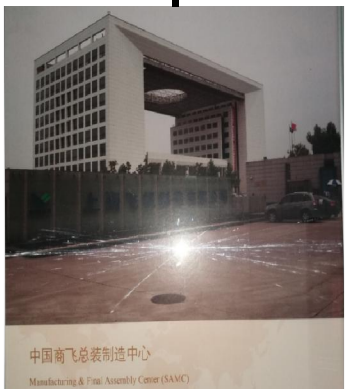

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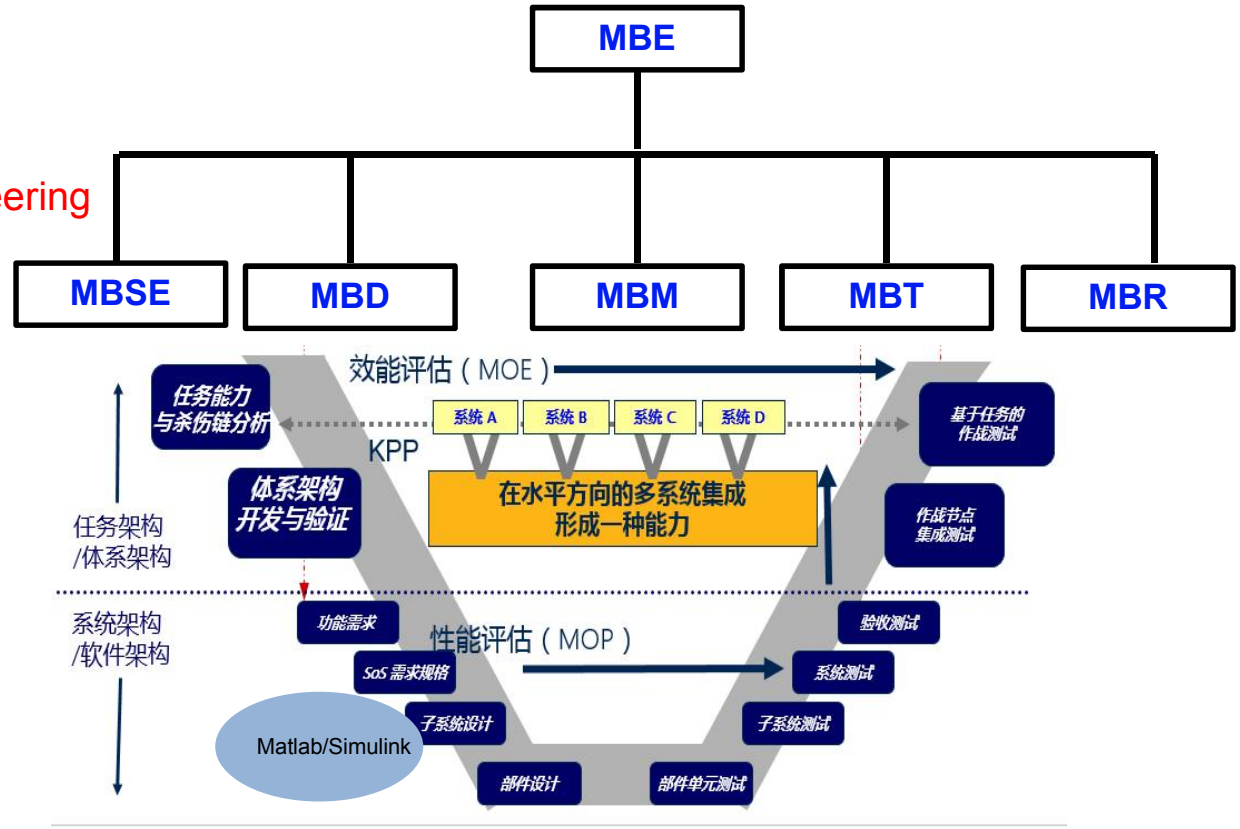
Challenges for Commercial Aircraft Development

MBSE v.s. MBD

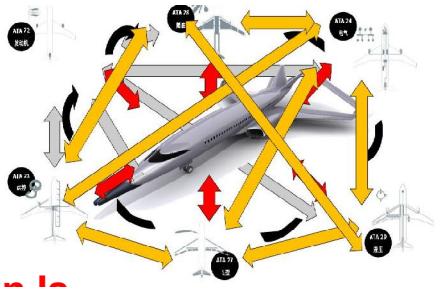
- MBE – Model Based Engineering
- MCE – Model Centric Engineering
- MBSE – Model Based System Engineering
- MBD – Model Based Development
- MBT – Model Based Test
- MBR – Model Based Reliability
- MBM – Model Based Manufacturing

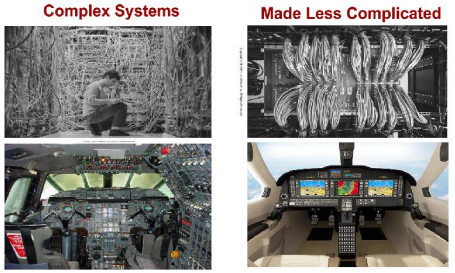


Background

- **MBSE Definition: The formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases"**

- **3 Key Characteristics of Commercial Aircraft**
  - **High Complexity**
  - **High Risk**
  - **High Cost**





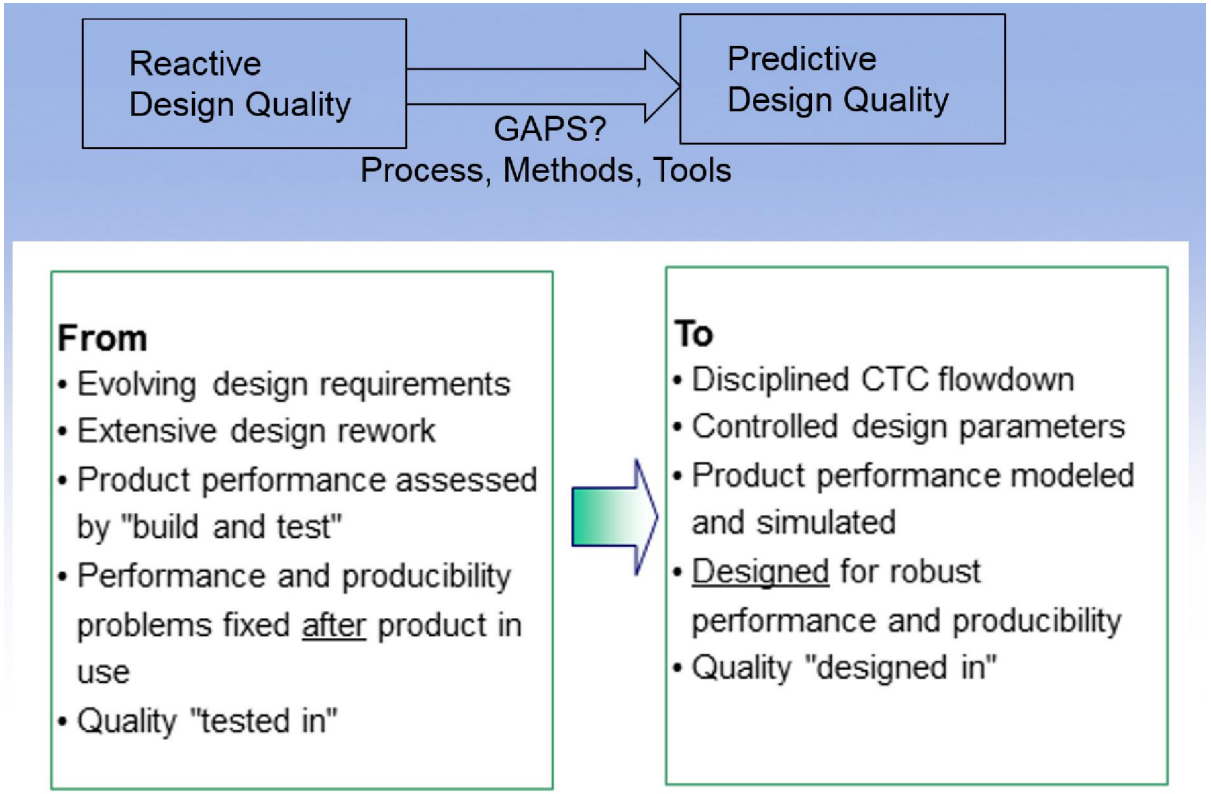
Virtual System Integration Is Very Critical in Early Stage

Motivation

- **MBSE/MBD is a cultural change, and a new disruptive development process**
- **Key SE Characteristics Requirements**
  - Open Minds
  - Independent Critical Thinking
  - Life-long learning
- **Overcome Psychological Inertia**
  - Understand how sub-conscious mind works
  - Be aware of mind-mistakes
  - Engage with active listening like an infant

Motivation – Paradigm Shift

In order to implement MBSE successfully, a mindset change is needed and required



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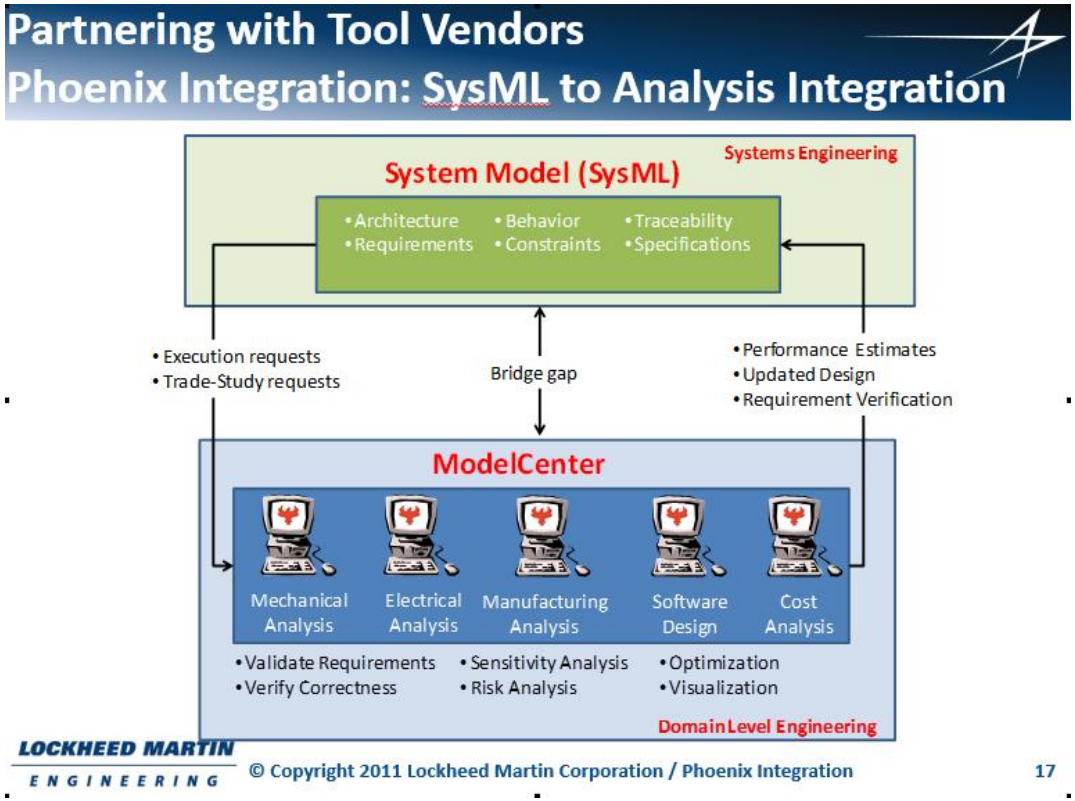
Benchmarking – Lockheed Martin 1

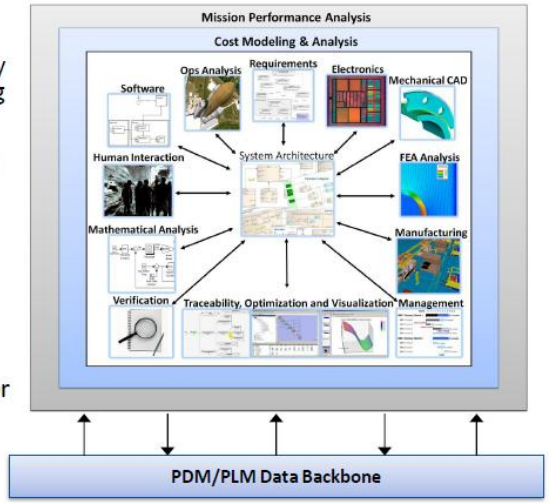
Complex Model Ecosystem – Combined a fully integrated digital system model enables programs to pull a digital thread to analyze performance and change impacts faster and with more accuracy.



Benchmarking – Lockheed Martin 2

Model-Centric Engineering – Model is an essential part of product data baseline.

- A well defined System Architecture Model (SAM) is a key enabler for integrating and linking our engineering enterprise
- The SAM helps link requirements to logical and behavioral design
- Requirements can be fed into increasingly detailed levels of domain specific modeling
- Integration between Systems Engineering and the PDM/PLM backbone opens up a new frontier for integrated model-centric engineering

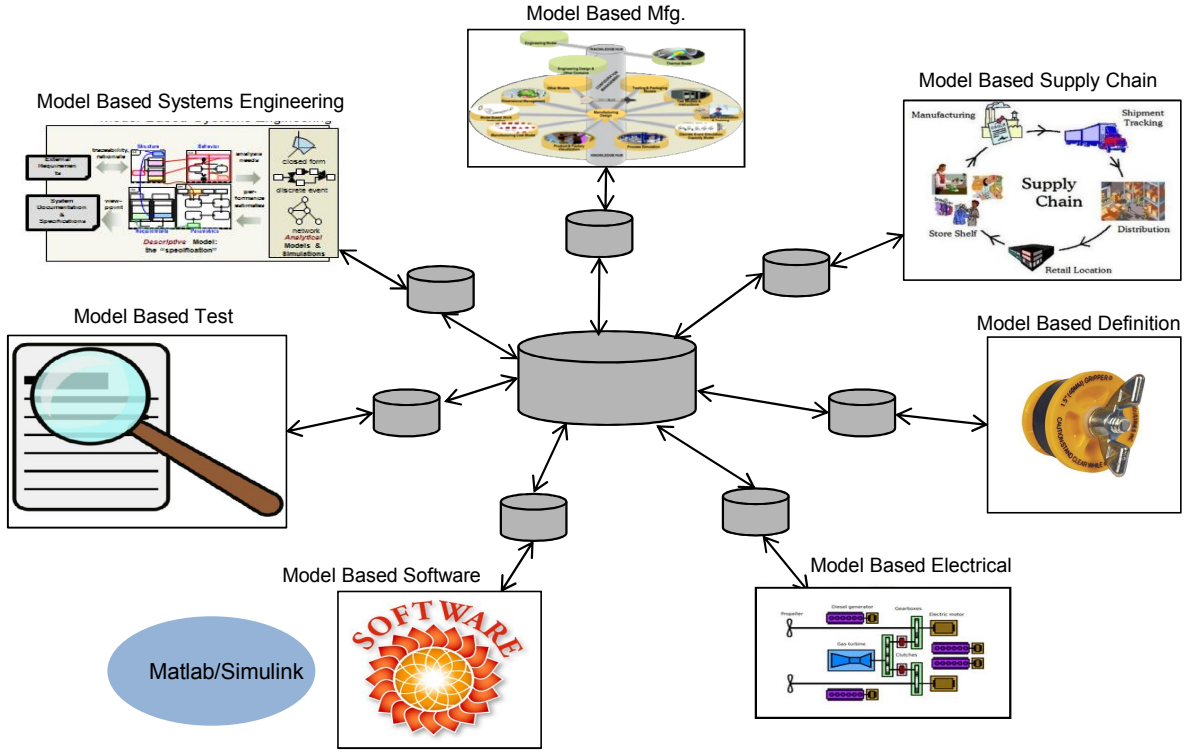


Key Points:

① System Architecture Model;
② SAM Links Reqs & Design;
③ Mission Analysis & Cost Model;
④ PDM/PLM Backbone；
⑤ Model-centric。

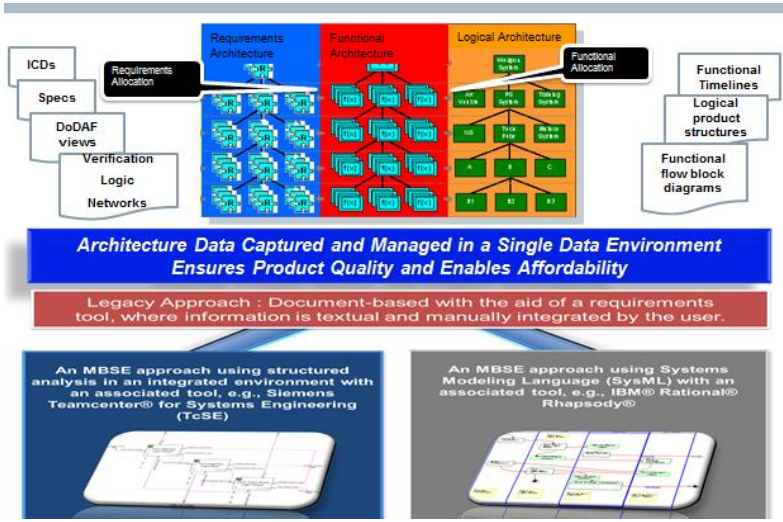
Benchmarking – Raytheon

Complex Model Ecosystem – Combined A fully integrated digital system model enables programs to pull a digital thread to analyze performance and change impacts faster and with more accuracy.



Benchmarking – Boeing Company

Integrated Product Architectures at The Boeing Company



- IPA is a enterprise effort to develop and deploy a common capability to enable Boeing engineers to integrate requirements, architectures, and analyses
- IPA uses a model based systems engineering (MBSE) approach in an integrated data environment
- The Integrated environment architectures enables consistent, seamless generation of SE artifacts and enables more effective system trades

BOEING

Paradigm Shift/Change:

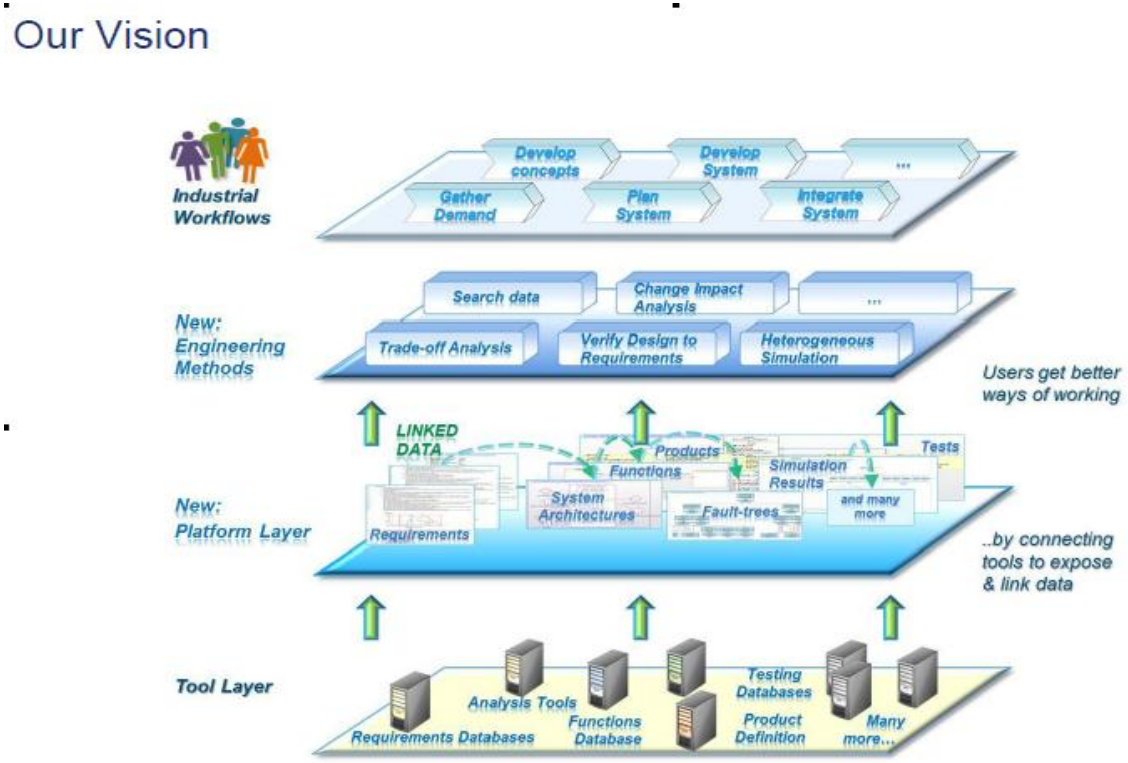
① Model is requirement;
② Model is technical baseline;
③ Model is component of product data;
④ Model is useful even it is not fully validated!

Key Points:

① Requirement Architecture;
② Single Data Environment;
③ Effective System Trades;
④ Quality & Affordability.

Benchmarking – Airbus Group

4 Layers: Workflow → Methods → Platform → Tools



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COMAC MBSE DreamWorks

Vision

- To be the industry leader in the area of MBSE

Mission

- To promote & Implement MBSE

Values

- Integrity, Innovation, Customer-Oriented, Continuous Improvement

Slogan

- We are OneTeam!

COMAC Approach to MBSE Implementation

- Education on the topic of MBSE
  - Grass-rooting 2 session of enterprise-wise formal SE training
  - Rotation within different organizations within COMAC for students
  - Re-establishment of basic SE beyond requirements management only
  - Importance of requirement & functional models
- Development of MBSE key capability for programs to use through pilot projects
- Development of guidance for how to use the MBSE developed capability
- A core group (COMAC MBSE DreamWorks) that provides support to all programs
- Means to capture and share successes and lessons learned within the enterprise

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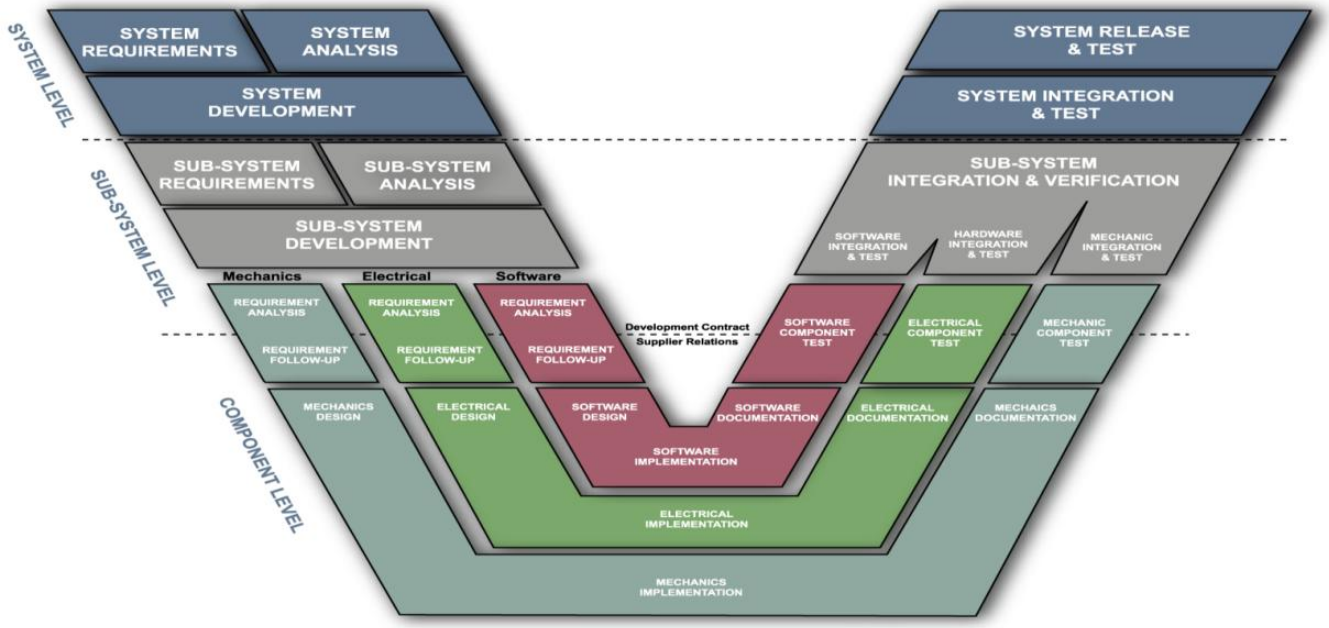
COMAC Approach to MBSE Tools & Methodologies

- Different tools & methodologies at different stages
  - Tools: Rhapsody, EA, Canpella, Matlab/Simulink, AMESim/SysDM/Synthesis
  - Methodologies: OOSEM(Incose Object-Oriented SE Method), RUP-SE



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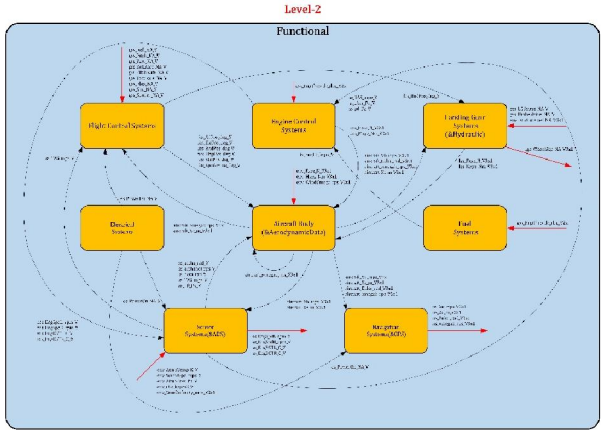
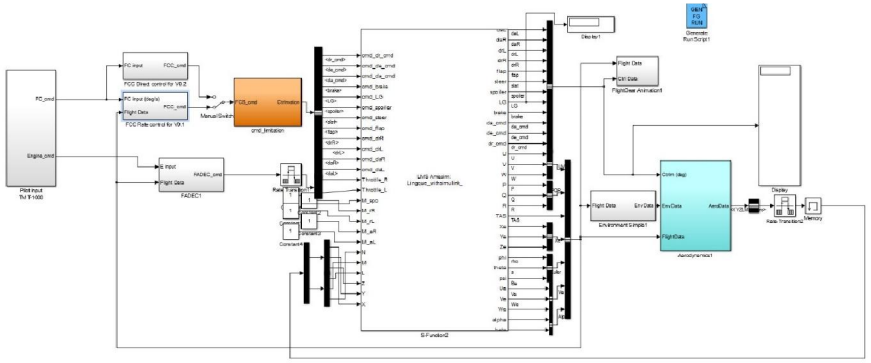
COMAC MBSE Implementation – Pilot Project

Use a small aircraft as a pilot project to demonstrate the MBSE implementation process





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COMAC MBSE Implementation – Pilot Project

Use a small aircraft as a pilot project to demonstrate the MBSE implementation process – Using Simulink as a common simulation platform

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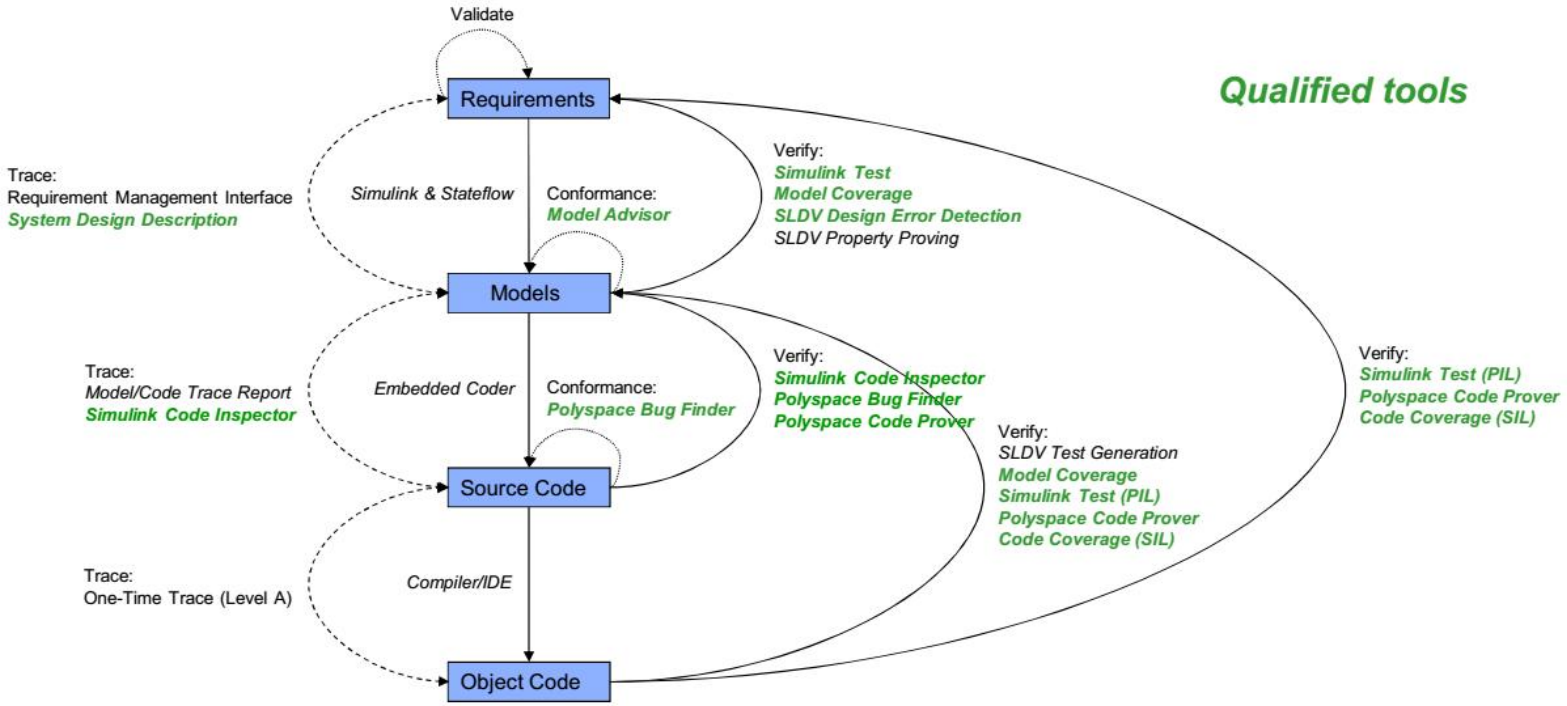
COMAC MBSE Implementation – Next Steps

Using MathWorks Certification Toolkit for Automatic Certification Compliance



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COMAC MBSE Needs

- **COMAC Cultural Change Needs**

- **COMAC Process Needs**
  - **Process methods to measure the impact of MBSE/MBD (Tangible values)**
  - **Training good modelers using levels I, II, and III**
  - **Process method to make sure the persistence of MBSE/MBD**
  - **Modeling guidelines and standards**

- **COMAC MBSE Tools Needs – With Tool Vendors Together**
  - **Tool support for distributed users across all enterprise**
  - **Tool support for reference model and model/data reuse**
  - **Configuration and version control tool for all objects**
  - **Exchange and synchronization of federated engineering data**
  - **Tool support for managing large quantity of model users**

COMAC MBSE Challenges

- **COMAC Cultural and Traditional Resistance (Need top leader)**
  - Communication and understanding of motivation of MBSE

- **COMAC MBSE Implementation Challenges**
  - Legacy and new product development methods conflicts
  - New MBSE process definition and adoption
  - MBSE V-shape whole life-cycle tool support
  - Product complexity and quantity of large engineering data
  - Diagramming (SysML) limitation

- **Training and Skill Challenges**
  - Knowing what to model at what level of detail based on the questions to be answered
  - Knowing what modeled data to analyze & how to analyze it
  - Need to have combination of 4 skills:
    1) SE knowledge and experience
    2) Product domain knowledge
    3) Tool use skills and modeling skills

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Summary

- **COMAC requires a balanced effort to implement MBSE/MBD due to the complex nature of commercial aircraft and cultural challenges**
- **Success has been seen on a variety of pilot programs**
- **COMAC will be committed to moving forward with MBSE/MBD**
- **COMAC needs help with integrating model/data among different tools for strengthening virtual system integration capability**

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Questions & Answers

Thank You for Your Attention

COMAC MBSE Approaches

OneVision, OneVoice, OneTeam, OneBrand