Model-Based IDSK: A Standardized Approach to Mitigating Decision Support Challenges during Acquisition Test and Evaluation

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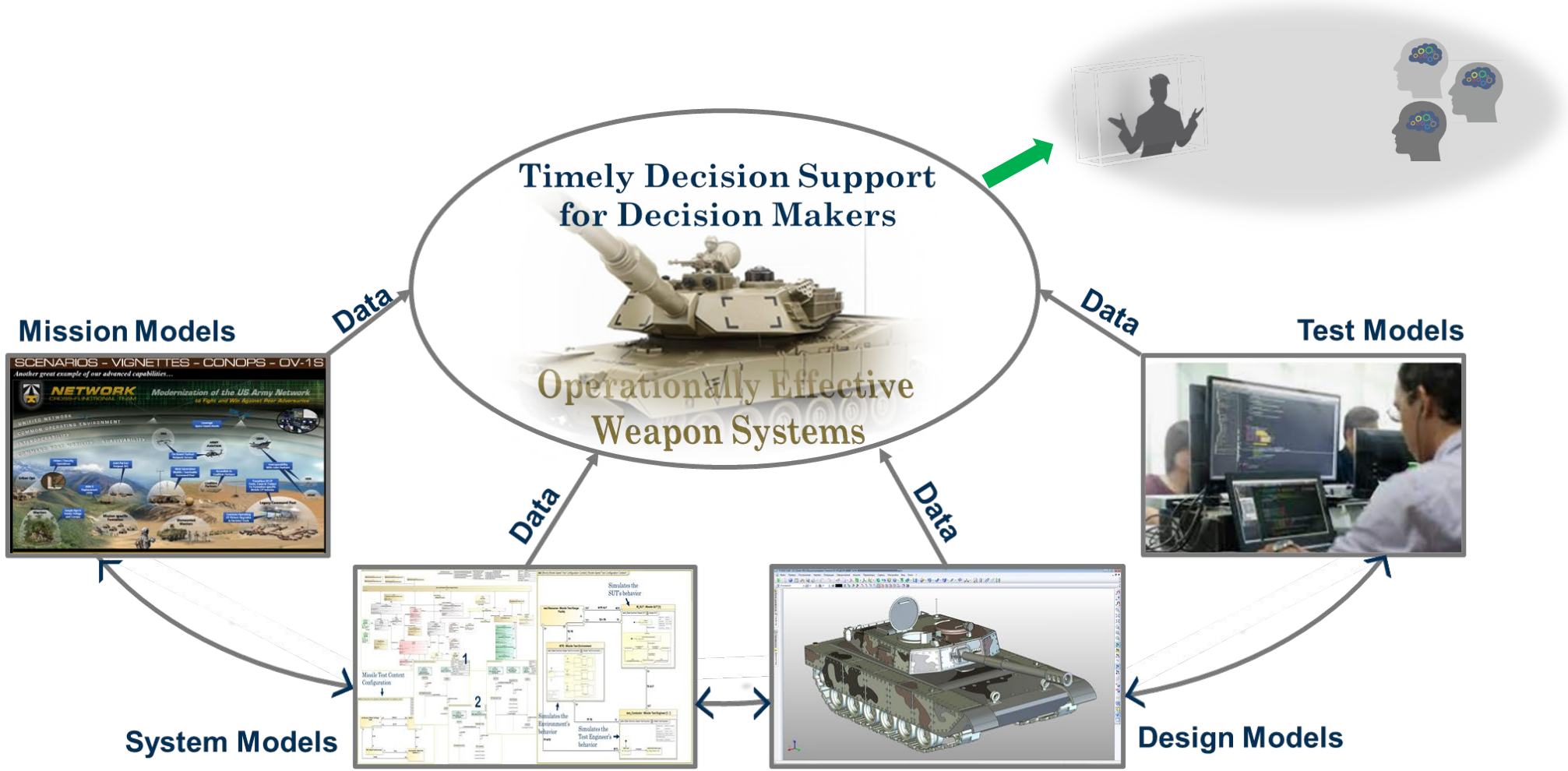
Linked data from digital models can be leveraged as an authoritative source of truth to inform or validate decisions.



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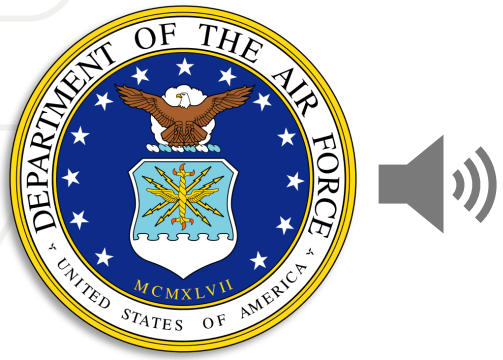
The Model-based IDSK Value Proposition

- The purpose of the IDSK is to clearly identify decisions of interest to the program, and then to tie these decisions to the tests and other data sources need to support these decisions.
- The IDSK allows programs to focus their resources around getting the data needed to make program critical decision in a timely manor.
- There is a wide range of technology which can be used to support the development of the IDSK for any given program.
- The value of using model-based tools in the IDSK process comes in the ability to automatically link many different technical and programmatic aspects of the program to the critical decision making process.
- The Model-Based IDSK can link requirements, the system model, the system design, system risk, test planning, and resource prioritization.

A tool easily implementable by digitally-born programs to support acquisition T&E decision makers is the goal.



Desired Characteristics:

- Relatively Easy to Use
- Standardized Decisions
- Standardized Data Formats
- Minimized Development Time
- Tailored to Program Decision Support Needs

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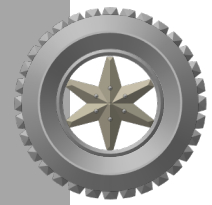

A model-based IDSK Reference Architecture provides practical guidelines for program-specific implementations.

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STEP-1

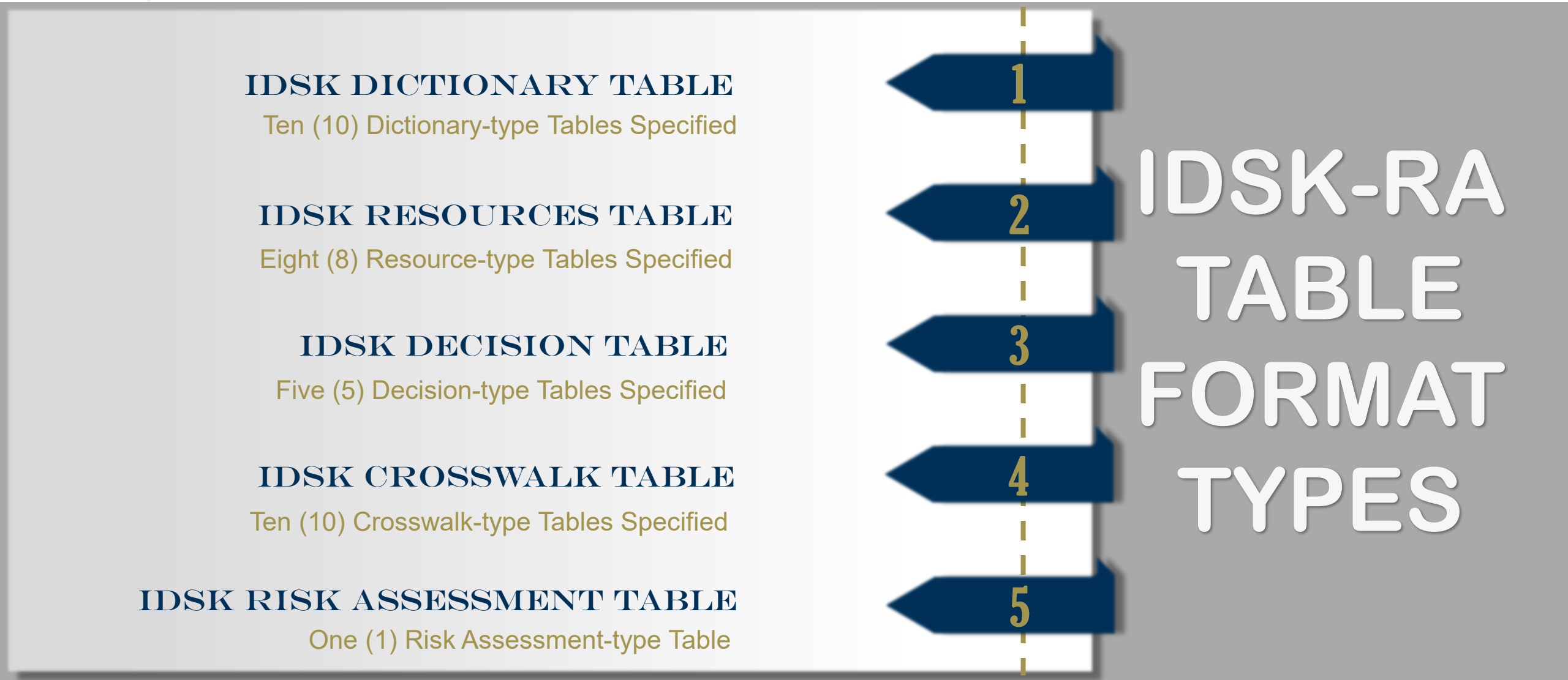
Identify and specify a standardized set of decisions and data formats to support test planning.

The IDSK-RA tables can be tailored/configured based on the needs and requirements of the decision makers.

Five sets of standardized decision classes and data formats are identified and defined in the IDSK-RA.

1. Critical Technical Performance Decisions
2. Program Milestone/Technical Review Decisions
3. Subsystem Critical Performance & Tech Maturity Decisions
4. Operational Performance Characteristic Decisions
5. Programmatic (Business) Decisions

Five standardized IDSK table formats capture test, test planning, mission, and acquisition-related data.



STEP-2

Develop a model-based IDSK Reference Architecture to guide and constrain program-specific implementations.

The MB-IDSK RA is developed as a lightweight architecture to encourage usage by programs.

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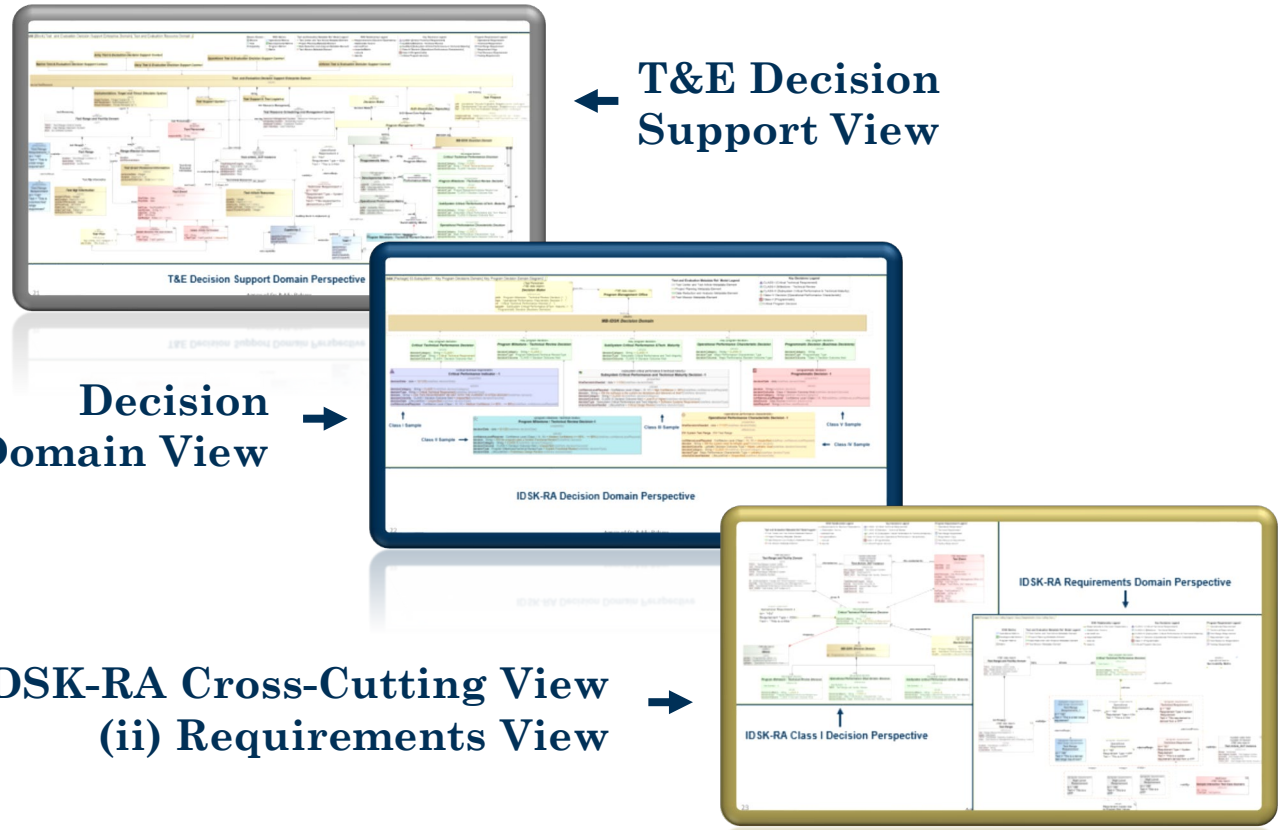
Ref. Arch. views portray the MB-IDSK-RA from multiple perspectives that address key concerns.

The following views of the model-based IDSK-RA serve as digestible chunks of the complete architecture:

1. T&E Decision Support Domain View
2. Program Office View
3. Decision Domain View
4. Decision Maker View
5. Metrics View
6. Requirements View
7. Test Article View
8. Test Range and Facility View
9. Test Personnel View
10. Test Budget View
11. Mission View



Tailorable tables generated from the architecture portray pertinent data to support T&E decision making.

Class I Decision Table – specifies decision data regarding critical performance requirements.

#	Name	Program Decision	Decision Type	Decision Category	Decision Outcome	Decision Date	Lifecycle Point	Confidence Level Required for Decision	Operational Requirement	Technical Requirement	Data Required	Data Source
1	EW SUT Critical Performance Indicator Decision	Decision question goes here	Critical Technical Requirement	CLASS I	Inconclusive	11/9/23	Milestone B	Unspecified	229.2 EW SUT Compute Target ID	184 EW SUT Compute Correct Target ID	Total Detected Targets	Test

Test Event Resource Table – captures test event meta data.

#	Name	Test Event Quarter & Fiscal Year	Type of Test	Test Number	Test Objective	Test Range
1	Missile SUT Test Event	Q1FY24	Developmental Test (DT)	4.3.2	Determine if the system requirement can be met by the current design.	Missile Test Range Facility

Test Article Resource Table – captures test article test-planning data.

#	Name	Test Article (SUT)	Quantity (SUT)	Support System(s) Required for Test	Quantity (Support System)	Duration_Hour	Dollar Cost	Dollar Cost Total
1	EW SUT Test Event	EW SUT Alpha	5	Test Aircraft	2	10	3000	30000
2	Missile SUT Test Event	Missile SUT	2	Nuclear Submarine	1	5	20000	65000

Operational Metrics Crosswalk Table – captures test article test-planning data.

#	Name	Operational Requirement	Operational Requirement Type	Derived Technical Requirement	Key Decision	Tests
1	Missile System Suitability	229.1 Missile Speed Requirement	KPP	219 Missile Speed Requirement	Missile System Critical Performance Indicator Missile System Functional Review	All Scenarios Test Missile Speed Test Scenario

STEP-3

Instantiate the MB-IDSK-RA to create program-specific MB-IDSK implementations.

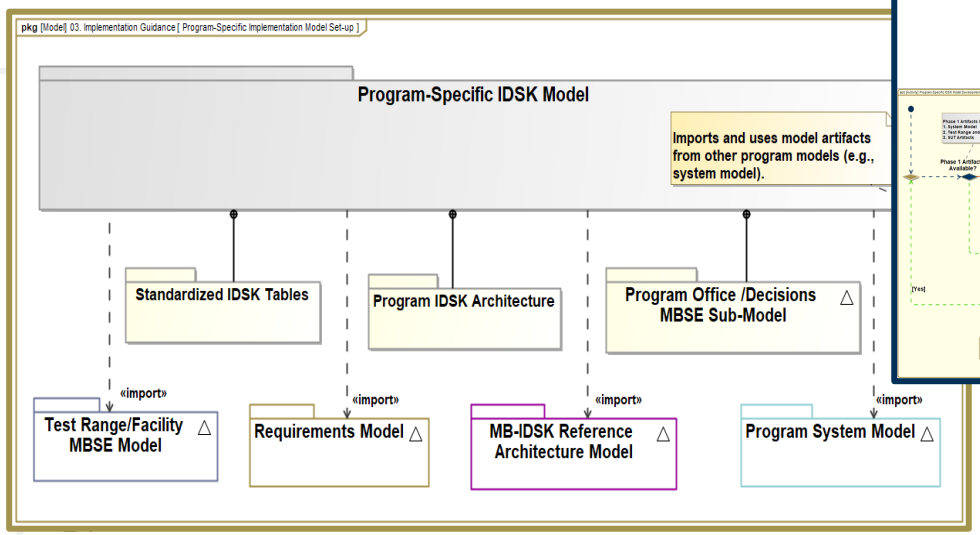
The IDSK-RA has a total of 34 IDSK table templates available.

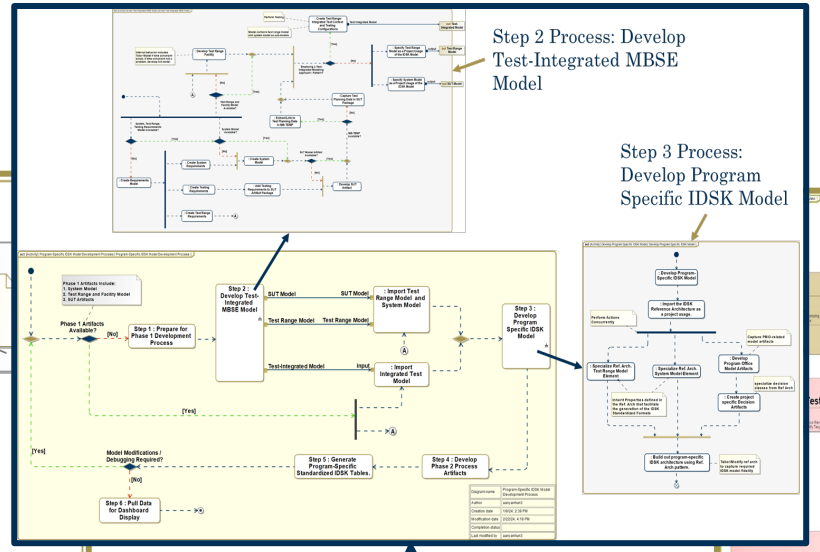
A how-to model development process guides program offices on creating program-specific implementations.

START → 1 — 2 — 3 — 4 → END

1. Access/Develop Digital Models
2. Develop Program-Specific IDSK Elements
3. Specialize Properties from the IDSK RA
4. Generate program-specific IDSK Tables

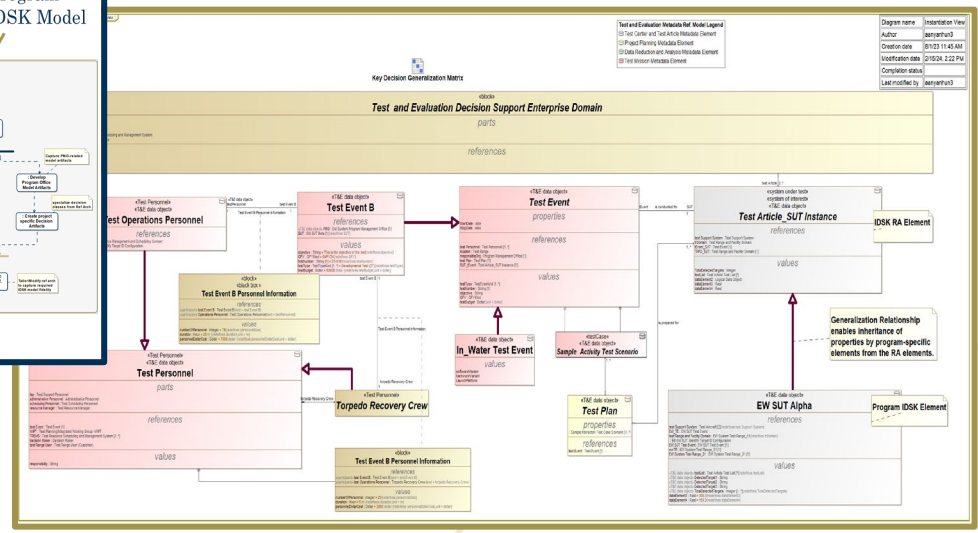
Program IDSK Model Setup View





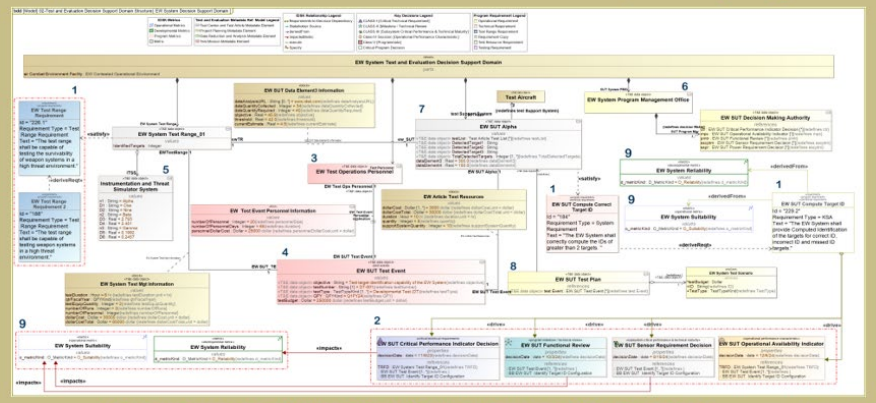
MB-IDSK Dev. Process

Program IDSK Instantiation View



An exemplar EW system MB-IDSK architecture proof-of-concept validates the MB-IDSK development process.

Diagram describes an exemplar MB-IDSK T&E decision support domain view for a notional EW system program.



(1) Requirements (2) Decisions (3) Test Personnel (4) Test Event
(5) Test Range (6) Program Office (7) SUT (8) Test Plan (9) Metrics

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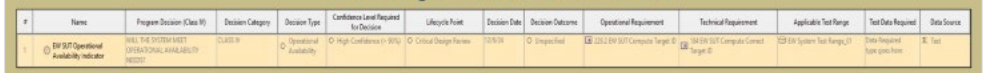
Notional EW program Implementation of the MB-IDSK RA architecture

Exemplar IDSK tables for a notional EW system Test (*detect target id* test) are generated from the IDSK model.

Detect Target Id Class II Decision Table

Detect Target Id Class III Decision Table



Detect Target Id Test Event Resource Table

#	Name	Test Personnel Type	Number of Test Personnel	Duration (Hours)	Personnel Dollar Cost
1	EW SUT Test Event	EW Test Operations Personnel	20	65	25000

Detect Target Id Class III Decision Crosswalk Table

Notional EW program Implementation of the MB-IDSK RA tables

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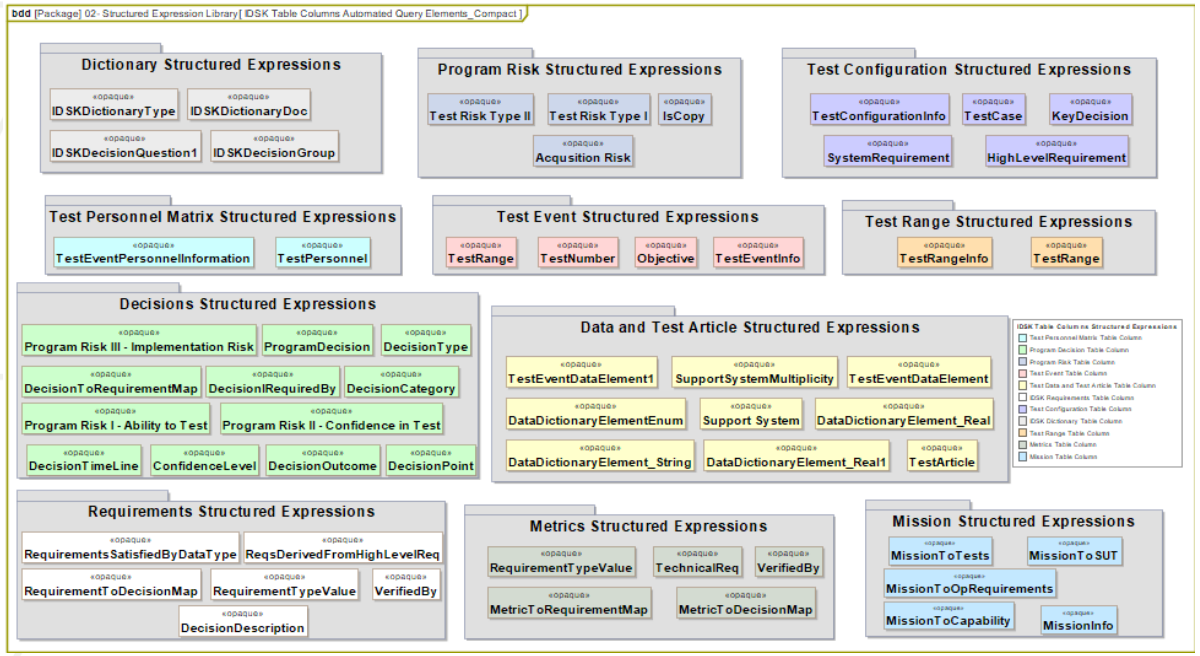
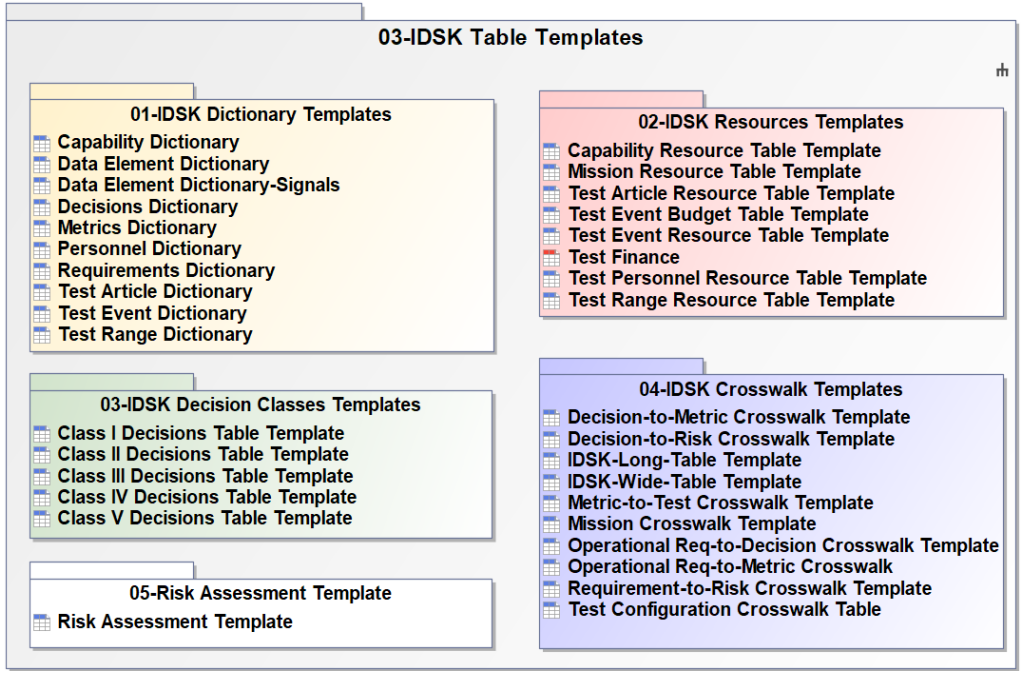
MB-IDSK-RA library resources help shorten the development timeline for programs.

- IDSK table templates that can be configured to show necessary data relationships
- Well-documented model query mechanisms (i.e. metachain navigation syntax)
- An IDSK Profile with stereotypes to facilitate communication and model development

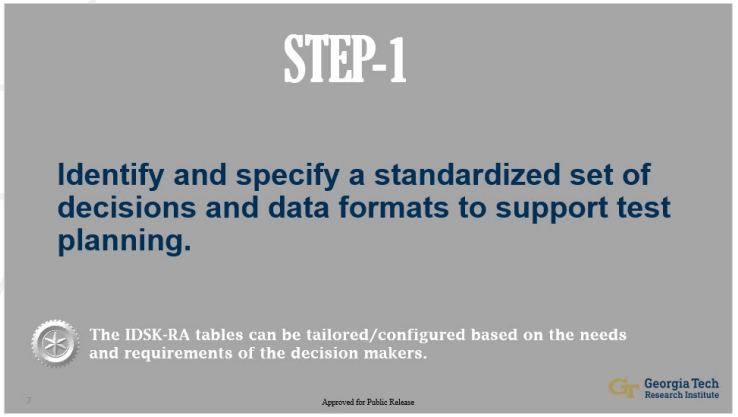


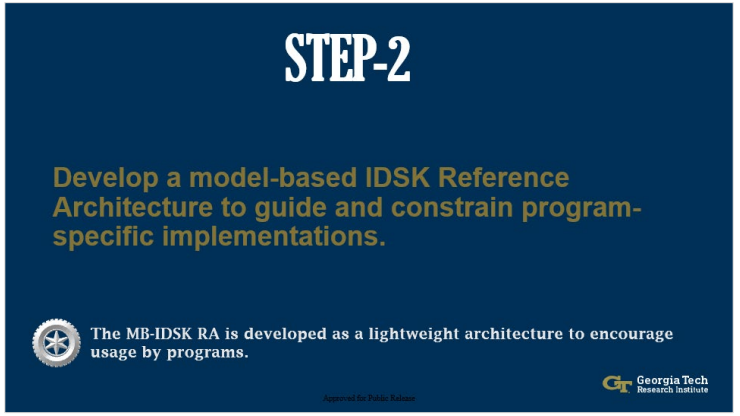


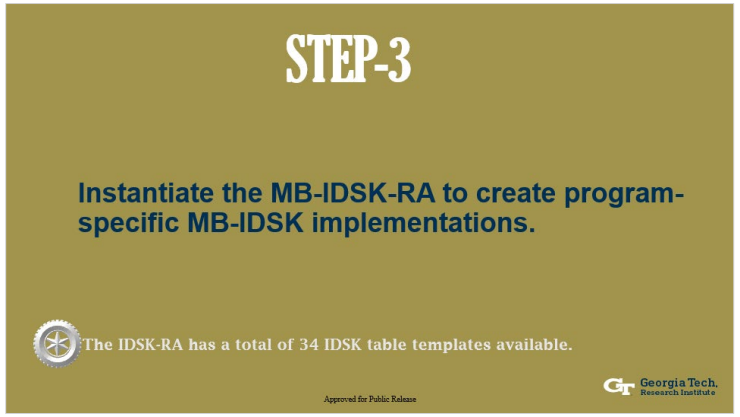
Structured Expression Query Mechanisms

MB-IDSK Table Templates

In summary, the MB-IDSK RA enables programs aggregate data from digital models to enable timely decision-making.







Model-Based IDSK: Mitigating Decision Support Challenges during Acquisition Test and Evaluation.

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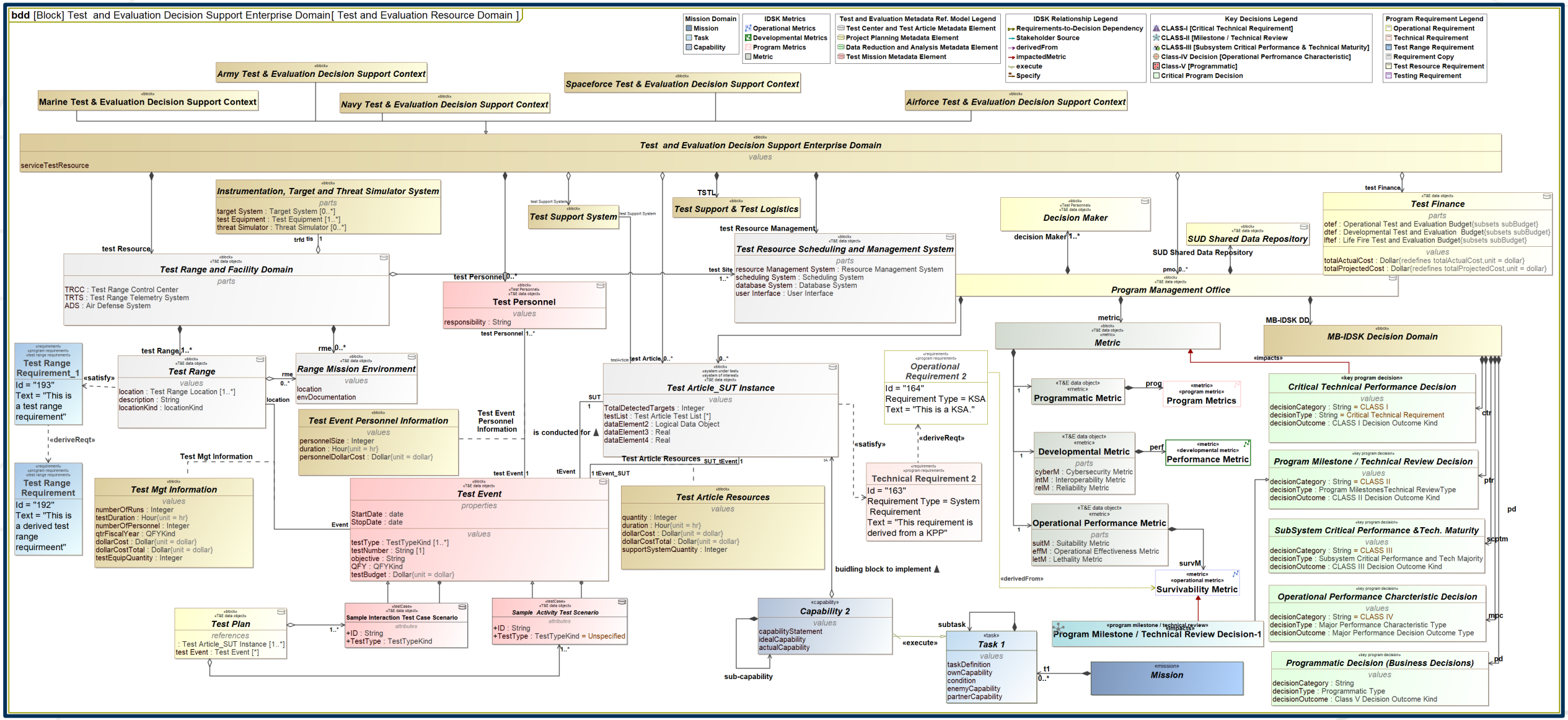
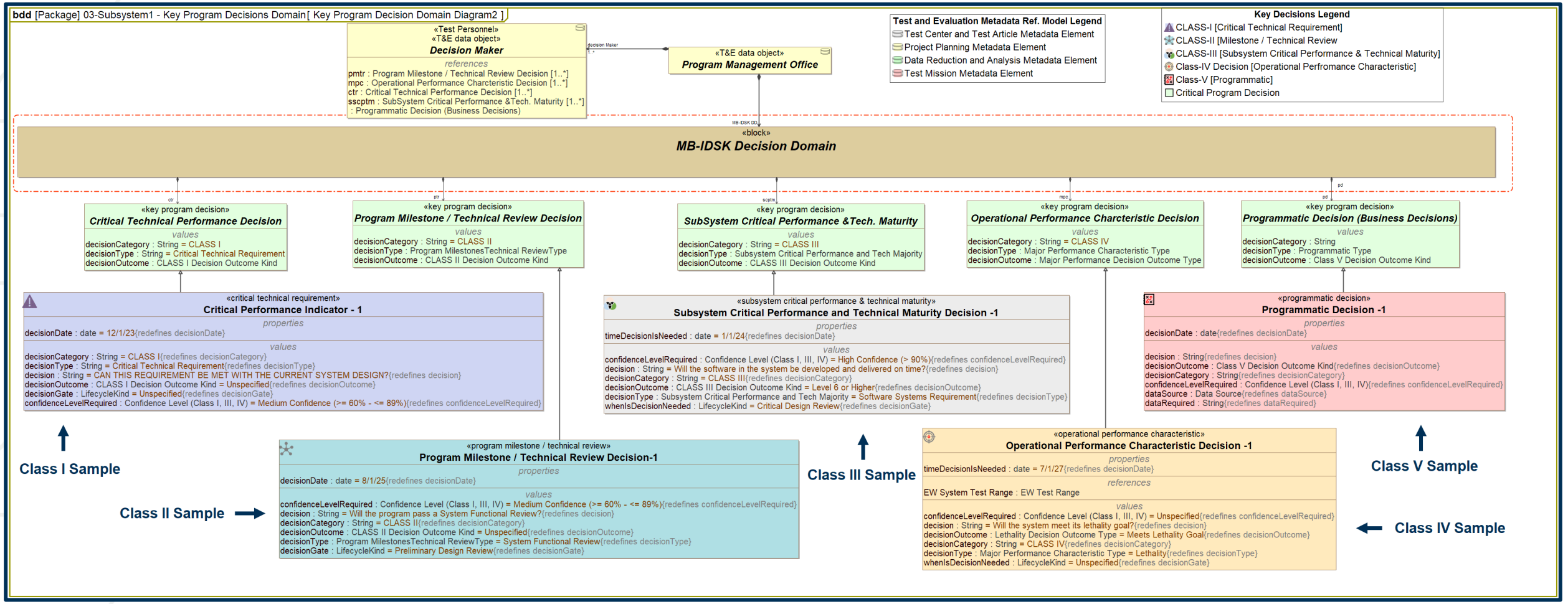
4. Werner, J. S., & Arndt, C. (2023). Development of Digital Engineering Artifacts in Support of MBSEbased Test Planning, Execution, and Acquisition Decision Making. Acquisition Research Program.

Paper Abstract

Providing timely decision support to decision-making authorities during the various phases of an acquisition program is critical for the on-time delivery of operationally effective weapon systems that meet the needs of the warfighter. To ensure decision makers are equipped with the necessary test and evaluation (T&E) data to inform decisions, the department of defense (DoD) recently mandated the use of the Integrated Decision Support Key (IDSK) as a tool to encapsulate (i.e., succinctly record) a program's decisions and the T&E data necessary to support the decisions. Therefore, an approach that utilizes digital engineering, specifically model-based systems engineering (MBSE) as a means to standardize the linkage of test data to decisions presents a significant value proposition for decision-making authorities — linking data from a program's system, design and test planning models to key acquisition decisions. An overt value of this approach is the resulting digital thread that connects data sources i.e., digital models into an authoritative source of truth to both inform and validate decisions. Hence, this paper presents a model-based Integrated Decision Support Key (MB-IDSK) Reference Architecture that integrates and links data from multiple digital models to a standardized set of acquisition, technical, and T&E decisions. The MB-IDSK RA provides a standardized pattern and approach for developing program-specific MB-IDSKs to support program acquisition and T&E decision-making.

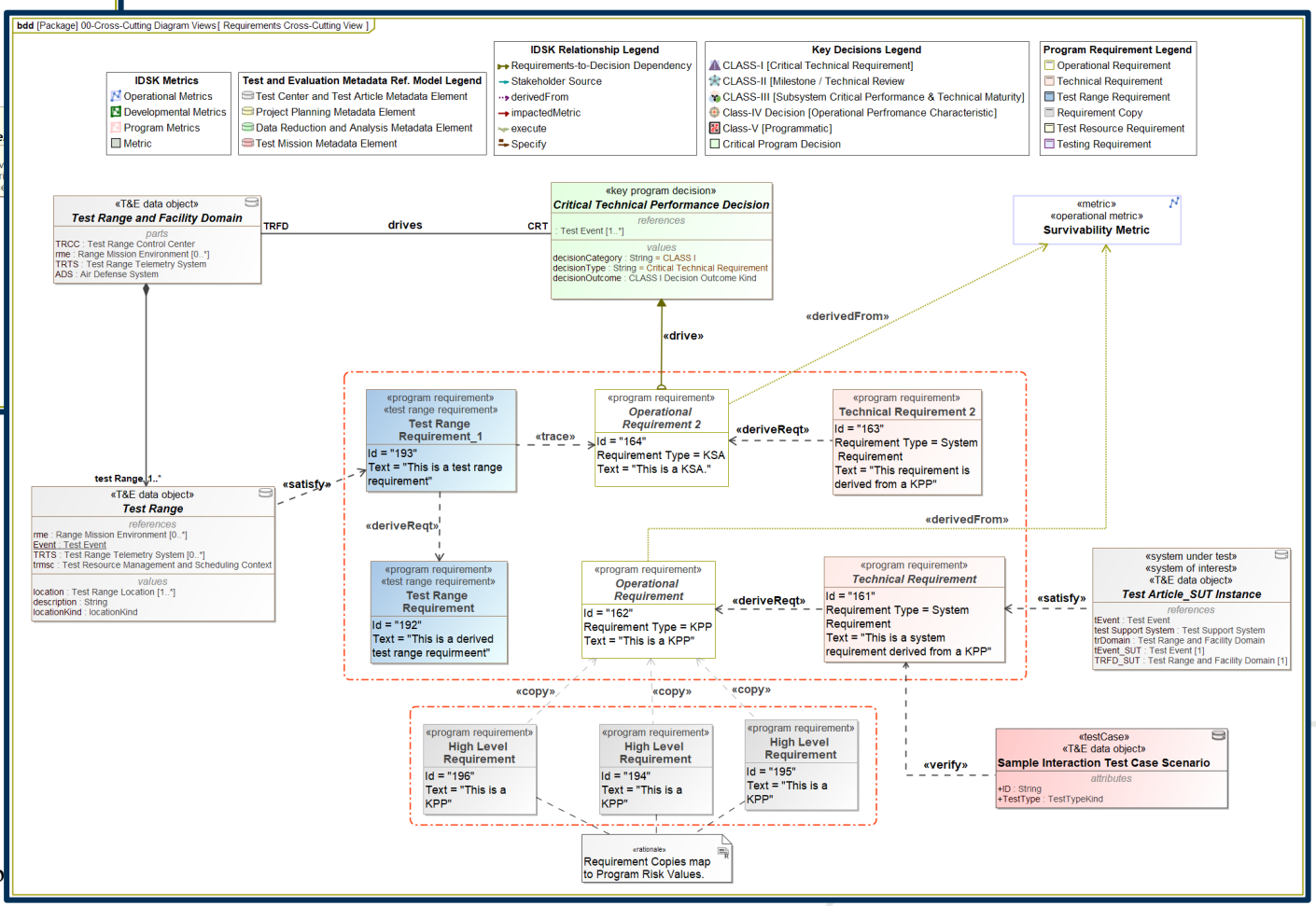


T&E Decision Support Domain Perspective



IDSK-RA Decision Domain Perspective

IDSK-RA Requirements Domain Perspective



IDSK-RA Class I Decision Perspective

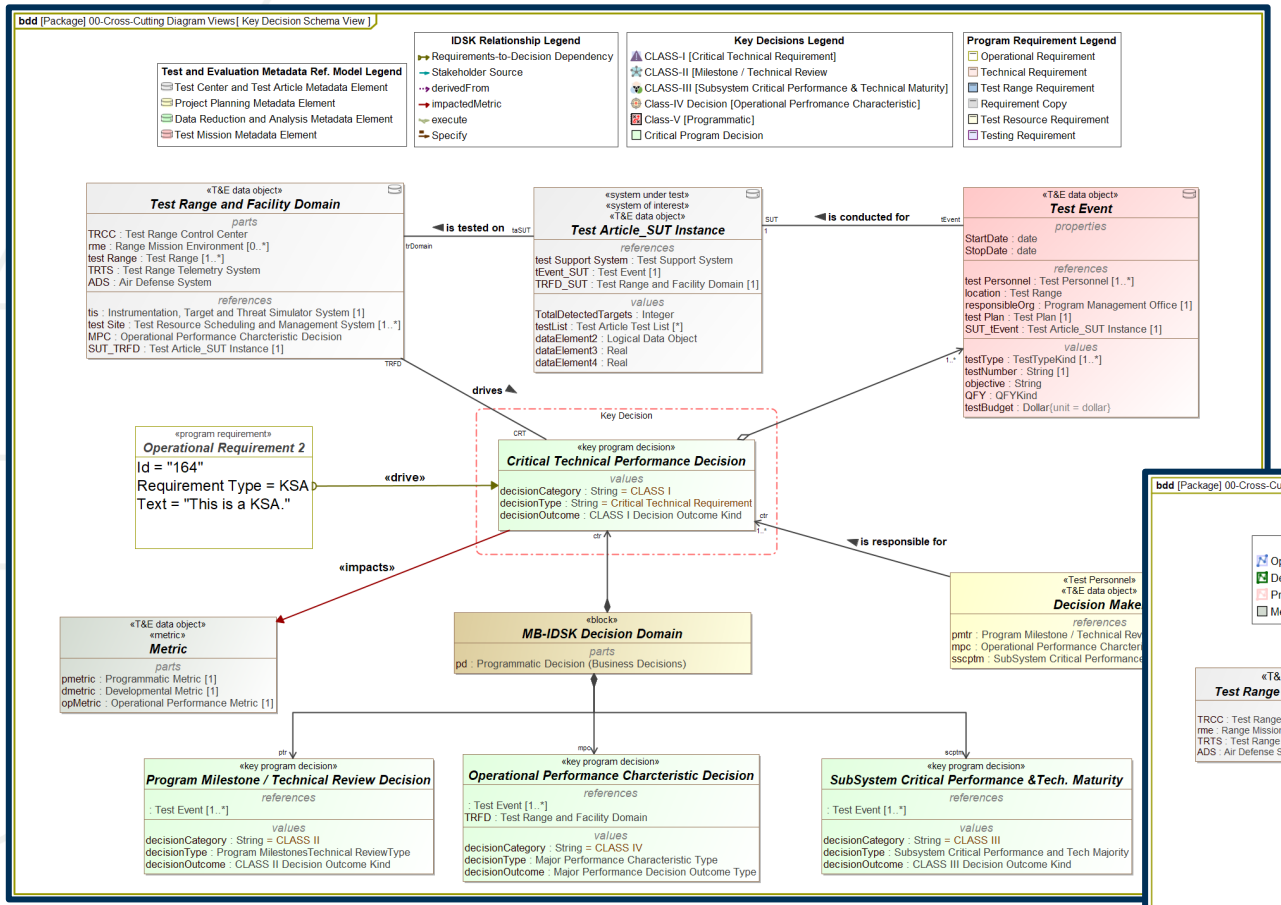
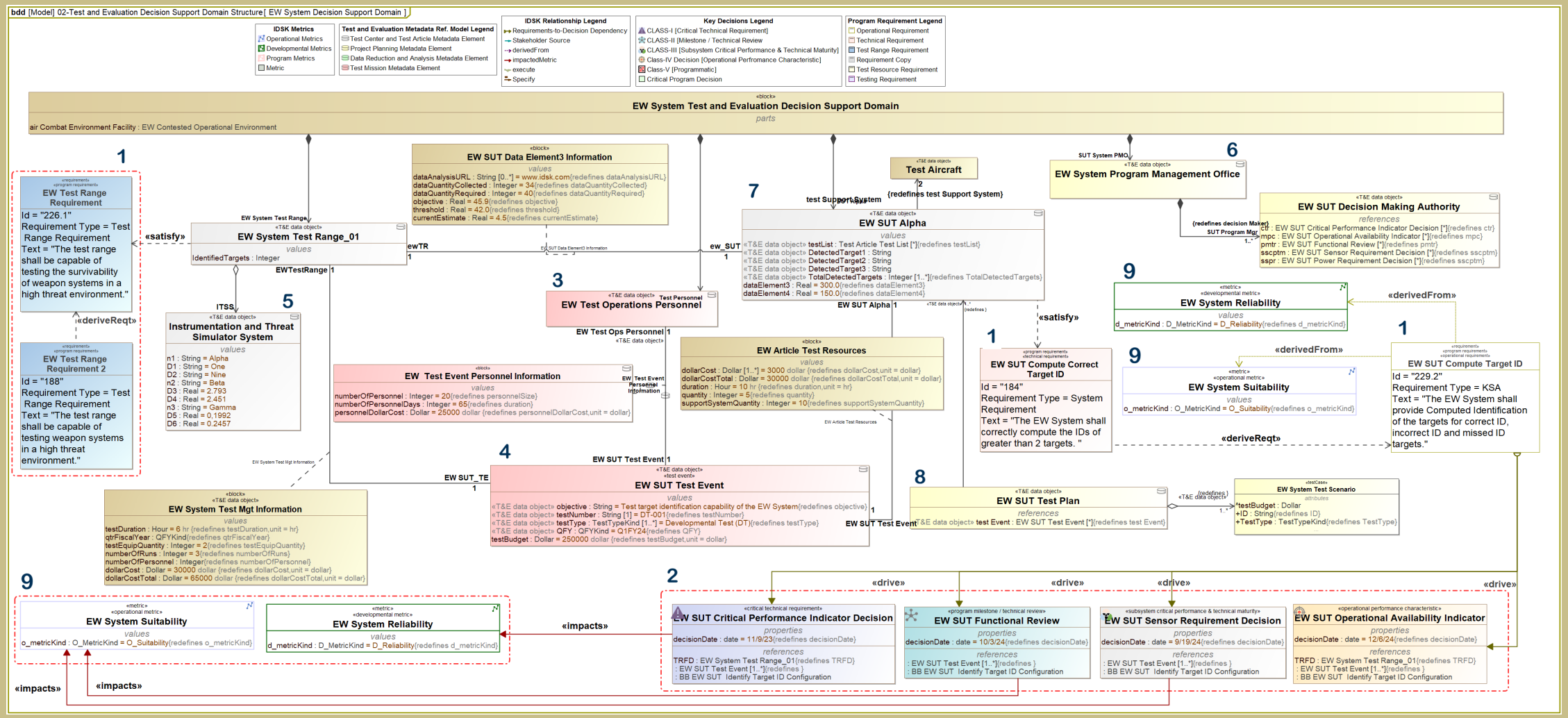


Diagram describes an exemplar MB-IDSK T&E decision support domain view for a notional EW system program.



(1) Requirements (2) Decisions (3) Test Personnel (4) Test Event
(5) Test Range (6) Program Office (7) SUT (8) Test Plan (9) Metrics

Exemplar IDSK tables for a notional EW system Test (*detect target id* test) are generated from the IDSK model.

Detect Target Id Class II Decision Table

#	Name	Program Decision	Decision Category	Decision Type	Confidence Level Required for Decision	Lifecycle Point	Decision Date	Decision Outcome	Operational Requirement	Technical Requirement	Data Source	Data Required
1	EW SUT Functional Review	DOES THE DESIGN MEET THE FUNCTIONAL REQUIREMENT NEEDS?	CLASS II	Milestone A - Technology Development and Risk Reduction	High Confidence (> 90%)	Critical Design Review	10/3/24	Pass Review	229.2 EW SUT Compute Target ID	184 EW SUT Compute Correct Target ID	Analysis	Data required goes here

Detect Target Id Class III Decision Table

#	Name	Program Decision (Class IV)	Decision Category	Decision Type	Confidence Level Required for Decision	Lifecycle Point	Decision Date	Decision Outcome	Operational Requirement	Technical Requirement	Applicable Test Range	Test Data Required	Data Source
1	EW SUT Operational Availability Indicator	WILL THE SYSTEM MEET OPERATIONAL AVAILABILITY NEEDS?	CLASS IV	Operational Availability	High Confidence (> 90%)	Critical Design Review	12/6/24	Unspecified	229.2 EW SUT Compute Target ID	184 EW SUT Compute Correct Target ID	EW System Test Range_01	Data Required type goes here	Test

Detect Target Id Test Event Resource Table

#	Name	Test Personnel Type	Number of Test Personnel	Duration (Hours)	Personnel Dollar Cost
1	EW SUT Test Event	EW Test Operations Personnel	20	65	25000

Detect Target Id Class III Decision Crosswalk Table

#	Name	Metrics	Operational Requirement	Data Element	Threshold	Objective	Test Data Collected	Test Data Quantity Required	Data an Analysis URL	Current Estimate
1	EW SUT Sensor Requirement Decision	EW System Suitability	229.2 EW SUT Compute Target ID	TestResult1 : VerdictKind = inconclusive dataElement3 : Real = 300.0 dataElement4 : Real = 150.0	42.0 55.0	45.9 56.0	34 22	40 22	www.idsk.com www.idsk.org	4.5 6.7