INTRODUCING THE

CAESAR Platform for MBSE

MBSE Symposium

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California Institute of Technology

What is CAESAR?

- CAESAR stands for **C**omputer **A**ided **E**ngineering for **S**ystems **AR**chitecture
  - A software platform to enable an integrated model centric approach to SE
    - Enables a methodology-driven use of SE tools to perform SE functions
    - Supports a federated multi-viewpoint agile systems development process
    - Promotes reuse of existing technology while minimizing vendor lock-in
    - Addresses key challenges of the current practice of MBSE
    - Infuses development best practices learned from software engineering

Model Based Systems Engineering (MBSE)

Integrated Model Centric Engineering (IMCE)

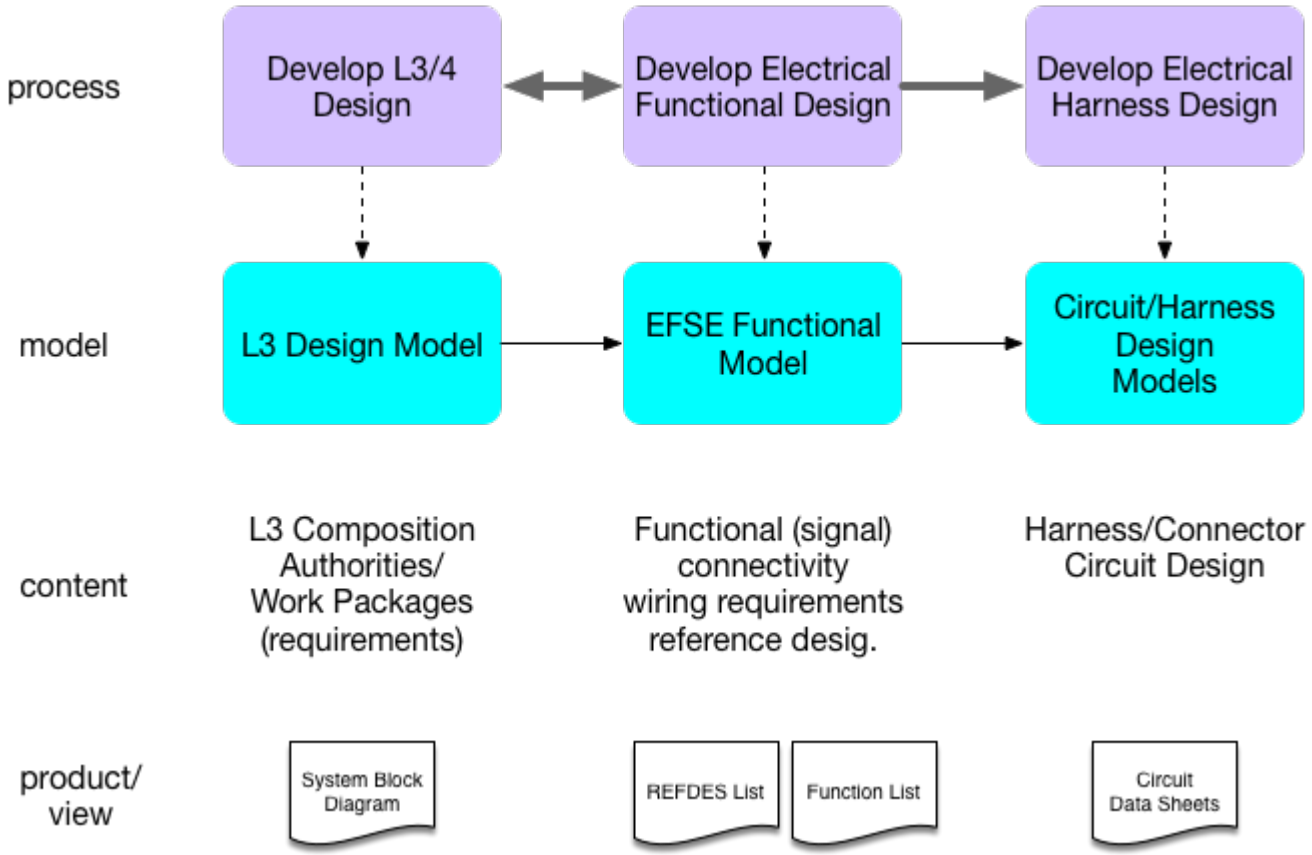
CAESAR Development Approach

Methodology

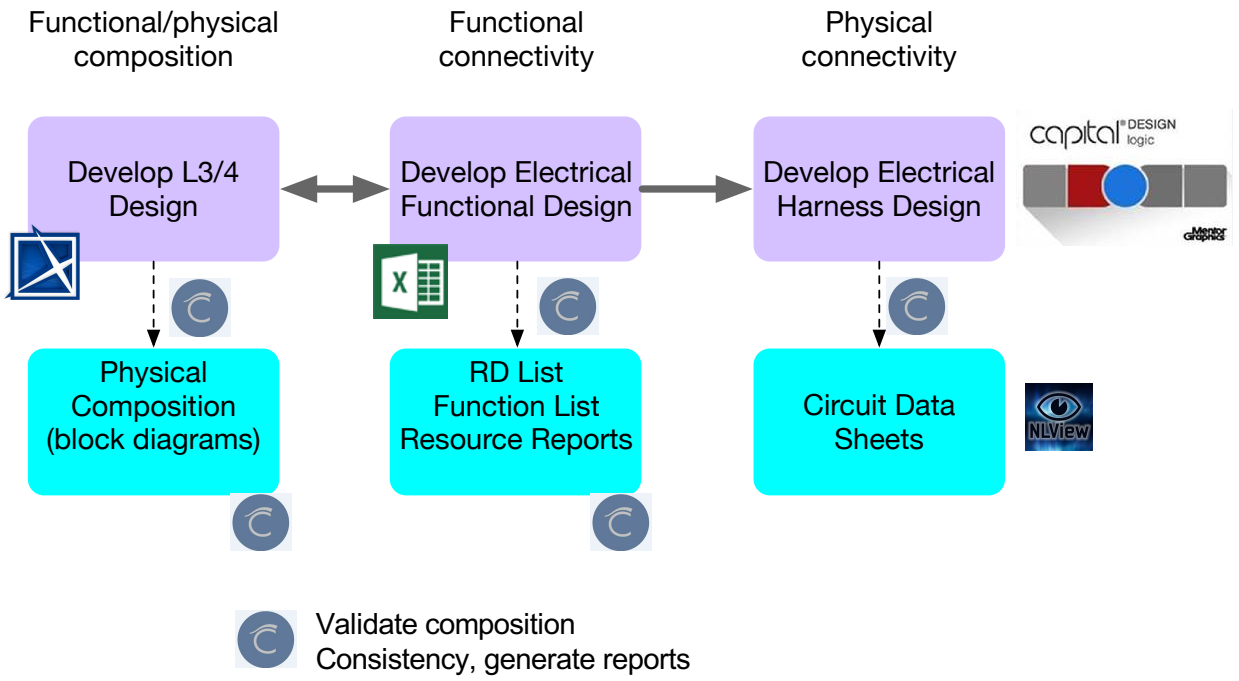
\+ Tooling/Models

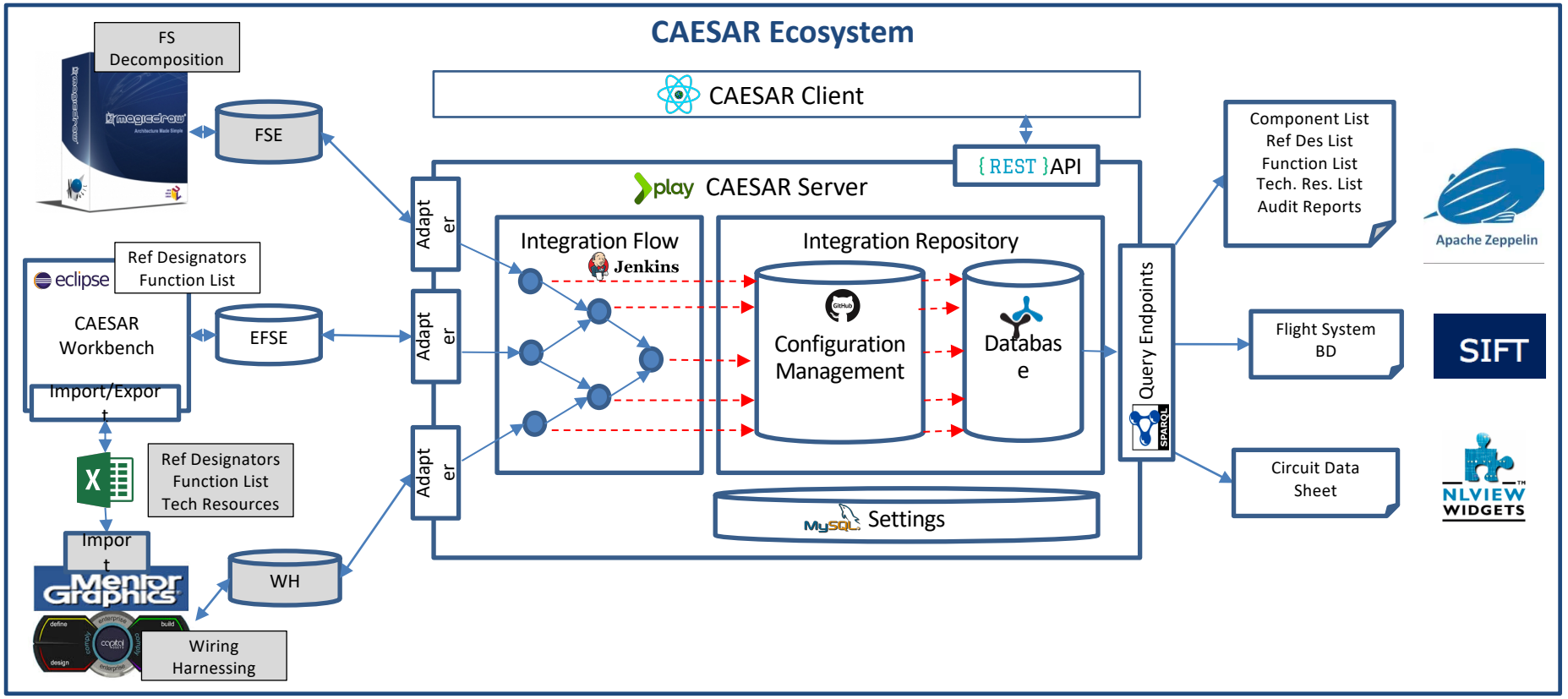
Product

Abstract EFSE-Harness Engineering Design Process



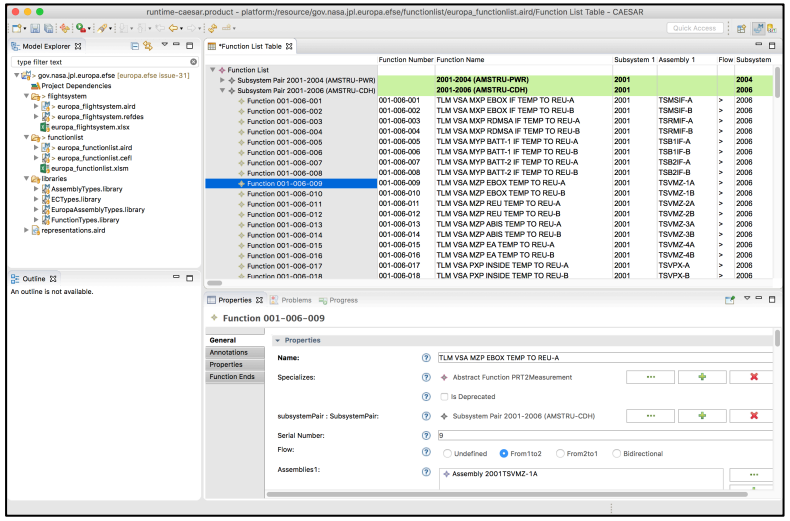
Functional Electrical FSE workflow




CAESAR Ecosystem
FS Decomposition
FSE
CAESAR Client
{ REST } API
play CAESAR Server
Adapter
Adapter
Adapter
Integration Flow
Jenkins
Integration Repository
Configuration Management
Database
Settings
Query Endpoints
SPARQL
Component List
Ref Des List
Function List
Tech. Res. List
Audit Reports
Flight System BD
Circuit Data Sheet
Apache Zeppelin
SIFT
NLVIEW WIDGETS
Ref Designators
Function List
CAESAR Workbench
Import/Export
EFSE
Ref Designators
Function List
Tech Resources
Import
Mentor Graphics
WH
Wiring Harnessing

CAESAR EFSE Workbench

- **Function**
  - Used to author EFSE models
- **Current implementation**
  - Import data from deprecated spreadsheets
  - Model physical FS decomposition
  - Model reference designators
  - Model electrical function list
  - Support model validation (error reports)
  - Support model export to Capital Logic
  - Support model change control in git
- **Going forward**
  - Authoring improvements suggested by users
  - Validation improvements suggested by users
  - New task-oriented viewpoints and analyses

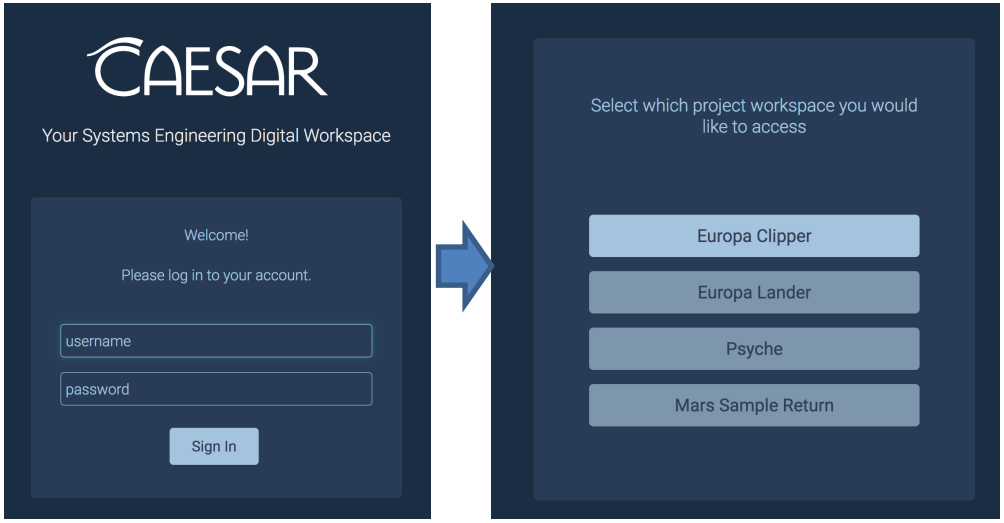


MBSE key challenges

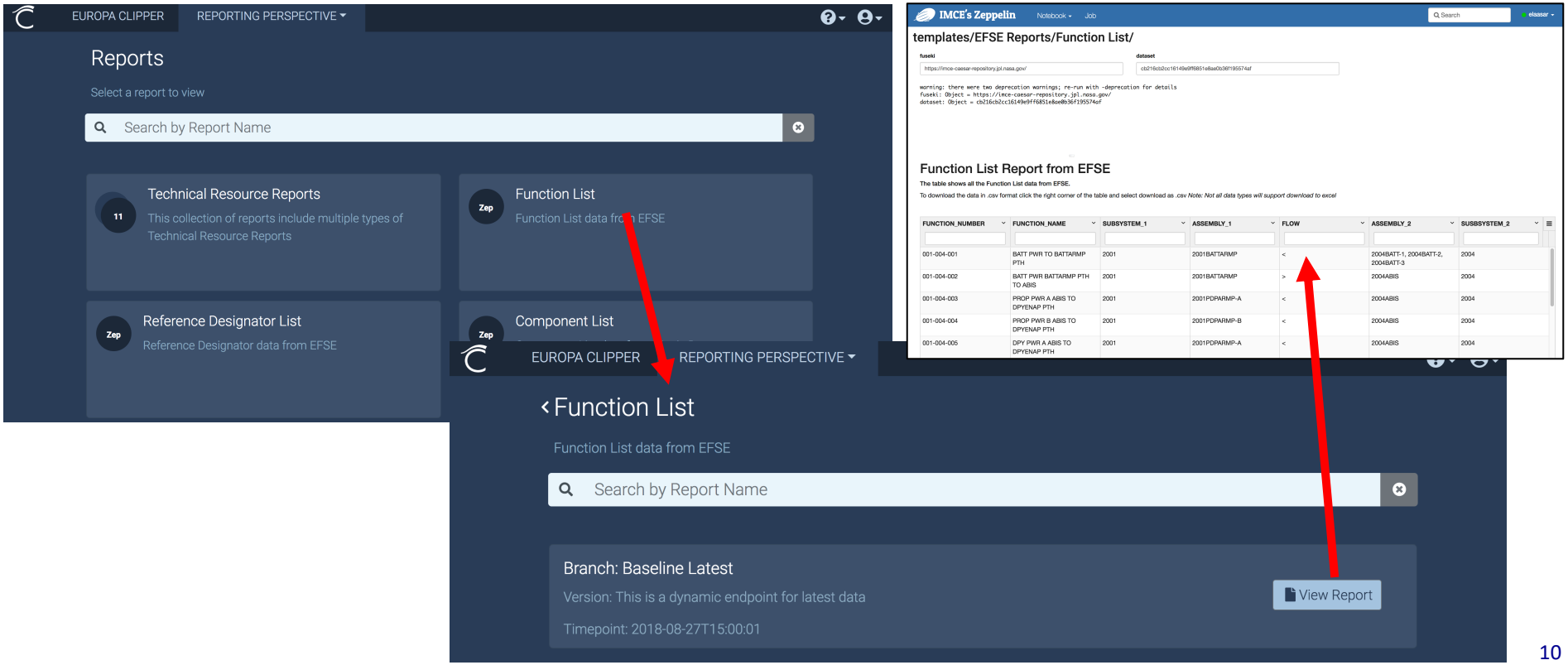
Challenges		Mitigations
System models can be created in SysML, but they are cumbersome to create and manage	→	We need to model using domain-specific vocabularies and tools to lower the bar to entry
Different projects create system models differently making it hard to reuse or analyze consistently	→	We need to define modeling methodologies and facilitate conforming to them using tools, as well as creating curated libraries and model templates
Heterogeneous tools and models are used in SE because many discipline-specific analyses are needed	→	We need effective model integration tools, facilitating cross tool linking or interchange, and methods to keep the models aligned
Model content is rapidly changing as work progresses, increasing risk, and latency in decision making	→	We need effective cross-tool configuration management, change management, and continuous and automated consistency check
For models to be effective, it has to be easy to present their content via meaningful viewpoints	→	We need easy to use reporting tools to generate reports, documents, and other viewpoints of model information

CAESAR Server

- **Function**
  - Used to run integrations, perform analysis, and produce reports
- **Current Implementation**
  - Adapters to CAESAR WB, MagicDraw, Capital Logic
  - Reporting perspective to search for or browse reports
  - Over 30 EFSE requested report types (function list, margin reports, overloaded switches …)
  - Flight system block diagram as a report (by integrating SIFT/Tom Sawyer)
  - Authentication via OpenID
- **Going Forward**
  - Configuration perspective
  - Integration perspective
  - Review and approve perspective
  - Role based access control
  - Single-sign-on (SSO) experience
  - Other adapters, analysis and report kinds



CAESAR Server (Reporting Perspective)



Example Reports

SUBSYSTEM_NUMBER	ACRONYM	NAME	REFERENCE_DESIGNATOR
2001	PDPARMP	PDPARMP-A	2001PDPARMP-A
2001	PDPARMP	PDPARMP-B	
2001	TSB1IF	TSB1IF-A	
2001	TSB1IF	TSB1IF-B	
2001	TSB2IF	TSB2IF-A	
2001	TSB2IF	TSB2IF-B	
2001	TSDSSH1AIFH	TSDSSH1AIFH-A	
2001	TSDSSH1AIFH	TSDSSH1AIFH-B	
2001	TSDSSH1BIFH	TSDSSH1BIFH-A	
			2001TSDSSH2AHIF-B

ss1_id	2000	2001	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2021
2000	·	·	·	·	·	·	·	·	·	·	·	·	·
2001	·	·	·	8	·	70	·	·	·	·	·	·	·
2002	·	·	4	24	·	114	·	·	·	·	·	·	·
2004	·	·	·	9	10	28	52	2	16	·	26	10	60
2005	·	·	·	·	·	24	·	·	·	·	·	·	·
2006	·	·	·	·	·	192	96	48	18	·	46	34	2
2007	·	·	·	·	·	·	56	·	6	·	·	·	·
2008	·	·	·	·	·	·	·	·	·	·	·	·	·
2009	·	·	·	·	·	·	·	·	10	·	·	·	·
2010	·	·	·	·	·	·	·	·	·	56	·	·	120
2011	·	·	·	·	·	·	·	·	·	·	14	·	·
2012	·	·	·	·	·	·	·	·	·	·	·	28	·

Function List Report from EFSE

The table shows all the Function List data from EFSE.

To download the data in .csv format click the right corner of the table and select download as .csv *Note: Not all data types will support download to excel*

FUNCTION_NUMBER	FUNCTION_NAME	SUBSYSTEM_1	ASSEMBLY_1	FLOW	ASSEMBLY_2	SUBSYSTEM_
		2004				
004-004-001	TLM BATT-1 VMON TO PBC	2004	2004BATT-1	>	2004PBC	2004
004-004-002	TLM BATT-2 VMON TO PBC	2004	2004BATT-2	>	2004PBC	2004
004-004-003	TLM BATT-3 VMON TO PBC	2004	2004BATT-3	>	2004PBC	2004
004-004-004	TLM BATT-1 INTEMP TO PBC PTH	2004	2004BATT-1	>	2004PBC	2004
004-004-005	TLM BATT-2 INTEMP TO PBC PTH	2004	2004BATT-2	>	2004PBC	2004
004-004-006	TLM BATT-3 INTEMP TO PBC PTH	2004	2004BATT-3	>	2004PBC	2004
004-004-007	TLM BATT-1 INTEMP TO PBC	2004	2004BATT-1	>	2004PBC	2004
004-004-008	TLM BATT-2 INTEMP TO PBC	2004	2004BATT-2	>	2004PBC	2004
004-004-009	TLM BATT-3 INTEMP TO PBC	2004	2004BATT-3	>	2004PBC	2004
004-004-010	UMB CMD BATT SW 1	2004	2004PBC	>	2004ABIS	2004

SUBSYSTEM	TOTALFUNCTION	2A	4A	5A
AMSTRU	79	6	0	0
CDH	958	0	0	4
EIS	94	13	0	1
ETHEMIS	21	2	0	1
GNC	210	4	0	4
ICEMAG	46	7	0	0
IMB	0	0	0	0
MASPEX	29	4	0	2
MISE	31	6	0	1
PIMS	29	4	0	0
PME	488	2	0	0
PMHARN	4	0	0	0
PMSTRU	614	0	0	0
PROP	340	0	0	0

Promo

- More detailed exposition of the architecture, extension points, and current applications
- Discussion on how other teams can contribute and collaborate

A Digital Transformation Platform for System Engineering

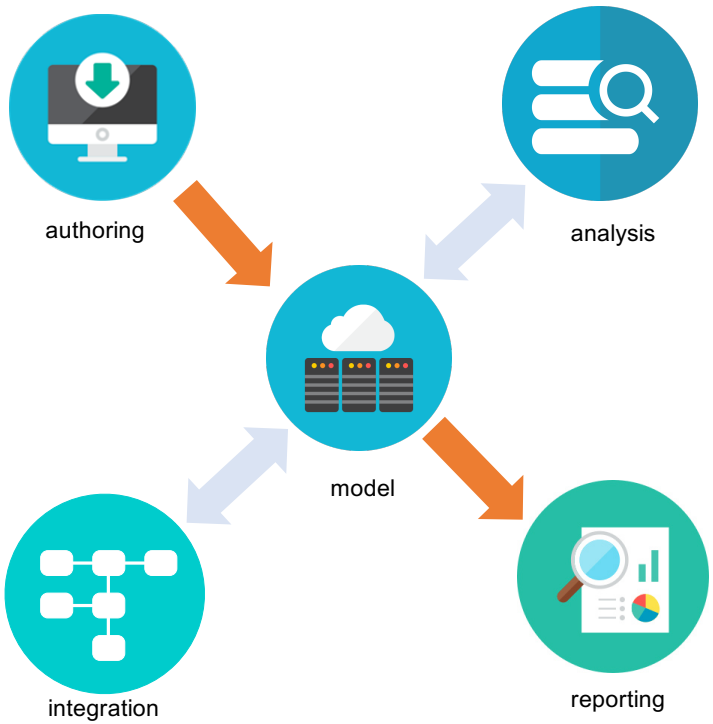
M. Elaasar (JPL), S. Gerard (CEA-LIST)

Break-out session today (Thursday Jan 24) 15:30

BACKUP

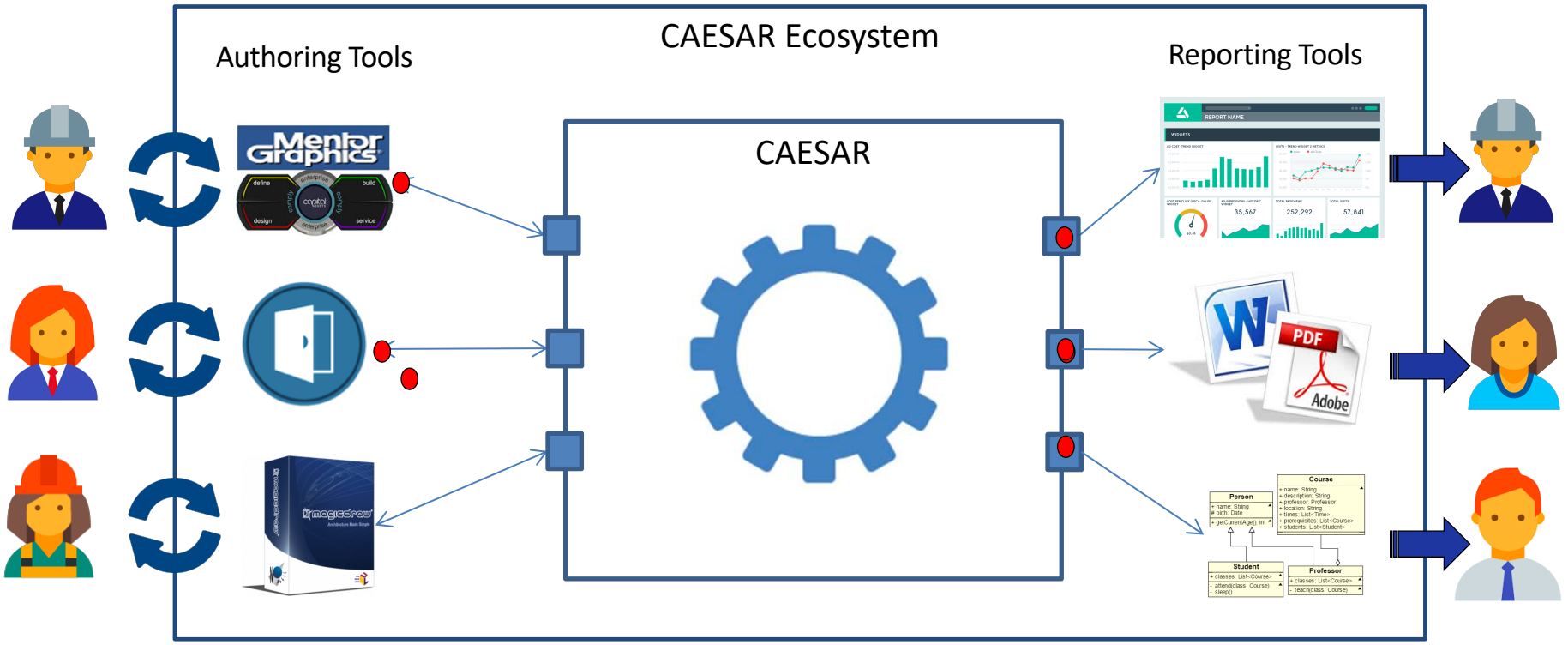
Key Functions

- **Information Management**
  - Configuration management, version control, and provenance for precise facts
- **Information Authoring**
  - Adapt viewpoints in existing model authoring tools
  - Build new domain-specific model authoring viewpoints as needed
  - Provide curated starting point model templates and libraries
- **Information Integration (Workflow)**
  - Modeling and executing information flow between models/repositories in a controlled way
- **Information Analysis**
  - Provide access to model information through simple, standards-based query languages (SPARQL)
- **Information Reporting**
  - Generate reports through multiple presentation tools
  - Provide APIs to enable version differencing, trending, etc.



CAESAR Concept

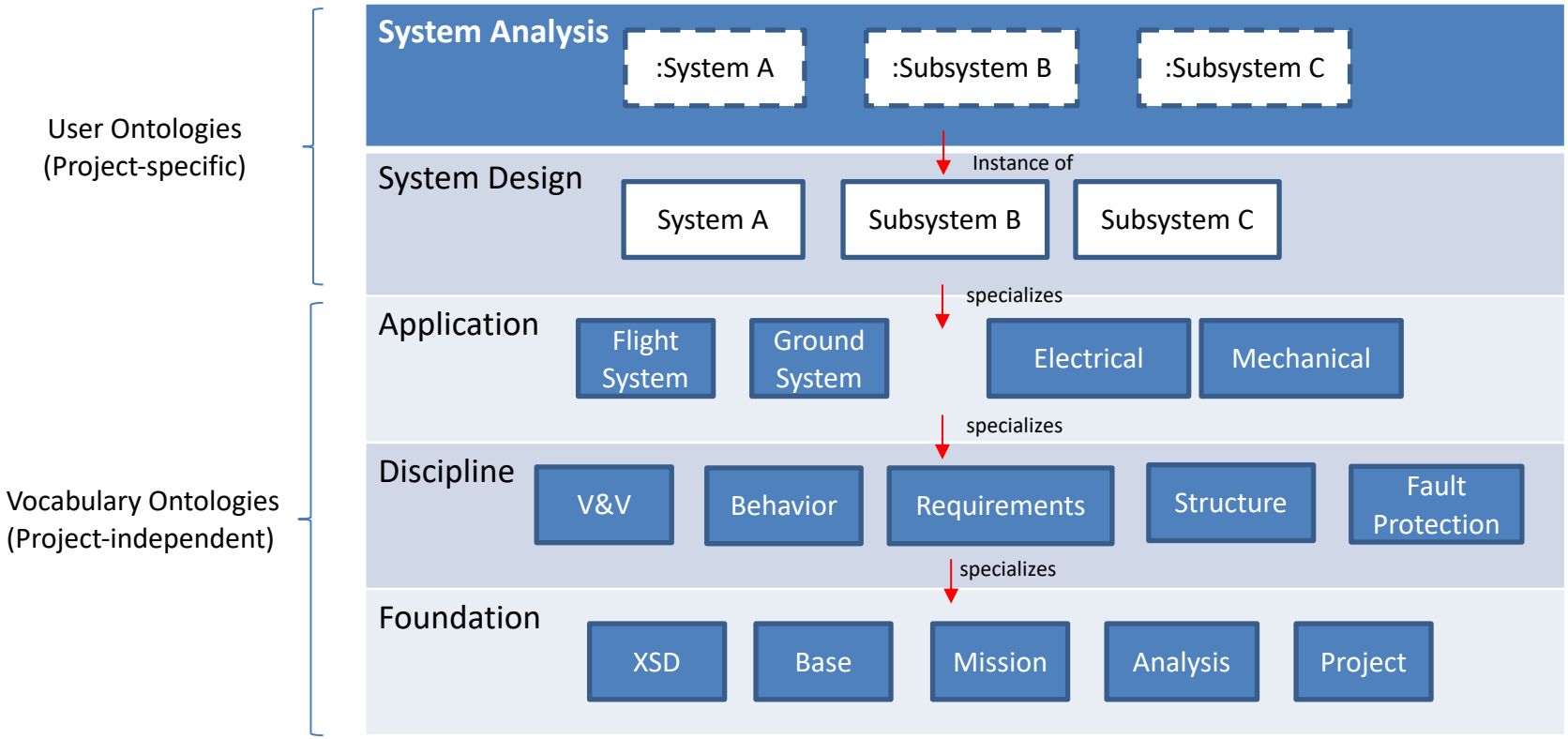
- **A semantic data warehouse system for MBSE**
  - Acquires information from SE authoring tools (COTS/custom) acting as data sources
  - Curates, integrates, configuration manages SE information in one place
  - Verifies the consistency of federated information and measures precise differences
  - Analyzes information, generates reports and proposes changes



Information Management

- **Focus on Information – not just Data**
- **Information we care about is modeled using Semantic Web ontologies**
  - Based on a widely used standard formalism for knowledge representation
  - Allows organization of information into loosely coupled components
  - Has well-defined semantics based on Description Logic (allows reasoning)
  - Essential that descriptions are precisely difference-able
- **Different tools may use different representations**
  - Ok as long as we can map to ontologies through model transformations
  - We've implemented OML as a more concise form of OWL2-DL with several different serializations to make some common transformations easy

Information architecture



Based on Semantic Web Standards

W3C OWL2 OML