



**Jet Propulsion Laboratory**  
California Institute of Technology

# CAESAR

## A Platform to Modernize Systems Engineering

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California Institute of Technology

# Roadmap of Systems Engineering



Document Based  
Systems Engineering



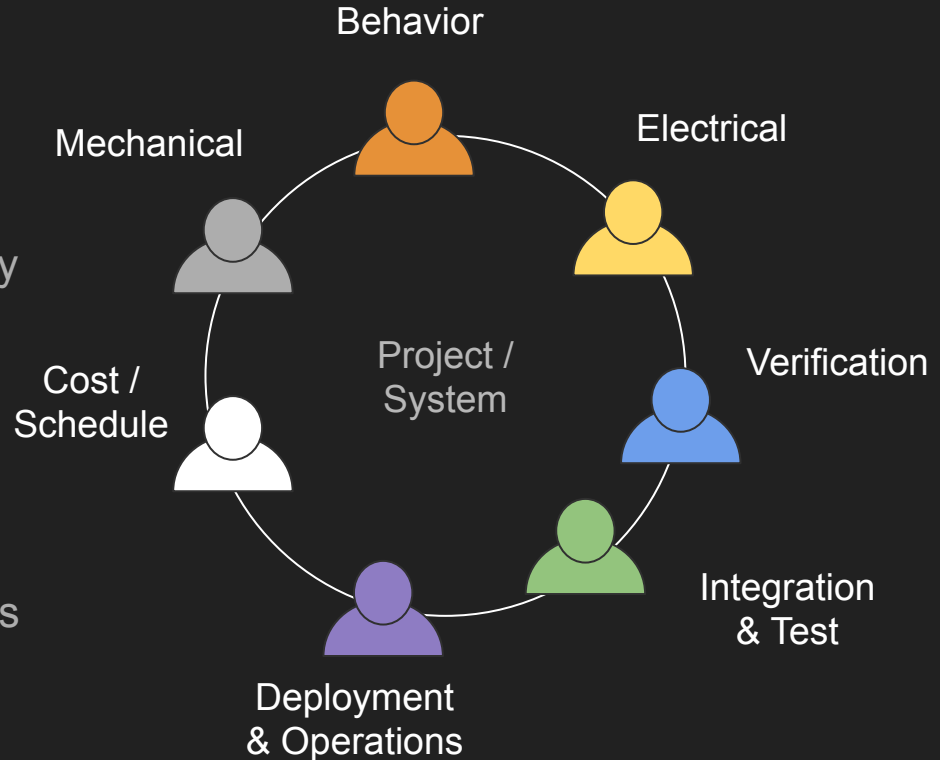
Model Based  
Systems Engineering



Integrated Model  
Centric Engineering

# Information in Systems Engineering Today

- ▼ Is mostly captured informally
- ▼ Spans multiple domains / disciplines
- ▼ Does not follow well-defined methodology
- ▼ Is configuration managed in silo tools
- ▼ Is adhocly and Infrequently integrated
- ▼ Is not analyzed automatically enough
- ▼ Is not easily traceable to its provenance
- ▼ Is not properly change controlled
- ▼ Is not effectively shared with stakeholders



# CAESAR: Computer Aided Engineering for Systems Architecture

DSL

Allows defining a SE methodology with a set of interrelated domain specific languages (DSLs)



Allows representing information precisely using semantic web (OWL2-DL) ontologies



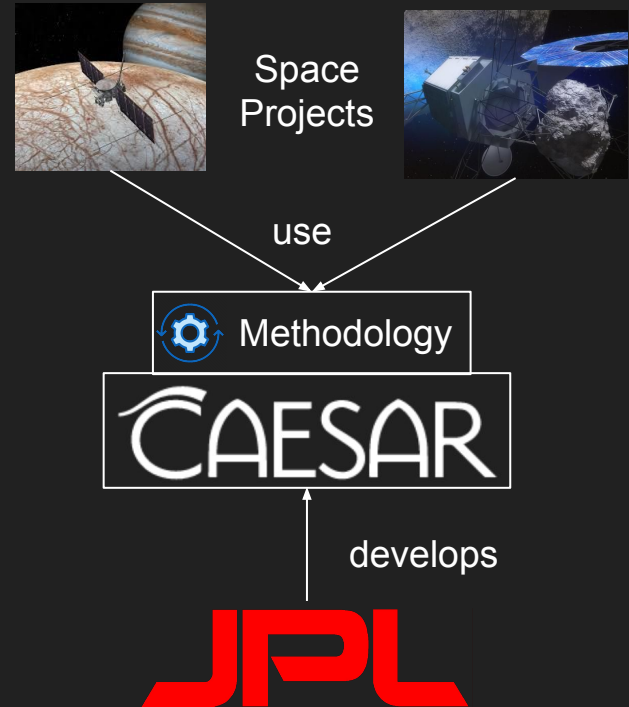
Allows integration of information in engineering tools based on the methodological DSLs



Allows federated configuration management, linking and reconciliation of datasets



Allows employing the DevOps practices (CI/CD) in the systems engineering process

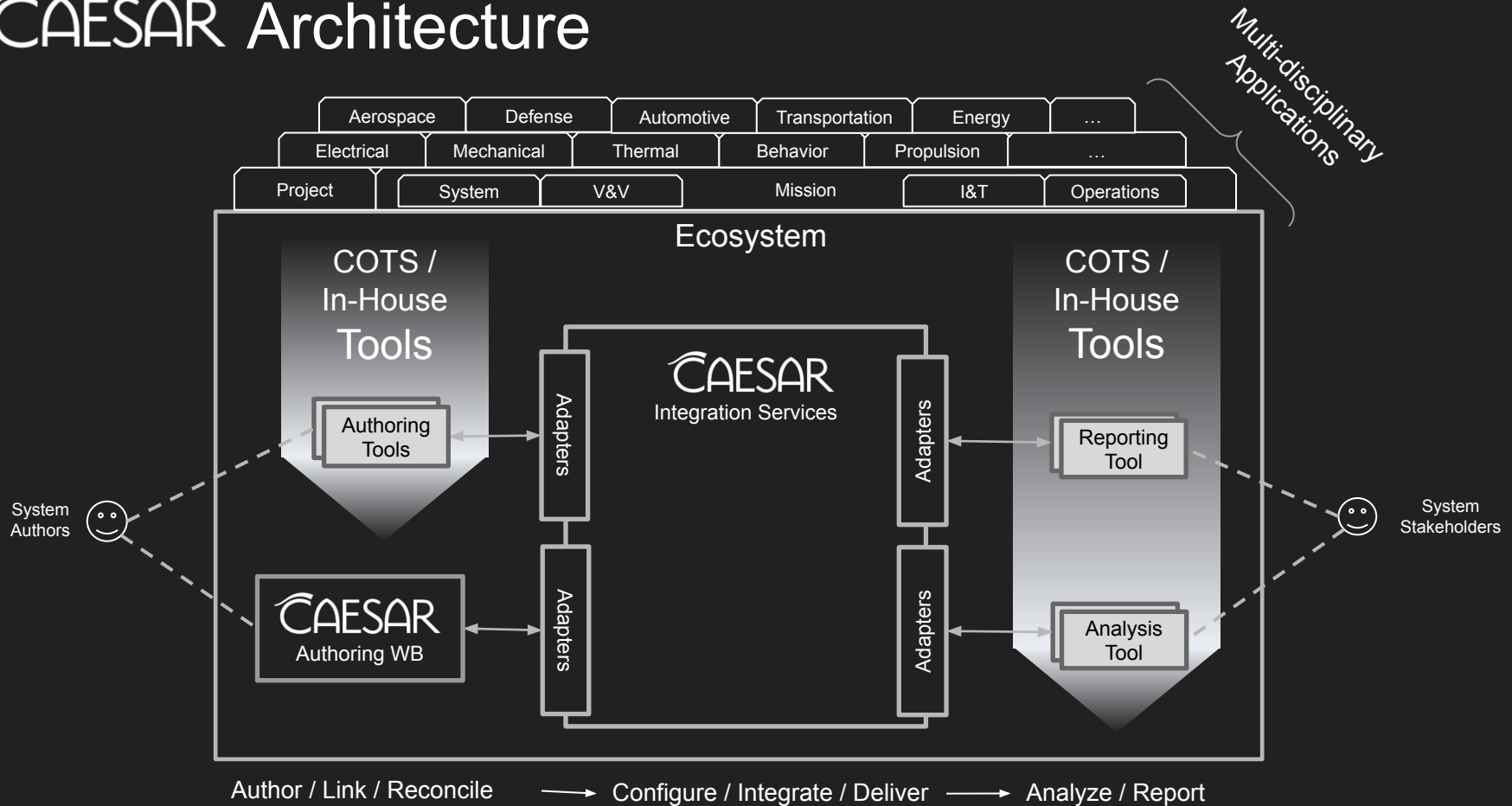


# CAESAR Main Functions


- 1. Information Representation**  
Semantic web ontologies with precise syntax and logical semantics
- 2. Information Authoring**  
Methodology-specific authoring using COTS and In-house tools
- 3. Information Federation**  
Organized based on provenance and managed by authorities
- 4. Information Configuration**  
Support for different configurations / management of dependencies
- 5. Information Integration**  
Continuous and incremental integration of federated datasets
- 6. Information Analysis**  
Scalable analysis of consistency, correctness, and completeness
- 7. Information Reporting**  
Dashboards of canned / dynamic reports for different stakeholders

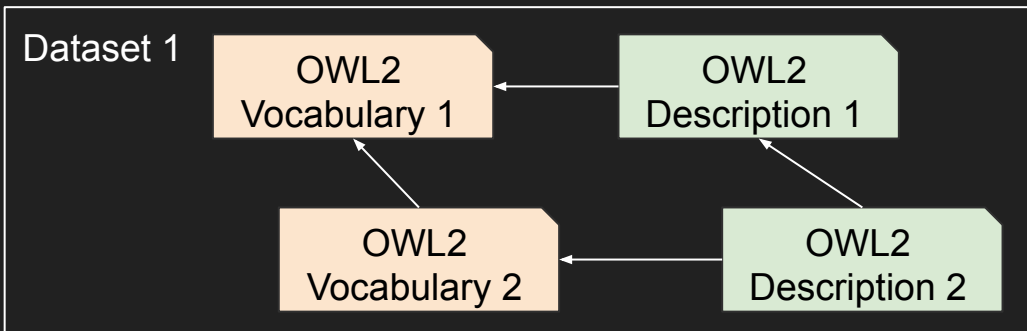


# CAESAR Architecture

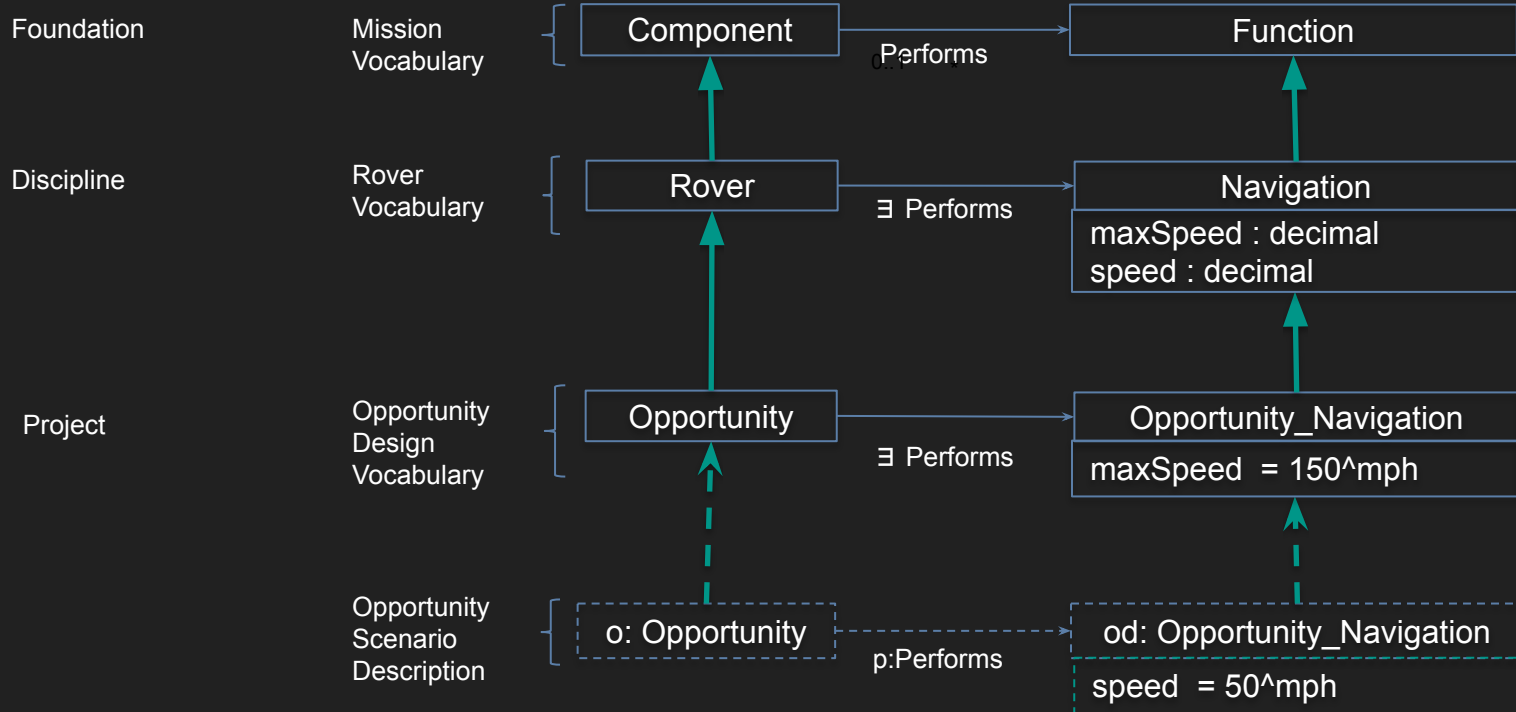


# Information Architecture

- Information is represented using  **OWL2** DL ontologies
- Ontology can be either Vocabulary (T-box) or Description (A-box)
- Vocabulary is used to define a DSL syntax and logical semantics
- Description is used to assert information using a vocabulary
- A catalog of interrelated ontologies is called a **dataset**

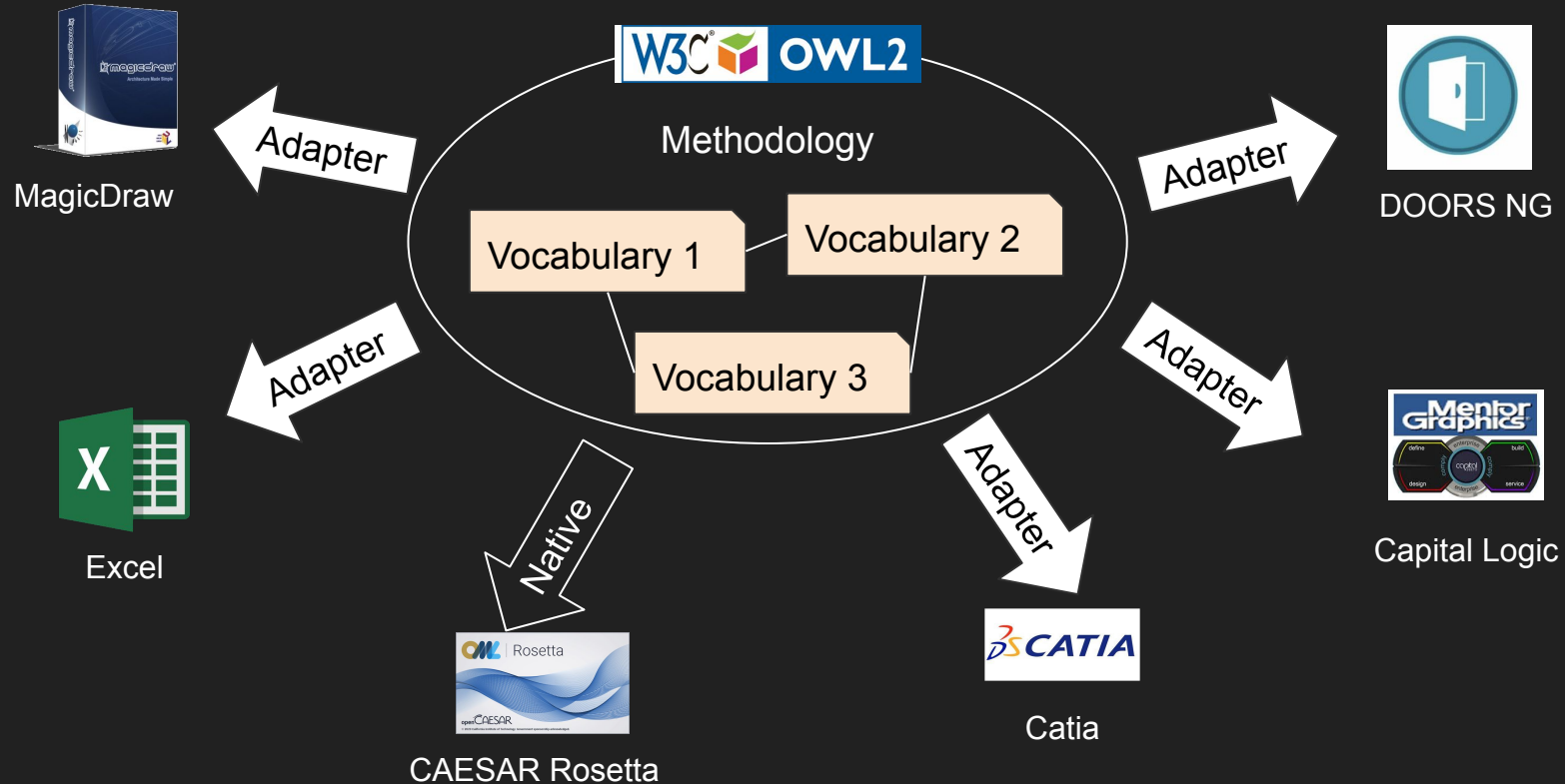


# Example Semantic Web Based Architecture

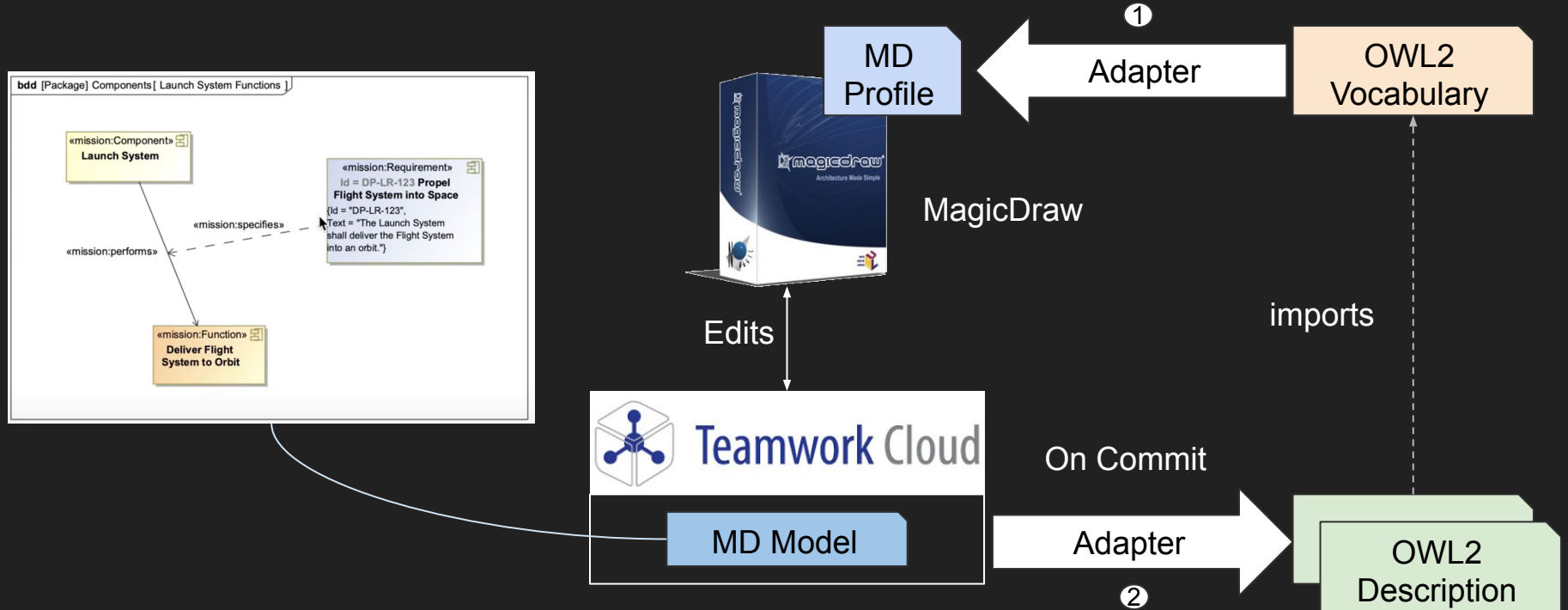




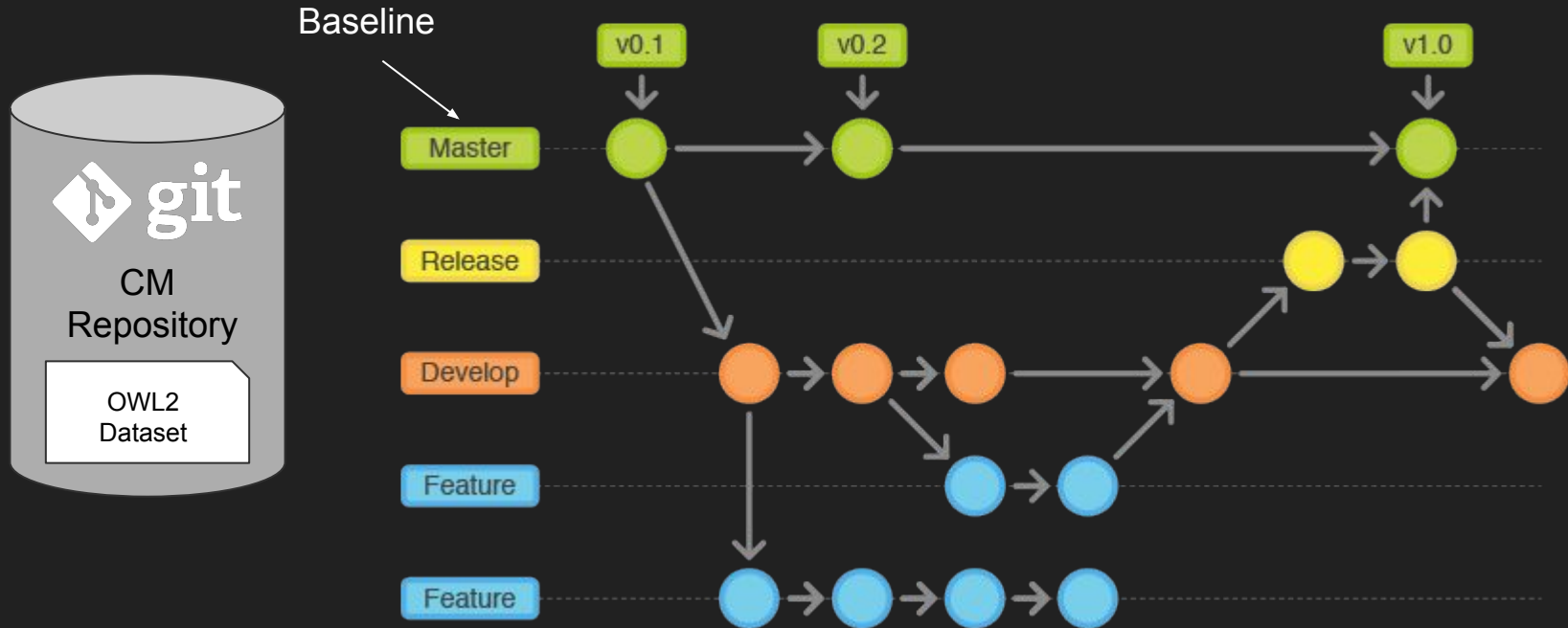
# UC1: Methodology Based Authoring



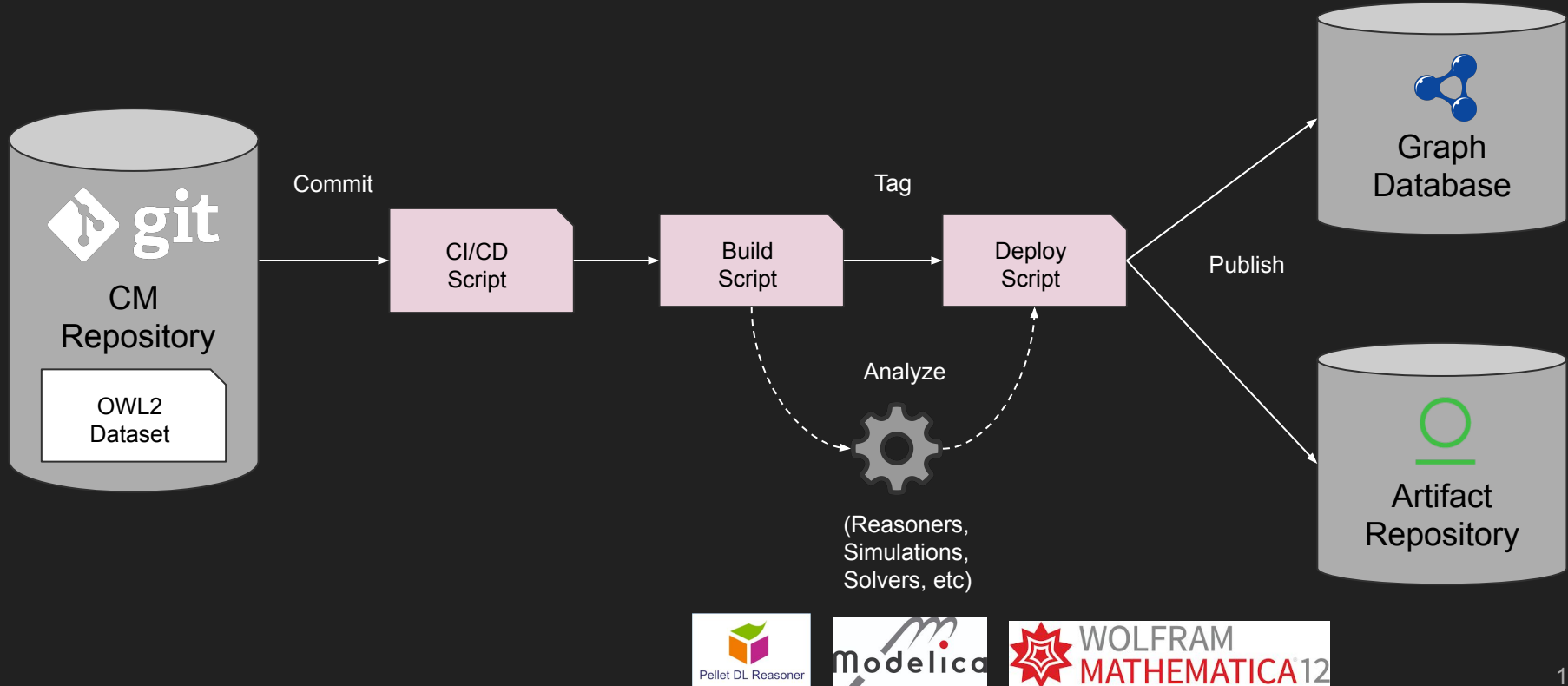
# Normalizing Systems Engineering Information



# UC2: Information Configuration Management

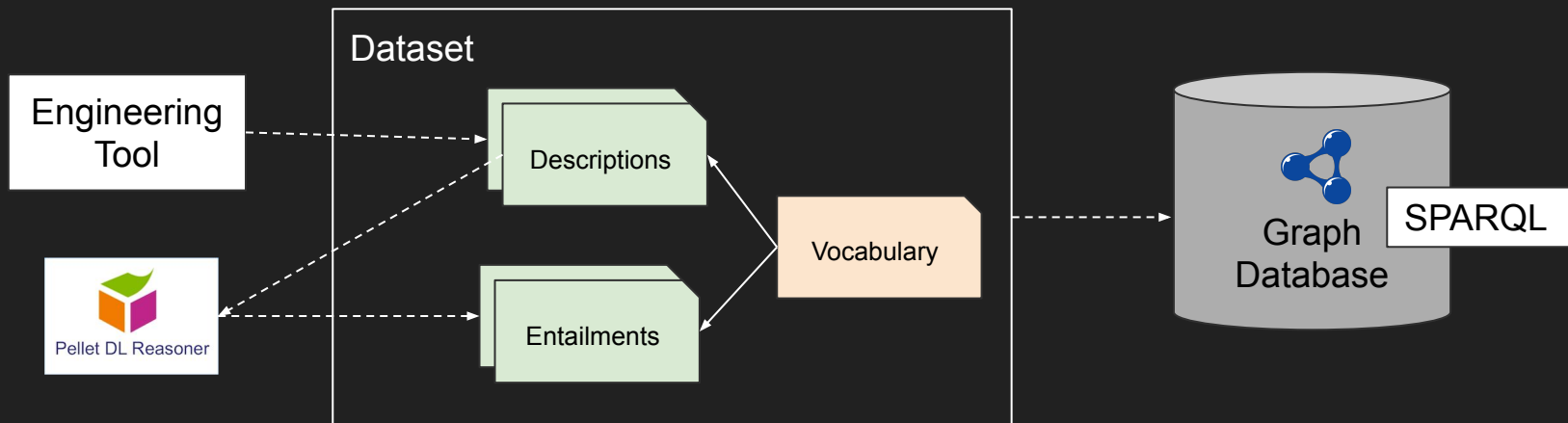


# UC3: Continuous Integration and Delivery



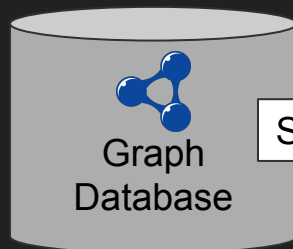
# Information Analysis

- OWL2-DL Ontologies can be checked for consistency using DL Reasoners
- Reasoner enriches a dataset with **entailments** using semantic rules
- Dataset can be loaded to a graph database with a **SPARQL** query endpoint



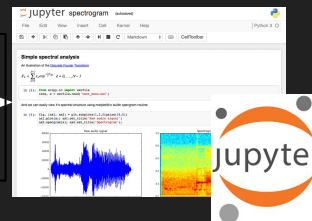
# UC4: Framing Stakeholder Concerns

Historical info can  
be reloaded from  
any commit in the  
CM repository

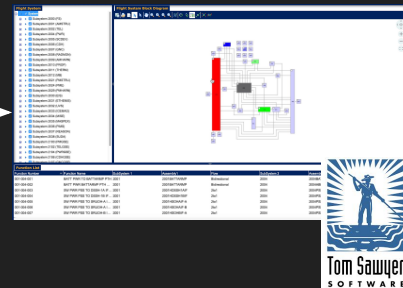
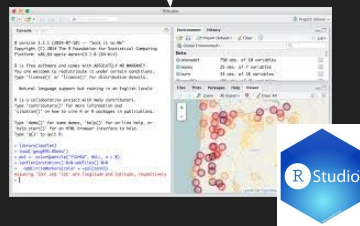
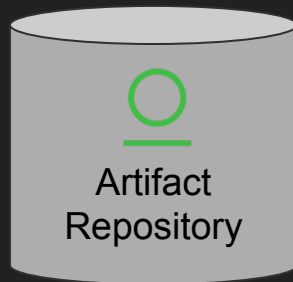


SPARQL

Dynamic viewpoints



Every artifact is  
stored with its full  
provenance info



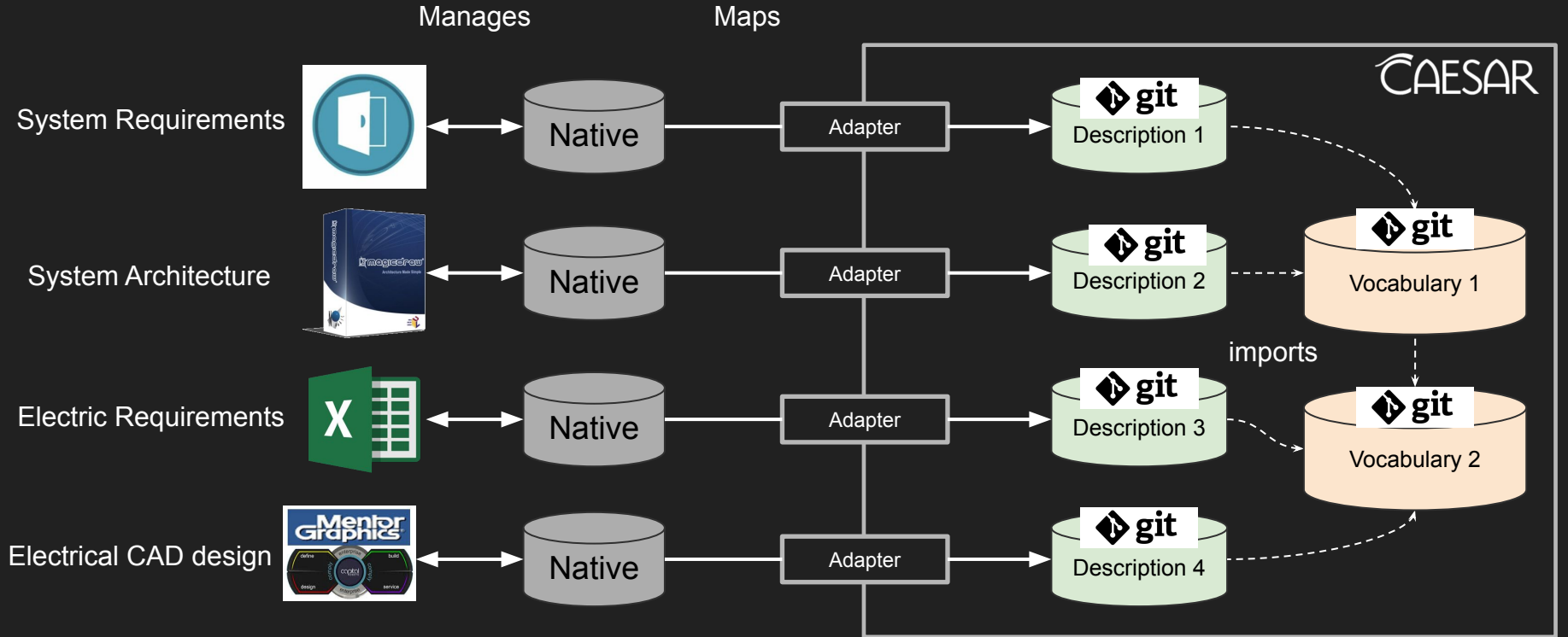
Canned viewpoints

A red icon representing a PDF file.

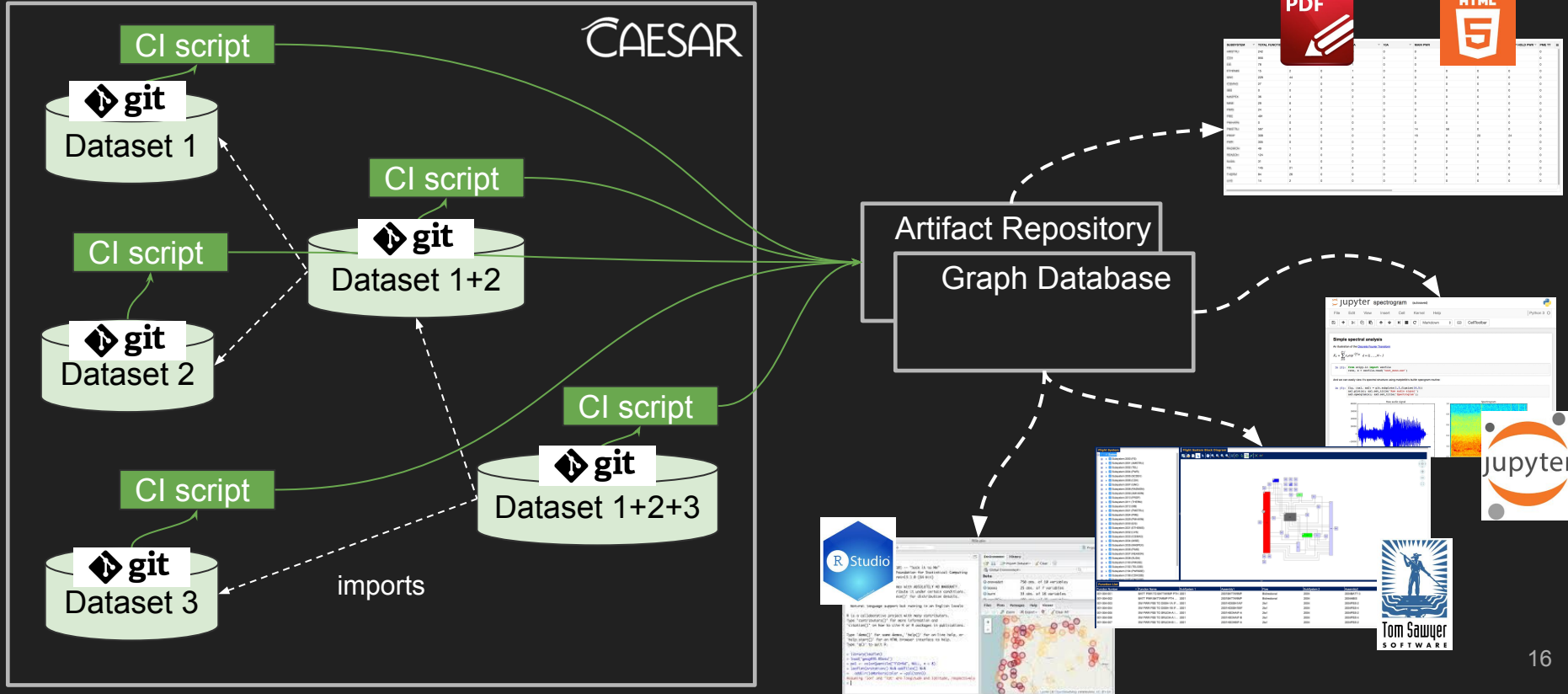
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1004	1004	1004	1004	1004	1004
1005	1005	1005	1005	1005	1005
1006	1006	1006	1006	1006	1006
1007	1007	1007	1007	1007	1007
1008	1008	1008	1008	1008	1008
1009	1009	1009	1009	1009	1009
1010	1010	1010	1010	1010	1010

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# UC5: Federation of Information Datasets

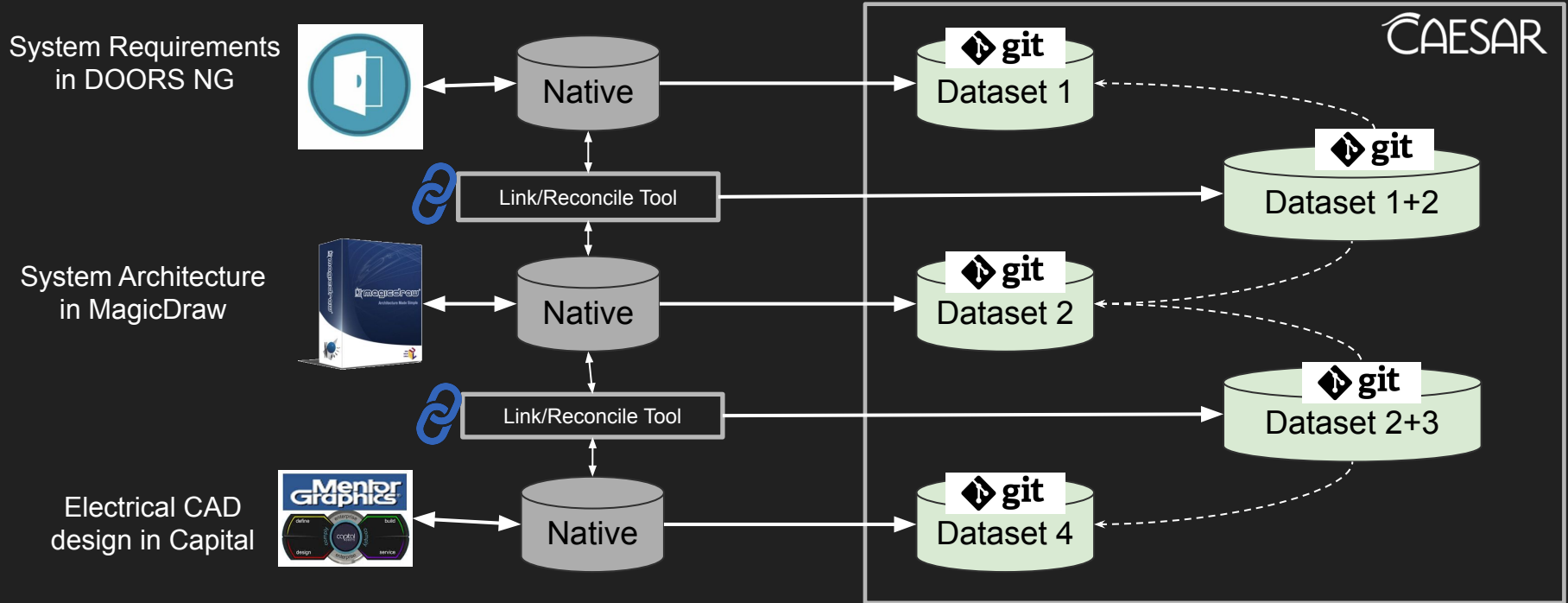


# UC6: Incremental Integration of Federated Datasets

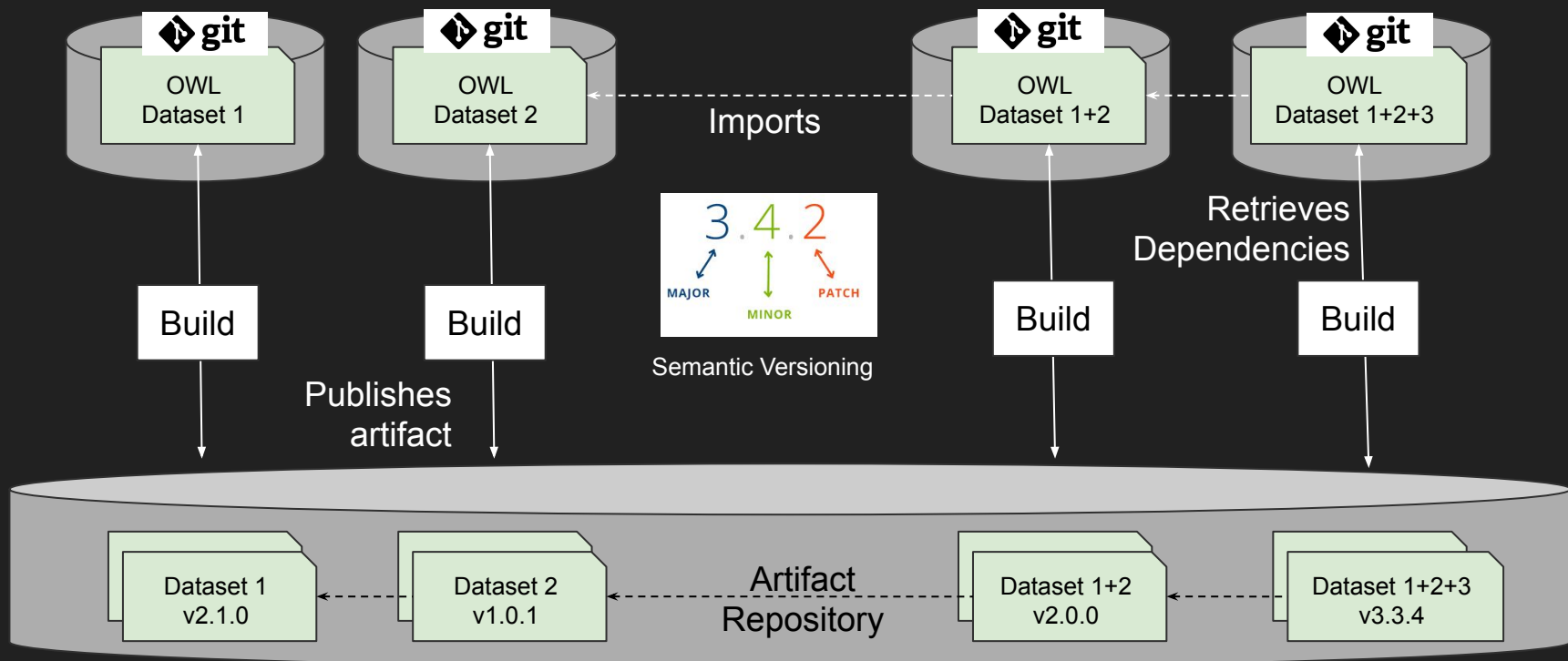




# UC7: Linking and Reconciliation

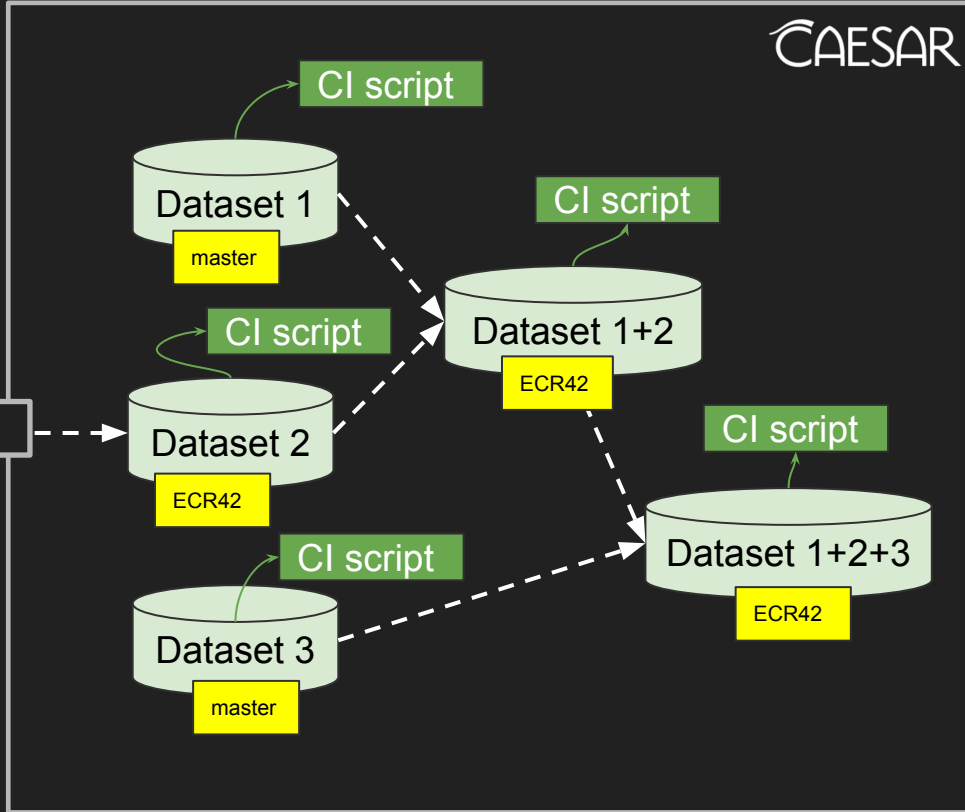
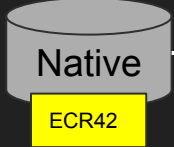


# UC8: Dependency Management



# UC9: Analyzing Change Impact

System Architecture  
in MagicDraw



CAESAR

master compared with ECR 42 [Full Report](#) | Differences Only

2002 TEL Telecommunications Subsystem

State	CBE	MEV	Contingency
■ Ka-Band Transmit	11.5W	13.2W	15%
	13.5W		
■ X + Ka-Band Transmit	15.0W	17.3W	15%
■ X-Band Transmit	9.8W	11.2W	15%
■ Ka-Band Transmit	11.5W	13.2W	15%
	10.5W	14.2W	13%
■ X + Ka-Band Transmit	15.0W	17.3W	15%

Power Equipment List Comparison

Generated: 2002-02-28 10:00:00

[Share Report](#) [Download](#)

1. 2002 TEL Telecommunications Subsystem

2. master compared with ECR 42

3. 2002 TEL Telecommunications Subsystem

State	CBE	MEV	Contingency
2002FRA-A Frontier Radio A			
■ Ka-Band Transmit	11.5W	13.2W	15%
	13.5W		
OFF	0.0W	0.0W	15%
■ X + Ka-Band Transmit	15.0W	17.3W	15%
X-Band Receive	6.3W	7.2W	15%
■ X-Band Transmit	9.8W	11.2W	15%
OFF	0.0W	0.0W	15%
X + Ka-Band Transmit	15.0W	17.3W	15%
2002FRA-A Frontier Radio B			
■ Ka-Band Transmit	11.5W	13.2W	15%
	10.5W	14.2W	13%
OFF	0.0W	0.0W	15%
■ X + Ka-Band Transmit	15.0W	17.3W	15%
X-Band Receive	6.3W	7.2W	15%
X-Band Transmit	9.8W	11.2W	15%
OFF	0.0W	0.0W	15%
X + Ka-Band Transmit	15.0W	17.3W	15%

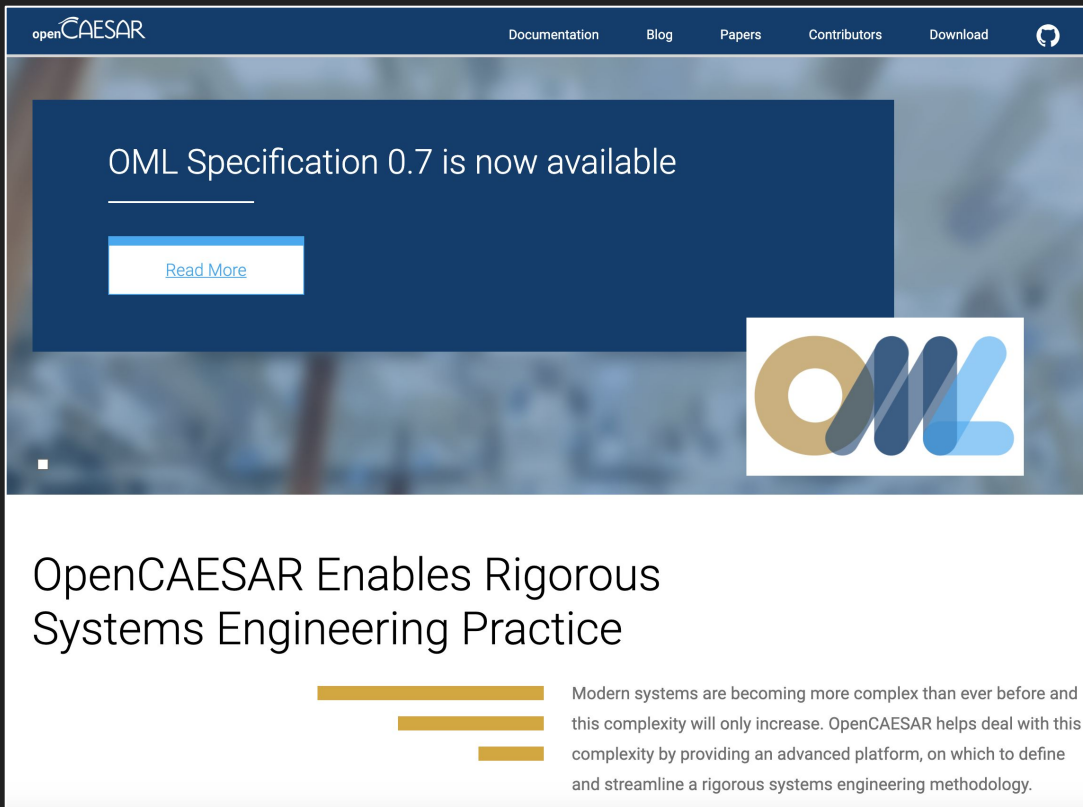
# openCAESAR

Blog: <https://opencaesar.github.io/>

Github: <https://github.com/opencaesar>



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A screenshot of the openCAESAR website. The header is dark blue with the 'openCAESAR' logo on the left and navigation links 'Documentation', 'Blog', 'Papers', 'Contributors', and 'Download' on the right. A large blue banner features the text 'OML Specification 0.7 is now available' and a 'Read More' button. To the right of the banner is the OML logo, which consists of a stylized 'O' and 'M' in blue and yellow. Below the banner, the main heading reads 'OpenCAESAR Enables Rigorous Systems Engineering Practice'. To the right of this heading is a quote: 'Modern systems are becoming more complex than ever before and this complexity will only increase. OpenCAESAR helps deal with this complexity by providing an advanced platform, on which to define and streamline a rigorous systems engineering methodology.' The quote is preceded by three horizontal bars of increasing length.

# THANK YOU !

