Reliability, Availability, Maintainability and Cost (RAM-C) Rationale Report Outline Guidance Training Brief

Office of the Deputy Assistant Secretary of Defense for Systems Engineering

Version 1.2
June 26, 2018

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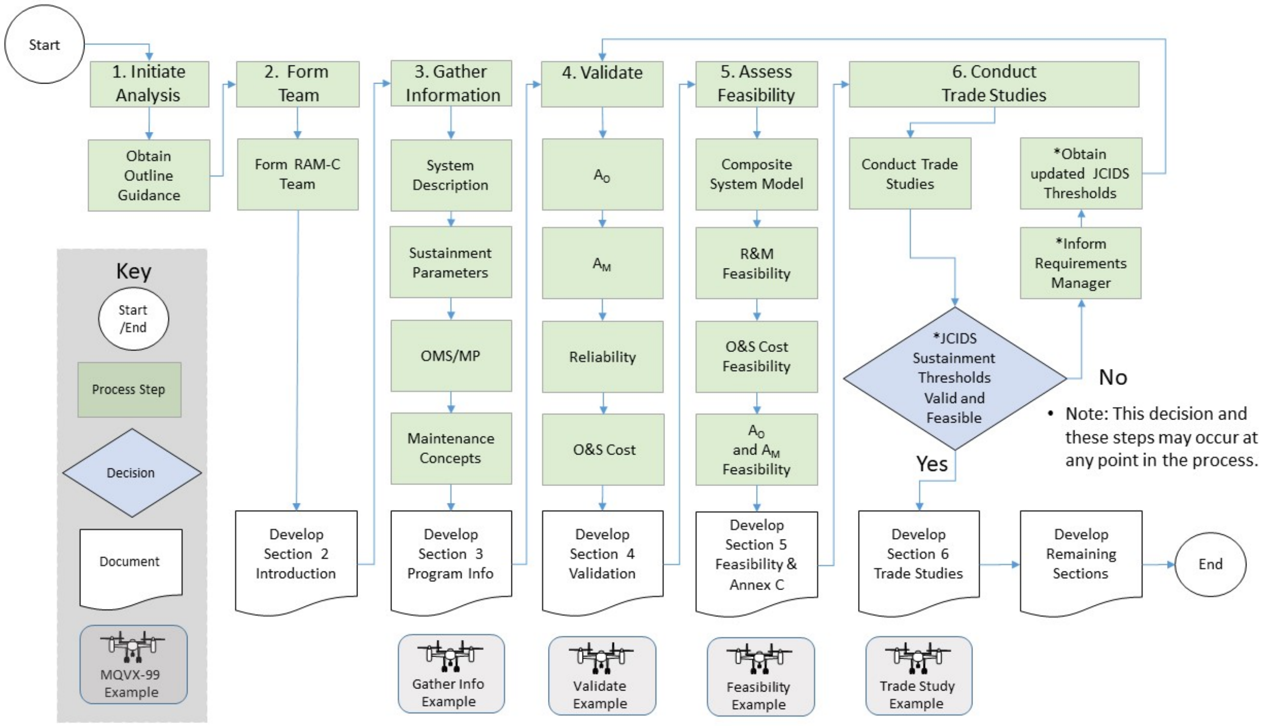
Navigating the Brief



Clicking on the compass icon on the bottom right of each page will take you to the RAM-C Flowchart and Navigation menu shown above. From there you can navigate directly to most of the blocks shown. Additionally, you may click on the icons below which will take you into the main areas of the RAM-C Analysis as well as the Introduction, Attributes of an Effective RAM-C and Summary.

Introduction

- **This training assists with the development of the RAM-C analysis.**
  - Supports RAM-C Rationale Report Outline Guidance as of 28 Feb 2017.
  - The MQVX-99 Unmanned Aerial Vehicle (UAV) system used within this brief is **fictional** and is used solely to demonstrate the concepts and methods related to the RAM-C analysis.
  - Analyses do not go into the depth and breadth of those required in actual practice. They use deterministic formulas instead of Modeling and Simulation (M&S) which is frequently required to obtain the most accurate and meaningful results for a complex system.

Introduction

RAM-C Rationale Report Policy

- **Joint Capabilities Integration and Development System (JCIDS) Manual**
  - RAM-C report will document the quantitative basis for the three elements of the Sustainment Key Performance Parameter (KPP) as well as the tradeoffs made with respect to system performance.
- **Department of Defense Instruction 5000.02 Operation of the Defense Acquisition System (January 7, 2015 incorporating Change 3, August 10, 2017)**
  - Applicable to Major Defense Acquisition Programs.
  - A preliminary RAM-C Report is required in support of the Milestone (MS) A decision.
  - RAM-C Report provides a quantitative basis for reliability requirements~~,~~ and improves cost estimates and program planning.
  - Attached to the Systems Engineering Plan (SEP) at MS A, and updated in support of the Development Request for Proposal (RFP) Release Decision Point, MS B, and MS C.

- **Attributes of an Effective RAM-C:**
  - JCIDS sustainment parameters are validated and feasible and meet the requirements of the JCIDS endorsement guide.
  - Program Office R&M Engineer, Product Support Specialist, and Cost Analyst are involved.
  - Sustainment Key Performance Parameters (KPPs)/Key System Attributes (KSAs)/Additional Performance Attributes (APAs) support the Operational Mode Summary/Mission Profile (OMS/MP), Concept of Operations (CONOPS), and maintenance/sustainment concepts.
  - The R&M metrics and Cost KSAs support the Operational Availability (A_O) and Materiel Availability (A_M) KPPs ("the math works") and are consistent with mission and sustainment needs indicating that the parameters are valid.
  - Model of the composite system is developed and based on comparison data and current state of the art, and feasibility is determined.
  - A trade analysis is conducted to illustrate trade space between R&M metrics within the feasible region showing the relationship of these metrics with A_O and Operating and Support (O&S) costs.
  - Conducted early enough to influence sustainment related decisions. Provides a history of those decisions. Not an afterthought, but a driver of program decisions.
  - Shows collaboration with requirements developers where issues arise during the analysis.
  - Uses the best information available at the time the RAM-C is written with an understanding that the accuracy of the information is based on the program acquisition phase.

Introduction

Attributes of an Effective RAM-C - Overview

- Verifies that the definitions of failure for each Sustainment KPPs/KSAs/APAs are included in the draft Capability Development Document (CDD), the CDD and Capability Production Document (CPD).
- Verifies that the definitions of failure for each Sustainment KPPs/KSAs/APAs are included in the draft CDD, the CDD and CPD.
- Demonstrates comprehensive analysis of the best information available. Analysis techniques used are appropriate to the information available and acquisition phase (analogy, parametric, engineering, M&S).
- Demonstrates an understanding of the options available within the trade space created within the feasible region and shows how the program used this to make better program sustainment decisions.

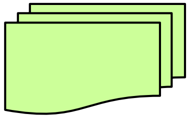
- **For additional information, see the Attributes of an Effective RAM-C section in this training. You can reach this section using the navigation bar at the bottom of any page.**

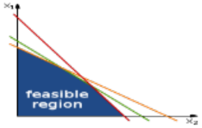
Introduction

Outline Guidance and Example

- **Follow along with the outline guidance as you proceed through this training.**
  - Instructions to download the outline guidance is provided during the first step of analysis.
- **The flowchart on slide 10 relates the RAM-C analysis steps to the outline guidance and provides tools to assist you with navigating within this training brief.**
  - For the six RAM-C steps in the flowchart, this training will:
    - Provide a purpose and overview.
    - Describe the activities involved.
    - Show how to fill in the outline guidance.
  - Additionally, in certain steps, this training will show an example from the fictional MQVX-99 UAV.
  - For each step, the title block of the slide will identify the step and the specific area discussed. The step will also be highlighted on the menu bar at the bottom of each page.

RAM-C Analysis Steps





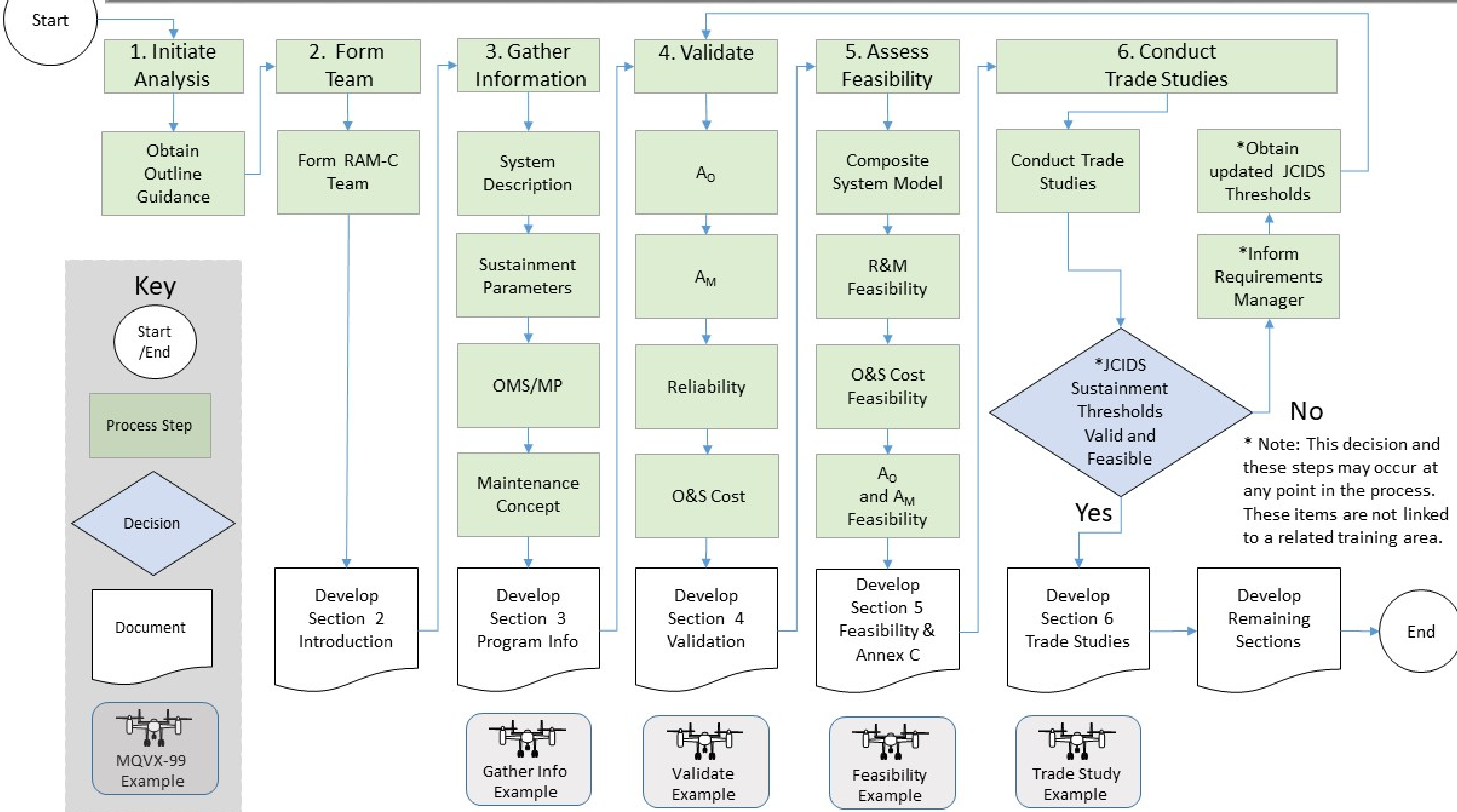
1. INITIATE ANALYSIS → 2. FORM TEAM → 3. GATHER INFO → 4. VALIDATE → 5. ASSESS FEASIBILITY → 6. CONDUCT TRADE STUDIES

Six Iterative Steps

RAM-C Analysis Steps

Flowchart and Navigation Menu

Click on a block to take you to the related training area. Click on the compass icon to return here.

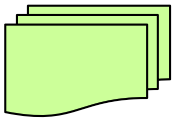


RAM-C Analysis Steps

- **The RAM-C Analysis has six iterative steps.**

1. Initiate Analysis: Obtain and become familiar with the most current guidance on the RAM-C analysis.

2. Form team: Form a multi-disciplinary team consisting of R&M engineering, product support/logistics and cost analysis.



3. Gather Information: Collect the documentation and other information needed to validate the sustainment parameters, perform the RAM-C feasibility analyses and conduct trade studies.

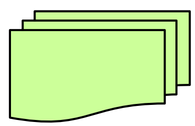
4. Validate: Analyze the sustainment parameters to show they are consistent with the CONOPS, the OMS/MP and maintenance/sustainment concept and that they support each other (the math works).

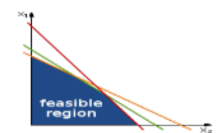
5. Assess Feasibility: Develop a composite model using legacy or analogous data to show the sustainment parameters are feasible and consistent with the current state of the art and technical maturity.

6. Conduct Trade Studies: Perform trade studies between sustainment parameters to show the relationship between Reliability, Availability, Mean Down Time (MDT) and O&S cost.

RAM-C Analysis Steps
Initiate Analysis





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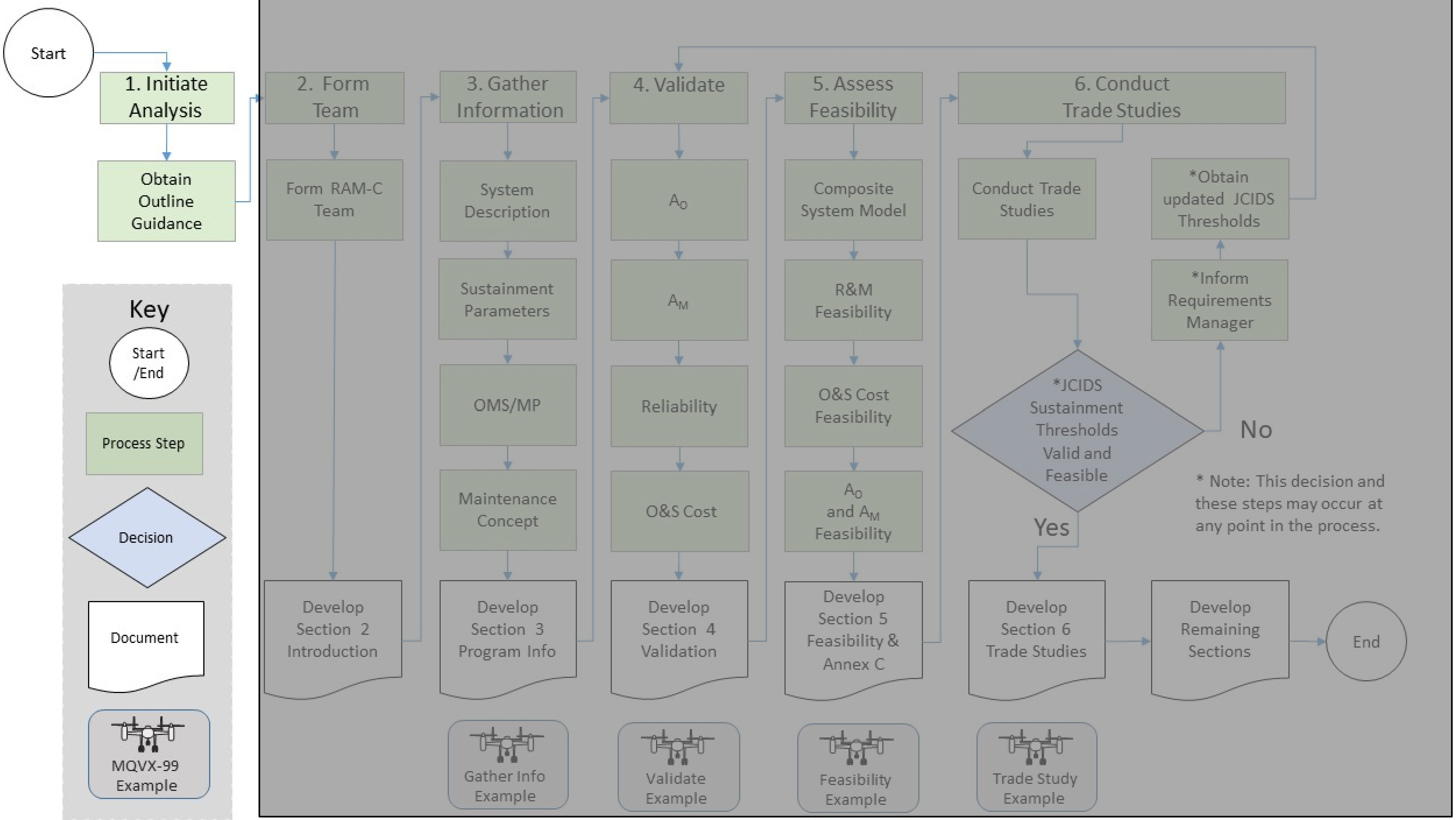
Six Iterative Steps

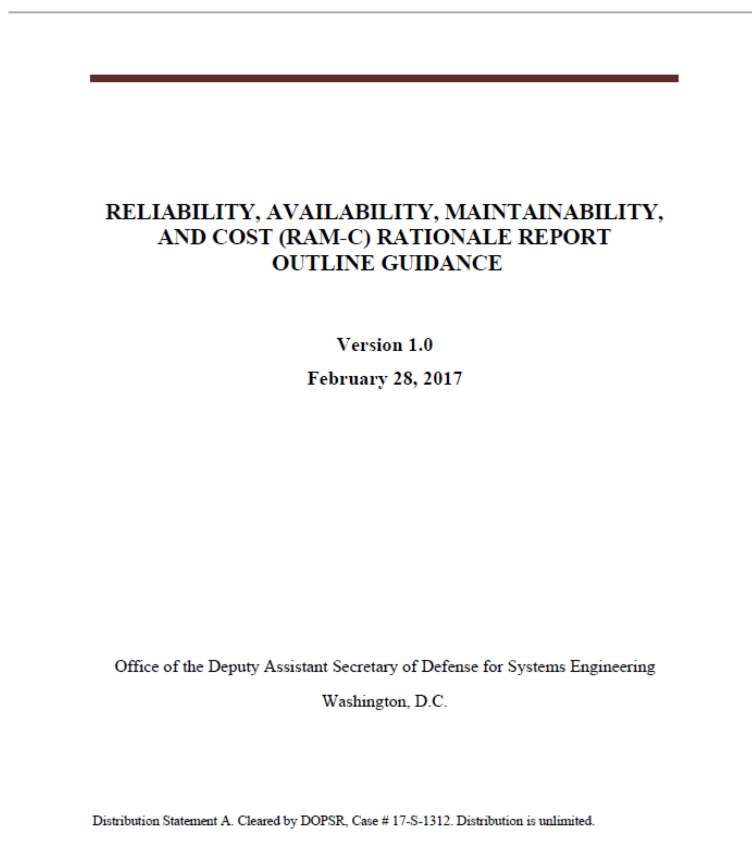
RAM-C Analysis Steps

1. Initiate Analysis



1. Initiate Analysis
Purpose/Overview & Activities

- **Purpose/Overview: To become familiar with the RAM-C Outline Guidance.**
- **Activities:**
  - Obtain Outline Guidance
    - This may be obtained at https://ac.cto.mil/wp-content/uploads/2019/06/RAMC-Outline-2017-07-07.pdf.
    - Outline guidance will provide a format for the report along with information relating to completing the RAM-C analysis and documenting it in the RAM-C report.
  - Familiarize yourself with the guidance.



RELIABILITY, AVAILABILITY, MAINTAINABILITY, AND COST (RAM-C) RATIONALE REPORT OUTLINE GUIDANCE

Version 1.0

February 28, 2017

Office of the Deputy Assistant Secretary of Defense for Systems Engineering

Washington, D.C.

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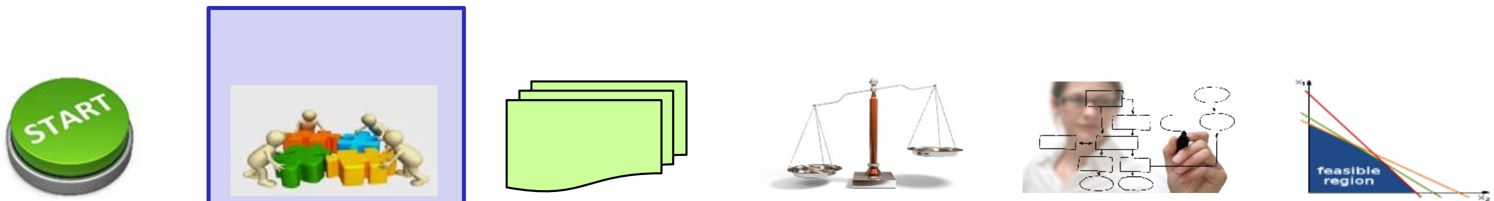
RAM-C Analysis Steps
Form Team

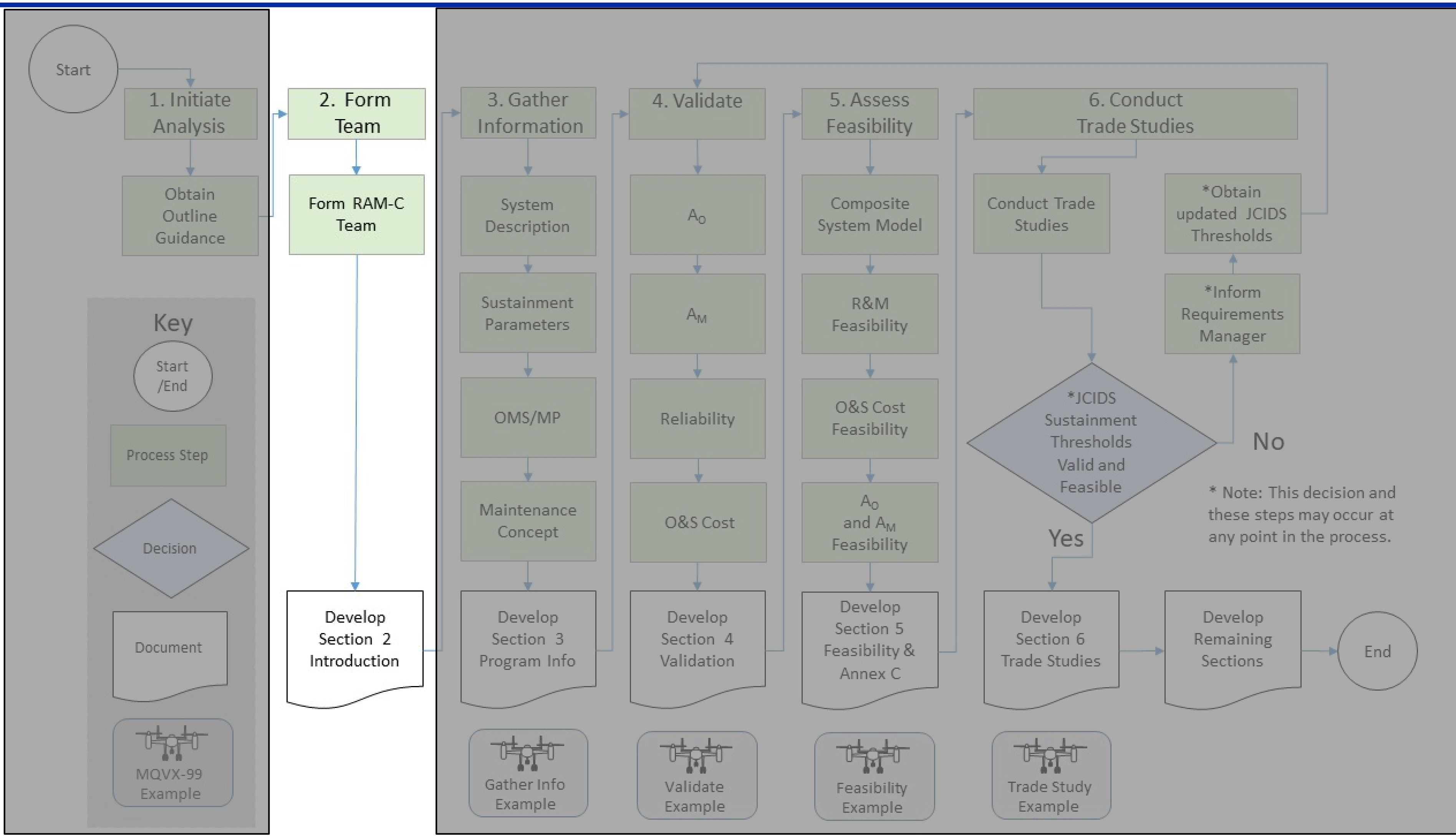


1. INITIATE ANALYSIS	2. FORM TEAM	3. GATHER INFO	4. VALIDATE	5. ASSESS FEASIBILITY	6. CONDUCT TRADE STUDIES

Six Iterative Steps

RAM-C Analysis Steps

2. Form Team



2. Form Team

Purpose/Overview

- **The purpose is to put together a multi-disciplinary team required to complete the RAM-C process.**
- **The team size and composition may vary over the duration of the project as different skill sets are required.**

2. Form Team

Activities

- **Assign team members with the core competencies of R&M engineering, cost analysis, and product support at a minimum.**
  - Other members may be required for specific analyses.
  - Form the RAM-C team early enough to ensure that sustainment parameters are considered early in the development cycle when any changes needed can have the largest impact on the future availability and cost of the system.
  - Personnel assigned to the team should have the technical and communication skills to work together effectively in the highly iterative fashion required by the analysis and be empowered to work across organizational boundaries.
- **Assign a team leader (usually a collateral duty) or make the team self managed.**
  - In either case, task assignments, schedules/deadlines and resource requirements should be coordinated with program management.
- **Maintain open communication with program management and other stakeholders such as the Requirements Manager.**
  - Resolve issues discovered during the RAM-C analysis.
  - Ensure the RAM-C analysis is effective and timely in addressing the sustainment parameters and any required changes.

2. Form Team
Activities (Supplemental Info)

- **The following table identifies the core team members and some "as required" team members.**

TITLE	RESPONSIBLITIES
RAM-C Team Leader	Coordinates efforts of team to meet required completion of RAM-C analyses and rationale report.
R&M Engineer	Performs R&M engineering analyses with full understanding of the inter-relationships of the sustainment metrics and operational scenarios.
Product Support Specialist	Develops product support concepts and estimates impact on other program resources with full understanding of the inter-relationships of the sustainment metrics and operational scenarios.
Cost Analyst	Performs costs analyses consistent with Cost Assessment and Program Evaluation (CAPE) guidance with full understanding of the inter-relationships of the sustainment metrics and other cost elements.
Data Analyst	Obtains and compiles legacy system and available test data. Has in-depth knowledge of service specific data systems. Provides comparisons of legacy systems to proposed solutions.
Operations Research Analyst	Develops optimization methodologies. Performs analysis of complex options using modeling and simulation.
Statistician/Mathematician	Performs high level statistics/mathematics required for analysis and optimization.
Supply Specialist	Provides supply expertise for development of product support strategies and estimates of performance and cost.

Core Members

As Req'd Members

2. Form RAM-C Team
Fill in Outline Guidance

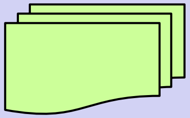
- **List the preparers of the RAM-C report in Table 2.3-1.**
  - Identify at a minimum the core team members involved in developing the RAM-C.
  - Add additional rows as needed.

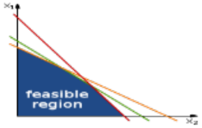
Table 2.3-1 RAM-C Preparers and Organizations

Function	Preparer	Organization
R&M Engineer	Name	Organization Name and Code
Product Support Specialist	Name	Organization Name and Code
Cost Analyst	Name	Organization Name and Code

RAM-C Analysis Steps
Gather Information





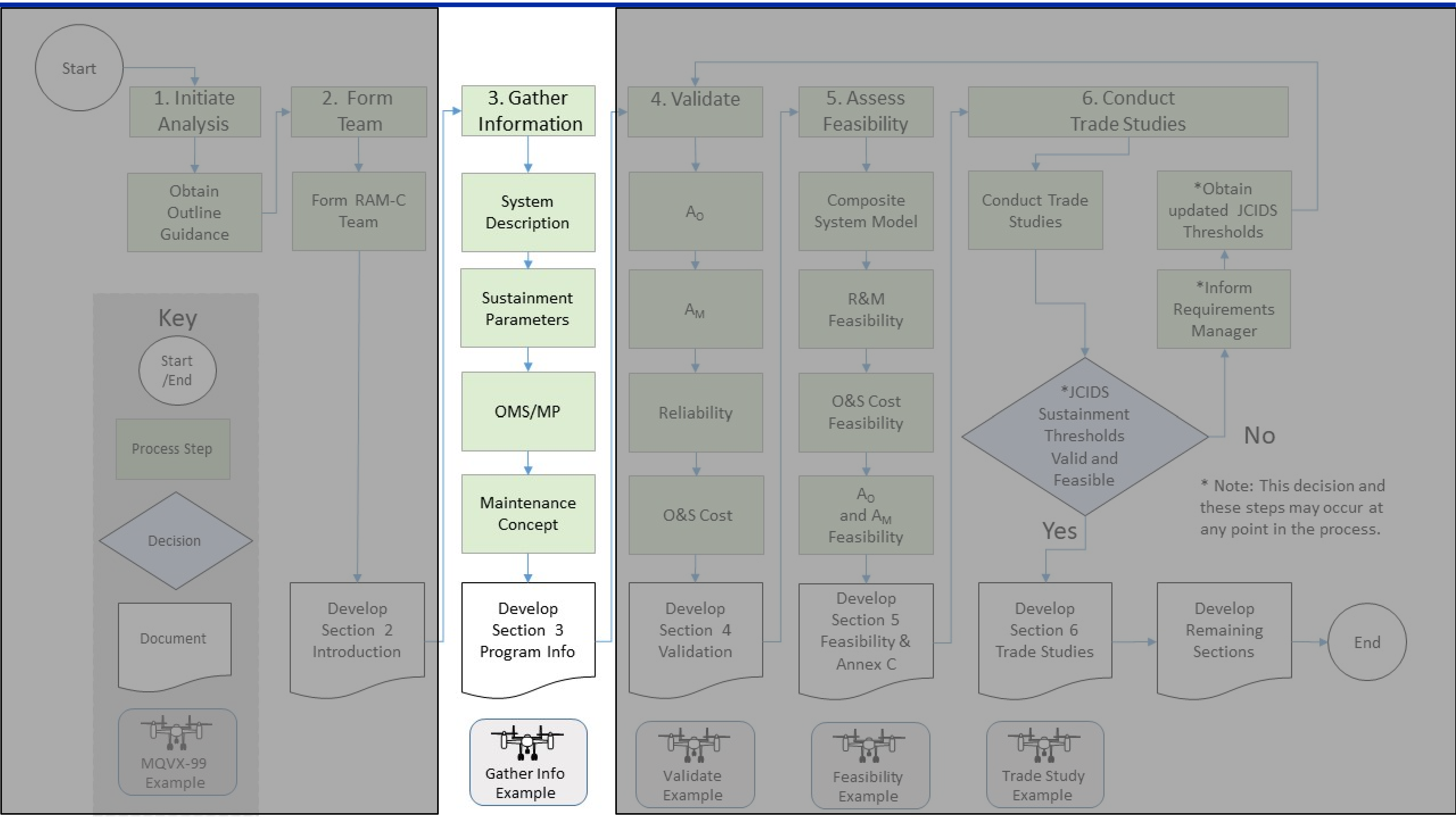



1. INITIATE ANALYSIS → 2. FORM TEAM → **3. GATHER INFO** → 4. VALIDATE → 5. ASSESS FEASIBILITY → 6. CONDUCT TRADE STUDIES

Six Iterative Steps

RAM-C Analysis Steps

3. Gather Information



3. Gather Information
Purpose/Overview

- **The purpose of this step is to obtain the documentation containing the source information needed to complete the RAM-C analysis.**
  - Requirements documentation may include: JCIDS requirements documents (Initial Capabilities Document (ICD)/Draft CDD/CDD/CPD), CONOPs, Sustainment and Maintenance Concept Documentation (may or may not be a part of CONOPs) and any other documentation that defines the requirements for the system and how it will be operated and sustained in the field.
  - Acquisition documentation may include: Life Cycle Sustainment Plan (LCSP), Acquisition Strategy, SEP, Cost Analysis Requirements Description (CARD), and various cost estimates such as the Program Cost Estimate.

3. Gather Information

Purpose/Overview

- **It is important to maintain close communication with the authors developing these documents to ensure that you have the most recent information and can identify conflicting information.**
  - In the early stages of acquisition, these documents may be in draft form and may be changing as the program matures.
  - In many cases the RAM-C will both inform and be informed by these documents due to the iterative nature of acquisition.

3. Gather Information

Activities

- **Gather the requirements and acquisition documents.**
- **Extract needed information:**
  - A system description:
    - Provides a framework for performing and understanding the subsequent analyses.
    - Includes purpose of the system, its major components/sub-systems, and how it is to be used in service.
    - May be found in the JCIDS documentation (ICD, draft CDD, CDD or CPD) as well as the Acquisition Strategy, LCSP and SEP.
  - The sustainment parameters:
    - Provide the quantitative basis for sustainment planning, enabling the requirements and acquisition communities to provide a capability solution with optimal availability and reliability to the warfighter at an affordable life cycle cost.
    - Include the sustainment KPP thresholds along with their associated KSAs and APAs.
    - Should be defined including the parameter name, the units of measurement and the threshold value and should be consistent with the Failure Definitions.
    - Are typically found in the JCIDS documentation (e.g., Draft CDD, CDD or CPD).
    - Are likely to be in work within the JCIDS documentation when the RAM-C analysis begins so preliminary inputs may be used to begin analysis. However, ensure that the approved metrics are used for the final analysis.

- **Extract needed information (cont.):**
  - The expected operating conditions:
    - o Ensure the reader understands how and in what types of environments the system is to be operated. Obtained from:
      - The Operational Mode Summary (OMS)
        - » Contains a description of the concept of employment, describes all types of operational modes that apply to a system, and shows the anticipated relative frequency of occurrence of these modes during the life of the system as it functions across the anticipated operational environment.
        - » Is a roll-up of the piece of equipment's wartime usage for the number of mission/combat operations (mission profiles) that are being analyzed to determine (as appropriate), the total operating time, alert time, and calendar time associated with each mission profile.
      - The Mission Profile (MP):
        - » Contains a time-phased, detailed description of the operational events (equipment usage) and environments (natural and man-made) that a formation or system experiences from the beginning to the end of a specific mission.
        - » There is a MP for each mission/combat operation in the equipment's wartime OMS.

(Note: The OMS and MP may be separate documents or combined in single document, the OMS/MP.

- **Extract needed information (cont.):**
  - The expected operating conditions (cont.):
    - The CONOPS:
      - » Is a verbal or graphic statement, in broad outline, of a commander's assumptions or intent about an operation or series of operations. It is designed to give an overall picture of the operation.
      - » Is typically a stand alone document.
  - o The expected operating conditions as obtained from the CONOPS and OMS/MP are used as the basis of determining if the sustainment thresholds are traceable to the warfighter's needs in the operational environment.

3. Gather Information
Activities

- **Extract needed information (cont.):**
  - The maintenance concept and planning factors:
    - o Describe the overall manner in which the system is to be maintained (e.g., 2 level vs. 3 level, organic vs. contractor and allowable use of contractors.) Planning factors include reset periods, depot maintenance schedule, supply requisition time, administrative delay time and pipeline sufficiency.
    - o Should support the sustainment capabilities as viewed by the user, maintainer, supplier and transportation providers, taking into account constraints and limitations (e.g., "core" requirements and statutory requirements).
    - o May be used to determine MDT and other maintainability KSAs or APAs needed to validate A_O and A_M.
    - o Are initially identified pre MS A in the CONOPS or other sustainment planning documents. They are then updated and refined with completion of the remaining planning factors during the subsequent acquisition phases as more detail on system design and supportability is known and may be found in the LCSP.

3. Gather Information

Fill in Outline Guidance

- **Complete Section 3.1 of RAM-C Report.**
  - System Description
    - o Using the reference design concept, identify major subsystems that are subject to R&M requirements.
    - o The system description should be user-oriented and operational and should include all elements of the system, including Government-furnished and contractor-furnished hardware (whether developmental or not), system software, operating and support documentation, and the crew and maintainer personnel.

3. Gather Information
Fill in Outline Guidance

- **Complete Section 3.2 of RAM-C Report.**
  - Sustainment Parameters
    - o Enter the sustainment parameters, along with the definitions, rationale, threshold and units.
    - o Reference the source documentation with version and date.

Table 3.2-1 Sustainment Parameters (sample aviation parameters and values based on continuous usage)

Parameter[1]		Definition (samples)	JCIDS Threshold	Units
KPP	Materiel Availability	Measure of the percentage of the total inventory of a system operationally capable, based on materiel condition, of performing an assigned mission.	0.65	
KPP	Operational Availability	Measure of the percentage of time that a system or group of systems within a unit are operationally capable of performing an assigned mission e.g. uptime/(uptime + downtime).	0.80	
KSA	Mission Reliability		46	Hours
KSA	Logistics Reliability	Total number of items removed from the aircraft that cause a demand to be placed on the supply system divided by the total number of flight hours	3.5	Hours
APA	Maintenance Burden		9	
APA	Corrective Maintenance[2]		2.0	Hours
KSA	O&S Cost[3]		$423.7M	2013 Dollars

Notes:
1. Include all relevant KPP, KSA and APA sustainment parameters and associated information including definitions (e.g. Failure definitions, mission duration, etc.) and rationale. Refer to the JCIDS manual.
2. Corrective Maintenance (Mct or MTTR) Include the tasks included in downtime, e.g., crypto load, start-up, active repair, verification of repair.
3. Include the type of dollars (e.g., then year, present year) and the units.

3. Gather Information

Fill in Outline Guidance

- **Complete Section 3.3 of RAM-C Report.**
  - OMS/MP
    - o Summarize the typical mission scenarios or profiles for each mission.
      - Highlight special conditions of use such as high/low temperatures or increased operational tempo with restricted preventive maintenance, that would affect sustainability of system.
      - Include the sources for the mission scenarios.
    - o Summarize and provide tables of relevant values.
    - o Example charts from Outline Guidance shown here for a land based system. Format and content may vary considerably based on the specifics of the system under consideration.

Table 3.3-1 Operational Mode Summary (sample land system functions)

Tasks or Functions	Frequency	Duration (hours)	Total Time (hours)
Extended Tactical Movement			
Combat Replenishment Operation (CRO)			
Deliberate Attack – Fix & Isolate Enemy			
Exploitation			
Sustainment Replenishment Operation (SRO)			
Deliberate Attack – Urban Environment			
Total			

Table 3.3-2 Summary of Environmental Data (sample land system environment)

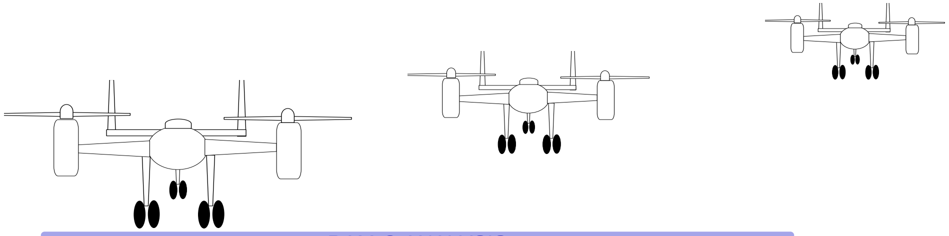
Operating Temperature		
Climate	**Operating Climate Temperature**	**% Use**
Basic	-25°F to 110°F	85%
Hot	Up to 130°F	10%
Cold	Down to -50°F	3%
Severe Cold	Down to -60°F	2%

3. Gather Information

Fill in Outline Guidance

- **Complete Section 3.4 of RAM-C Report.**
  - Maintenance Concept and Planning Factors
    - o Provide a description of the maintenance concept and list the maintenance concept planning factors for the system and source of the values.
      - Maintenance concept will provide the overview of how the system is to be maintained including: how many levels of maintenance; what types of tasks are to be done at each level and to what depth; and whether the maintenance is organic, contractor, or some mix.
      - The planning factors support the sustainment capabilities. Examples include:
        - » Reset periods and maintenance cycles (dry-dock repairs, periodic depot maintenance).
        - » Preventive and corrective maintenance time.
        - » MDT including Mean Corrective Maintenance Time (MCMT) and Administrative and Logistics Delay Time (ALDT).
        - » Scheduled maintenance requirements.
        - » Supply requisition time.
        - » Administrative delay time.
        - » Spares sufficiency.(e.g. 95%)

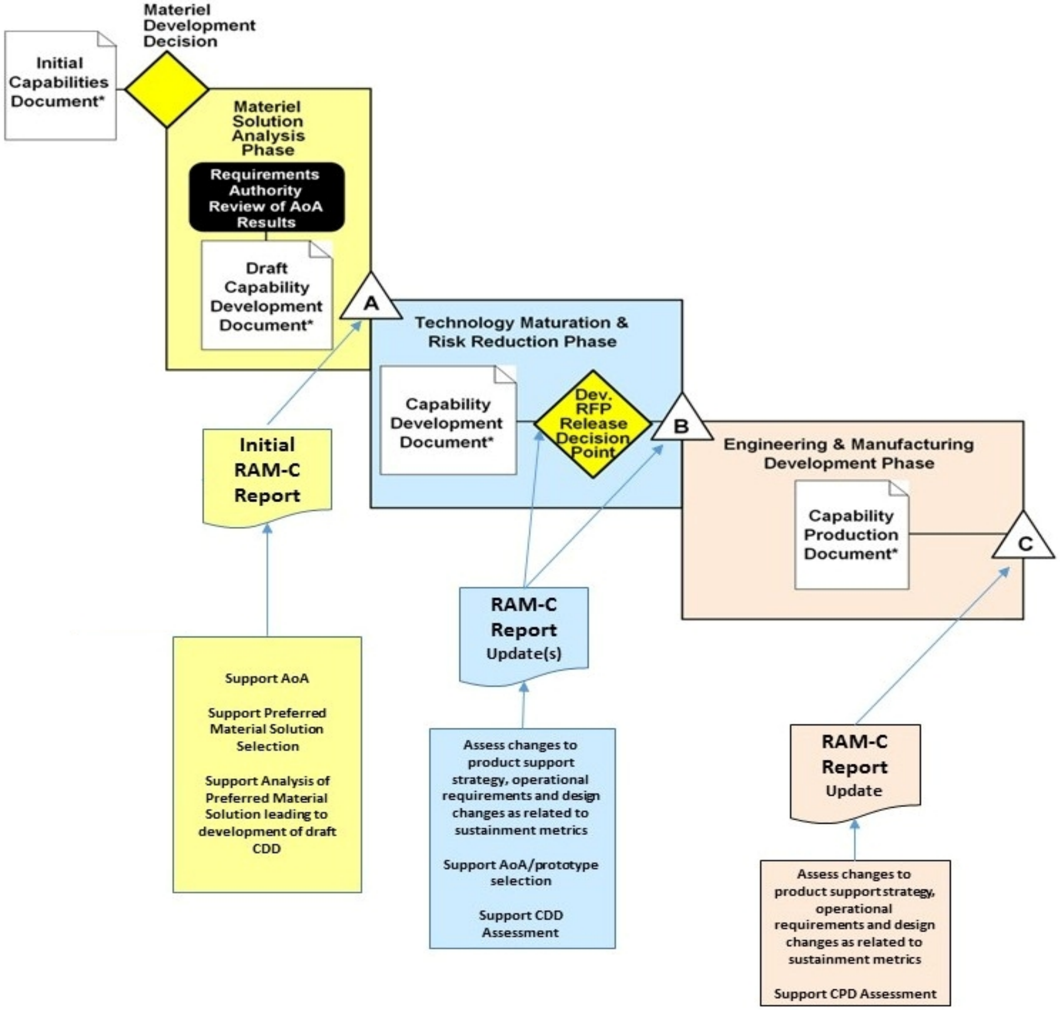
- **MQVX-99 UAV is a fictional system used as an example for this training.**
  - The year is 2035 and the program is moving towards MS A approval and your program is developing a RAM-C for the MQVX-99 in parallel with the development of the draft CDD.
- **System Overview:**
  - Fully autonomous and used for unmanned resupply missions.
  - All electric and powered by recently developed quantum ionic plasma batteries (initial technology fielding in 2030) with greater energy density than traditional carbon based fossil fuels.
  - Vertical takeoff and landing with transition to fixed wing flight, allowing operation in austere environments without runways.



3. Gather Information

MQVX – 99 Example / Overview

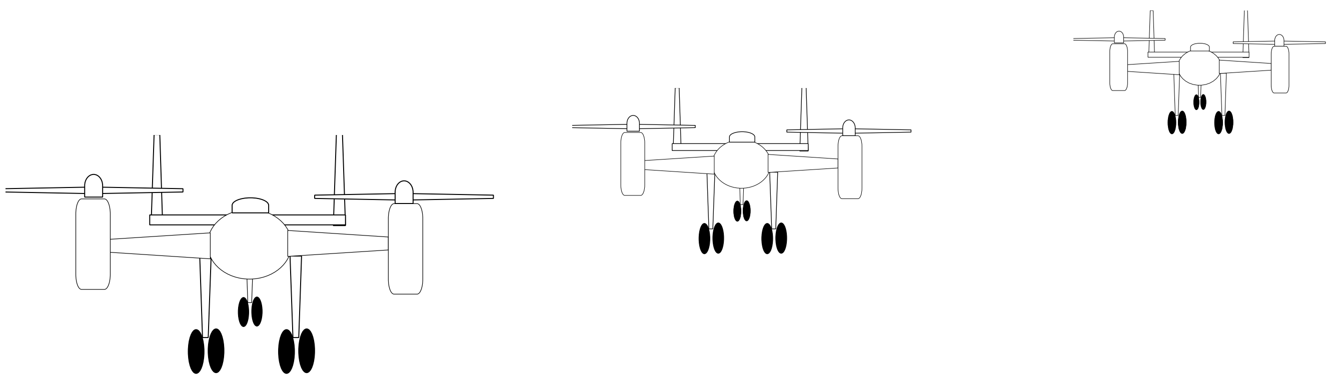
- The initial RAM-C submittal will support MS A, and an updated RAM-C is required at the Development RFP Decision Point, MS B, and MS C as shown.
- Interaction with the JCIDS Requirements Officer who manages the ICD, draft CDD, CDD and CPD is important as the sustainment metrics are developed and matured.



3. Gather Information

MQVX-99 Example

- **The following section will provide some examples of the types of information to be gathered for the RAM-C report for the MQVX-99.**
  - The information is used in subsequent sections to demonstrate the steps used in developing a RAM-C.
  - **All data was created for this training and does not represent any existing or planned system.**



3. Gather Information

Excerpts from MQVX-99 CONOPS

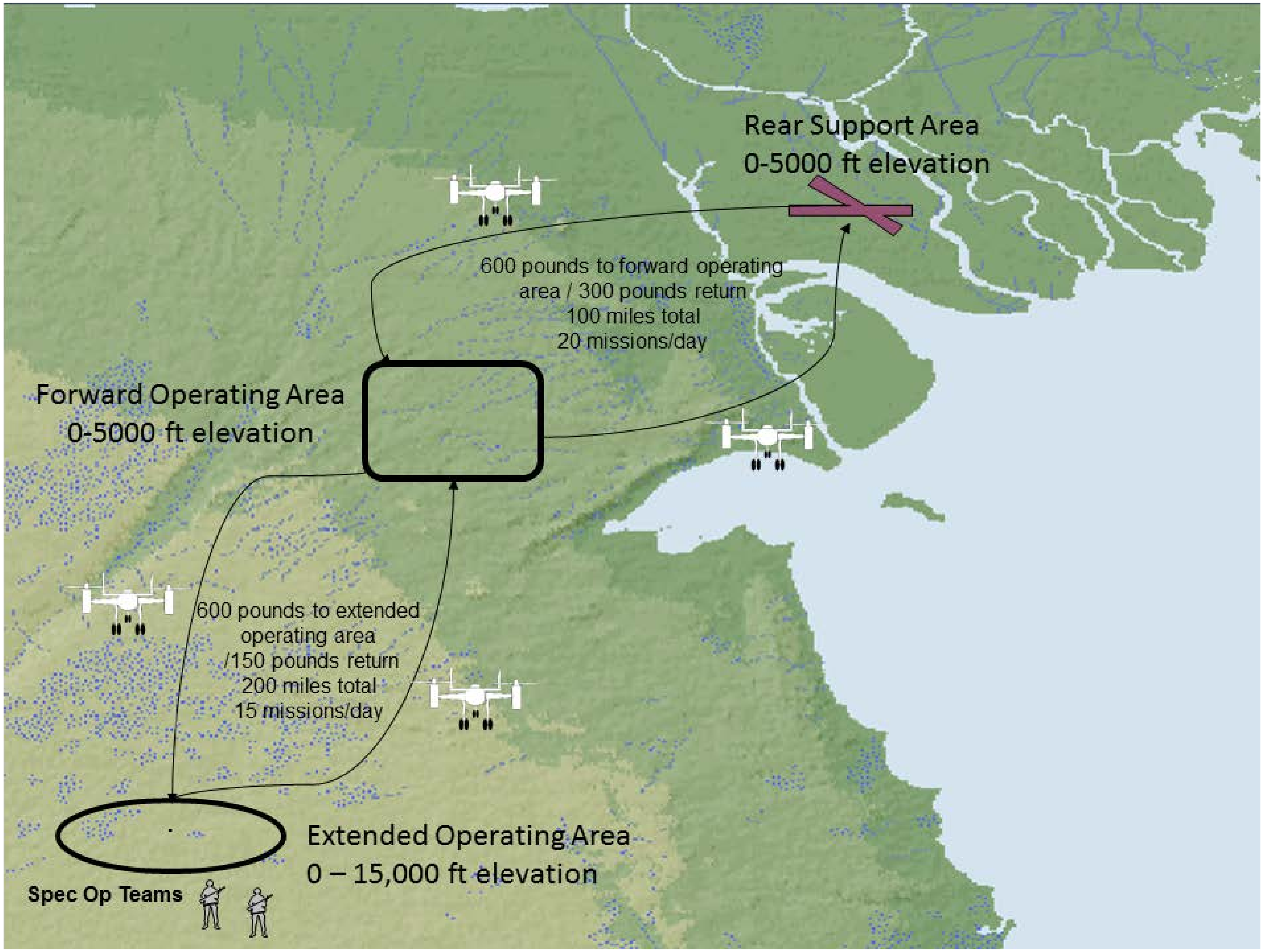
- **The MQVX-99 will operate in support of special operations units of all services.**
  - Fully autonomous operation once mission plans are loaded via secure com link from existing common ground control station. The ground control station is not included in the MQVX-99 operational thresholds.
  - No carbon based fuels required. Operates using quantum ionic plasma batteries with 2 fully charged batteries having the capability to power the UAV for range of 225 miles. Charges from standard Department of Defense charging stations available at all rear operating areas.
  - Max takeoff payload is 600 pounds at altitudes up to 10000 feet. Above 10000 feet to 15000 feet, max takeoff payload is 300 pounds.
  - Capable of lifting cargo, but not certified for humans.
  - Two motors with capability of landing safely with one motor and one battery operational.
  - Full diagnostic/prognostic capability minimizing unscheduled maintenance.

3. Gather Information
Excerpts from MQVX-99 CONOPS

- **Deployment Scenario:**
  - A squadron of 12 UAVs is to be deployed on a 1206 Flight Hour (FH) (approx. 11 month) deployment cycle. After 1206 Flight Hours, the UAV is returned to home base/depot for a one month depot level maintenance cycle and then will return to service for another 1206 FH deployment.
  - Daily operations will consist of the following missions during a 12 hour window for flight operations.
    - Rear to Forward Area Resupply – 600 pounds cargo outbound/ 300 pounds inbound - 100 miles total - 20 missions/day carrying 12,000 pounds of cargo to the Forward Area.
    - Forward to Extended Area Resupply – 600 pounds cargo outbound / 150 pounds inbound – 200 miles total - 15 missions / day carrying 9,000 pounds of cargo to the Extended Area. Up to 5 missions may be required concurrently during combat operations.
    - With 12 UAVs available to fly 35 missions daily delivering a total of 21,000 pounds of cargo, a Sortie Generation Rate (SGR) of 35/12 = 2.92 is required.
    - The System On to Flight Hour (S/F) ratio is 1.27 for the combined missions.

3. Gather Information

Excerpts from MQVX-99 CONOPS



3. Gather Information

Excerpts from MQVX-99 CONOPS

- **Operations and Maintenance:**
  - Rear Operating Areas: The UAV is transported by cargo aircraft, truck, helicopter, or via ship to rear operating areas. They are maintained in these areas primarily using on-board diagnostics/prognostics and replacement of main modules. Inoperative modules and UAVs deemed beyond capability of repair at rear operating levels are to be sent to depots/main bases for repair. Sufficient spares are to be available at rear areas to sustain operational availability.
  - Forward Operating Areas: The UAV then resupplies forward operating areas with necessary materiel to sustain combat operations. Maintenance at forward operating areas will consist only of system functional tests, battery swaps, preventative maintenance checks and very limited corrective maintenance actions.
  - Extended Operating Areas: From the forward operating areas, each UAV will resupply extended operating areas with necessary material to sustain combat operations. There is no planned maintenance at these areas except verifying on-board Built in Test (BIT) to determine UAV is ready for flight.

3. Gather Information

Excerpts from MQVX-99 Acquisition Strategy

- **Quantities to be procured / Total Operational Hours:**
  - 48 UAVs are to be procured to create 4 squadrons with 12 UAVs each.
  - 9 Aircraft are to be procured to cover depot pipeline and other maintenance delay.
  - 6 UAVs are to be assigned for training operators and maintainers.
  - 5 additional assets are to procured to account for attrition losses.
  - 20 year program life, 54 active UAVs, 1206 FH/year/active UAV.

3. Gather Information

3.2 Example JCIDS Thresholds MQVX-99

Parameter		Definition (samples)	JCIDS Threshold	Units
KPP	Materiel Availability (A_M)	Measure of the percentage of the total inventory of a system operationally capable, based on materiel condition, of performing the assigned mission.	87	%
KPP	Operational Availability (A_O)[1]	A_O equals 1-% downtime. Downtime is based on all Failures as defined in the Failure Definitions and Mission Essential Subsystems Matrix (MESM.)	90	%
KSA	Mean Flight Hours Between Failure (MFHBF)	Total number of flight hours for all UAVs divided by total number of failures.	42	Flight Hours
KSA	Mean Flight Hours Between Operational Mission Failure – (MFHBOMF)[2]	Total number of flight hours divided by the total number of Operational Mission Failures (OMFs). OMFs inhibit the MQVX-99 from performing its missions and result in an abort. In flight hardware and software failures count. Pre-flight failures do not. The MQVX-99 MESM defines the subsystems required for these missions.	81	Flight Hours
APA	Maintenance Burden	Maintenance Man Hours/Flight Hour (MMH/FH). All maintenance hours at organization levels divided by all flight hours.	5.7	Man Hours Per Flight Hour
APA	Mean Corrective Maintenance Time (MCMT)	Average time to return the MQVX-99 to full mission capability either through repair or by remove and replace action at operational level. Does not include scheduled maintenance.	3.5	Hours
KSA	Operating and Support (O&S) Cost	All operations and support costs in accordance with CAPE guidance over the lifetime of the system	$3,381.4M	2035 Dollars

1. Rationale for Operational Availability: For takeoff, all systems must be fully functional including redundant systems, thus all failures impact A_O. The MDT required to restore the MQVX-99 to its operational capability is 27.5 hours. Includes MCMT of 3.5 hours and ALDT of 24 hours. These values were based upon similar systems operating in like operational environments.

2. Rationale for MFHBOMF: The MFHBOMF of 81 flight hours supports a 98% or higher probability of success for mission lengths up to 1.64 hours. The sortie durations for Forward Area Resupply and Forward to Extended Area Resupply are 0.95 and 1.62 flight hours respectively, and are both within the 1.64 max mission length having a 98% or higher success probability. Given the number of aircraft in a squadron, the other sustainment metrics, and the maintenance concepts, a 98% probability of mission success is required to ensure that the operational requirements within the CONOPS and OMS/MP are met. 12 UAVs are required to fly the 35 missions daily delivering a total of 21,000 pounds of cargo. The Sortie Generation Rate (SGR) of 35/12 = 2.92 supports the mission requirement to deliver the 21,000 pounds of cargo as specified in the CONOPS.

3. Gather Information

3.3 Example OMS/MP for Rear to Forward Resupply Mission - MQVX-99

Segment	Operating Mode	Altitude Range (Ft)	Temp (Degrees F)	Time (Minutes)	Distance (Miles)	Payload (Pounds)	Speed (MPH)
1	Startup	0	110	5	0	600	0
2	Vertical Takeoff	0-500	110	3	0	600	0
3	Transition	500	108	1	2	600	0-125
4	Climb	500-10000	77	10	21	600	125-150
5	Cruise	10000	77	8	20	600	150
6	Descent	10000-5500	93	4	8	600	150-125
7	Transition	5500	93	2	2	600	125-0
8	Vertical Land	5500-5000	95	2	0	600	0
9	Shutdown/Unload/Load	5000	95	30	0	300	0
10	Startup	5000	95	5	0	300	0
11	Vertical Takeoff	5000-5500	95	3	0	300	0
12	Transition	5500	95	1	2	300	0-125
13	Climb	5500-10000	77	4	8	300	125-150
14	Cruise	10000	77	8	20	300	150
15	Descent	10000-500	110	8	17	300	150-125
16	Transition	500	108	1	2	300	125-0
17	Vertical Landing	500-0	110	2	0	300	0
18	Diagnostics/Shutdown	0	110	10	0	300	0
*Total Mission (Minutes - Miles)				107	100		
*Total Mission (Hours - Miles)				1.78	100		
*Total Flying (Minutes - Miles)				57	100		
*Total Flying (Hours - Miles)				0.95	100		
*Total System On Time (Minutes)				77			
S/F Ratio				1.35			

*Note: Mission Time includes all segments. System On Time excludes segment 9. Flying Time excludes segments 1, 9, 10 and 18.

3. Gather Information

3.3 Example OMS/MP for Forward to Extended Area Resupply Mission - MQVX-99

Segment	Operating Mode	Altitude Range (Ft)	Temp (Degrees F)	Time (Minutes)	Distance (Miles)	Payload (Pounds)	Speed (MPH)
1	Startup	5000	95	5	0	600	0
2	Vertical Takeoff	5000-5500	95	3	0	600	0
3	Transition	5500	93	1	2	600	0-125
4	Climb	5500 -20000	0	15	30	600	125-150
5	Cruise	20000	0	19	48	600	150
6	Descent	20000-10500	23	8	17	600	150-125
7	Transition	10500	23	2	2	600	125-0
8	Vertical Land	10500-10000	25	2	0	600	0
9	Shutdown/Unload/Load	10000	25	30	0	150	0
10	Startup	10000	25	5	0	150	0
11	Vertical Takeoff	10000-10500	23	2	0	150	0
12	Transition	10500	23	1	2	150	0-125
13	Climb	10500-20000	0	10	22	150	125-150
14	Cruise	20000	0	19	47	150	150
15	Descent	20000-5500	93	12	30	150	150-125
16	Transition	5500	93	1	2	150	125-0
17	Vertical Landing	5500-5000	95	2	0	150	0
18	Dignostics/Shutdown	5000	95	10	0	150	0
*Total Mission (Minutes - Miles)				147	200		
*Total Mission (Hours - Miles)				2.45			
*Total Flying (Minutes - Miles)				97	200		
*Total Flying (Hours - Miles)				1.62			
*Total System On Time (Minutes)				117			
S/F Ratio				1.21			

*Note: Mission Time includes all segments. System On Time excludes segment 9. Flying Time excludes segments 1, 9, 10 and 18.

3. Gather Information

3.3 Example OMS/MP Combined Mission Totals - MQVX-99

Rear to forward	Total Mission (minutes)	2140
Totals	Total Flying (minutes)	1140
	Total System On Time (minutes)	1540
	S/F Ratio	1.35
Forward to extended	Total Mission (minutes)	2205
Totals	Total Flying (minutes)	1455
	Total System On Time (minutes)	1755
	S/F Ratio	1.21
Combined	Total Mission (minutes)	4345
Totals	Total Flying (minutes)	2595
	Total System On Time (minutes)	3295
	S/F Ratio	1.27

3. Gather Information

3.4 Example Maintenance Concept and Planning Factors - MQVX-99

- **Rear Operating Areas: UAVs are maintained in these areas primarily using on-board diagnostics/prognostics and replacement of main modules. Inoperative modules and UAVs deemed beyond capability of repair at rear operating levels are sent to depots/main bases for repair. Sufficient spares are planned to be available at rear areas to sustain operational availability.**
- **Forward Operating Areas: Maintenance at forward operating areas will consist only of system functional tests, battery swaps, preventative maintenance checks very limited corrective maintenance actions.**
- **Extended Operating Areas: There is no planned maintenance at these areas except verifying on-board BIT to determine UAV is ready for flight.**
- **Source – CONOPS V2.3 dated 09 Jun 2032.**

3. Gather Information

3.4 Example Maintenance Concept and Planning Factors - MQVX-99

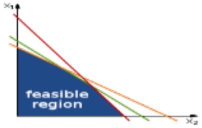
- A squadron of 12 UAVs are to be deployed from main bases/depots to rear operating areas on a 1206 hour (approx 11 month) deployment cycle. After 1206 FHs, the UAV returns to home base/depot for a one month depot level maintenance cycle and then will return to service for another 1206 FH deployment: Source – CONOPS V2.3 dated 09 Jun 2032.
- Each UAV will fly for approximately 1206 FH per year. For the purpose of determining A_O, flying time is used as measured by FHs. The maintenance data collection systems will also measure time in FHs requiring adjustments for time in operation for systems that operate while not flying. Sources - OMS/MP V 1.5 dated 06 Sep 2032.
- OMF Failure Rate = 81 Mean Flight Hours Between Operational Mission Failure (MFHBOMF): Source – KSA from in work draft CDD V1.0 as of 10 Sep 2035 (unsigned).

3. Gather Information

3.4 Example Maintenance Concept and Planning Factors - MQVX-99 (cont.)

- Mission Reliability (R_M) = 0.98: Source – rationale from in work draft CDD V1.0 as of 10 Sep 2035 (unsigned).
- Logistics Reliability (R_L) = 42 MFHBF: Source – KSA from in work draft CDD V1.0 as of 10 Sep 2035 (unsigned).
  - (Note: For this system all logistics failures also impact A_O).
- K' = 7.3 : Ratio of Total Calendar Hours/Operating Time : Source – from in work draft CDD V1.0 as of 10 Sep 2035 (unsigned). (See OPNAVINST 3000.12A for info on K')
- MCMT = 3.5 hours for operational level failures : Source – KSA in from in work draft CDD V1.0 as of 10 Sep 2035 (unsigned).
- ALDT = 24 hours for operational level failures: Source – rationale from in work draft CDD V1.0 as of 10 Sep 2035 (unsigned).
- UAVs will operate over a 20 year period with 54 UAVs active at any time (48 in operational squadrons and 6 in training squadrons): Source – Acquisition Strategy V1.0 dated 09 Apr 2035.

RAM-C Analysis Steps
Validate

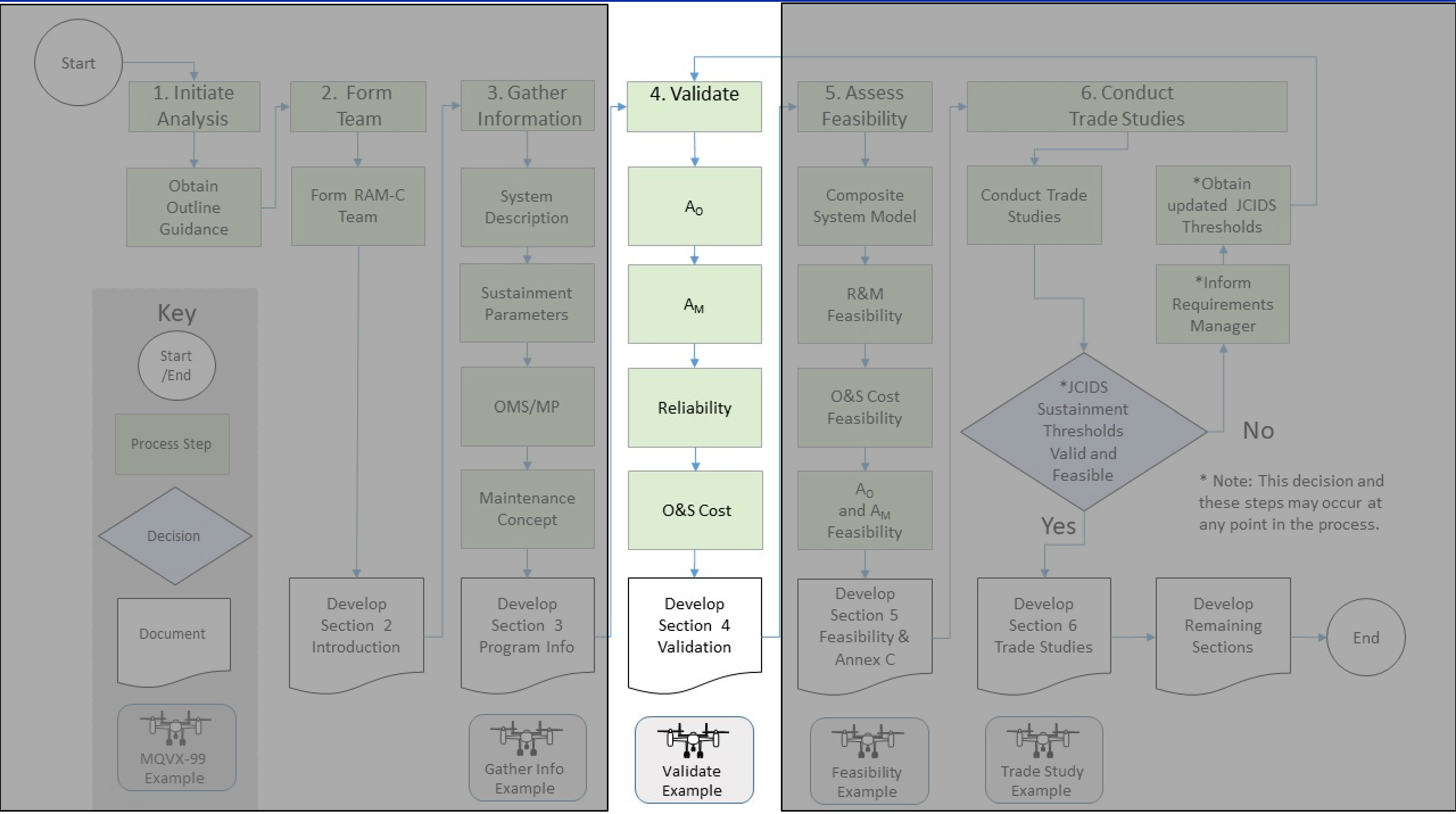


1. INITIATE ANALYSIS → 2. FORM TEAM → 3. GATHER INFO → 4. VALIDATE → 5. ASSESS FEASIBILITY → 6. CONDUCT TRADE STUDIES

Six Iterative Steps

RAM-C Analysis Steps

4. Validate



4. Validate
Purpose/Overview

- **What is validation and why do it?**
  - Determines if the sustainment thresholds for the program are in alignment with the warfighter requirements. Are the sustainment thresholds traceable to the requirements prescribed in the JCIDS documents and in alignment with the CONOPS, Maintenance/Sustainment Concept and OMS/MP?
  - Determines if the correct results are obtained when the underlying sustainment metrics are used to calculate availability, mission success, and O&S costs.
  - Ensures the sustainment KPP and KSA thresholds support the warfighter needs.

Are thresholds traceable and does the math work?

4. Validate
Purpose/Overview

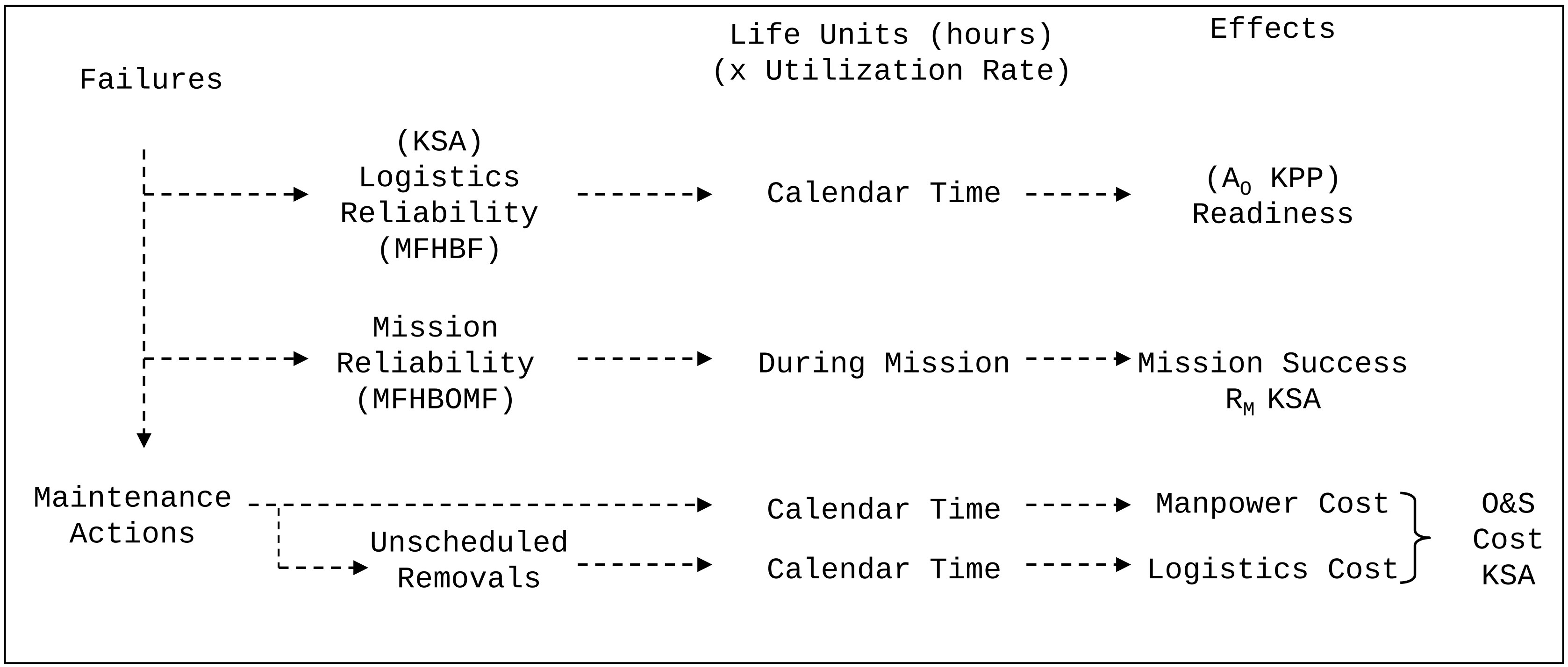
- **The sustainment thresholds are valid when they:**
  - Are traceable to JCIDS requirements documents with consistent definitions and values.
  - Support the other sustainment parameters as evidenced by using calculation and/or M&S and as shown on the following two slides.
  - Are consistent with the CONOPS, Concept of Employment, OMS/MP, environmental profiles, maintenance concept/sustainment strategy, planned inventory, operating hours (mission durations), Failure Definitions, and planned downtimes.
- **They are developed using service specific guidance.**
- **Validation does not address whether the system can actually achieve the sustainment thresholds. That is determined during the feasibility assessment.**

4. Validate

Purpose/Overview

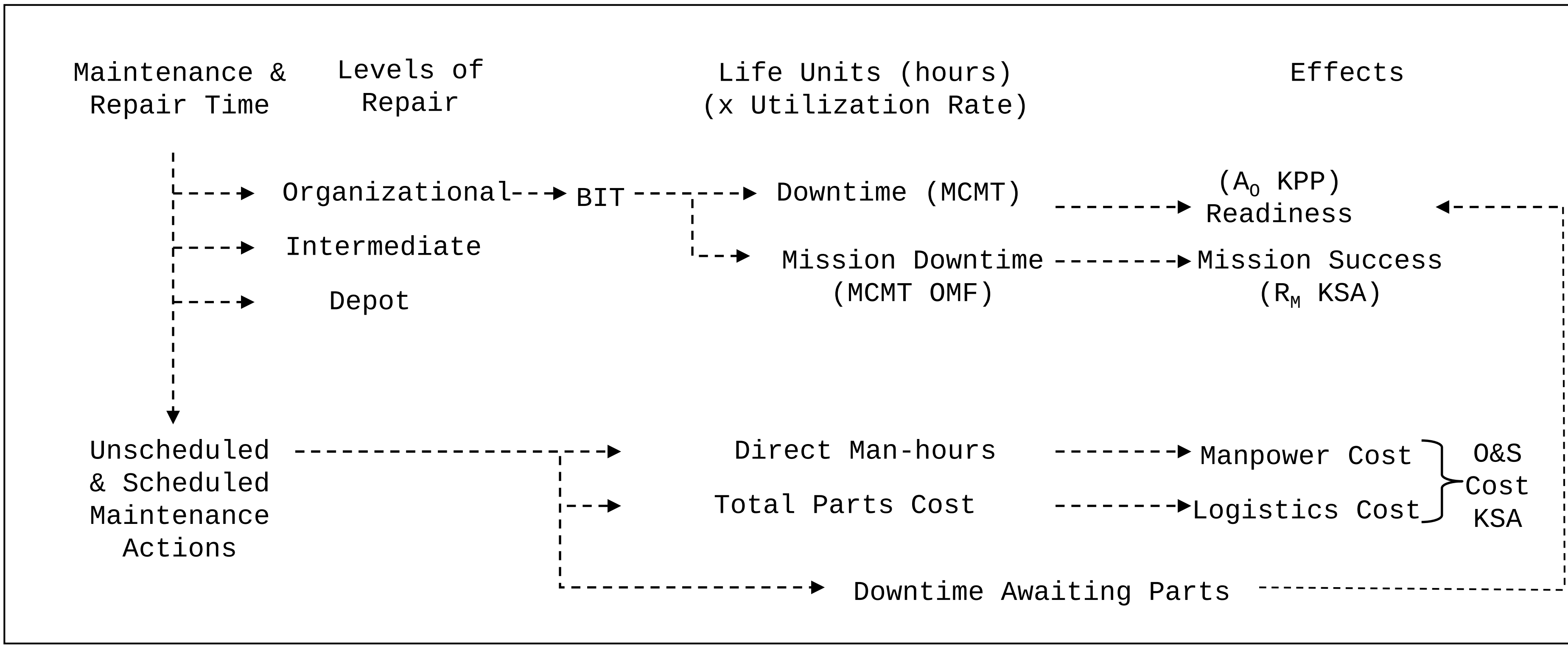
Linkage of Measures – Aircraft Example

Reliability Example



4. Validate
Purpose/Overview
Linkage of Measures – Aircraft Example

Maintainability Example



- **Obtain the definition of A_O used for the system under development.**
  - Usually from the JCIDS document or other authoritative program acquisition document.
  - Fully understand what is meant by uptime and downtime and how they are measured consistent with the A_O definition.
  - Fully understand against what population and in what time frame A_O is measured. Is it the entire fleet or a sub-set at a unit level? Is it measured steady state or at a specific time?
    - In reporting systems – those that are in an operational environment where they can be called upon to perform a mission, are generally considered when measuring A_O.
      - Downtime is usually driven by unscheduled/corrective maintenance including the time to repair the system and the time to get the parts to the maintainer. (MCMT+ ALDT).
      - Scheduled/preventive maintenance is often completed during periods when the system is not required for a mission and thus it may have limited effect on A_O
        - The analysis of A_O should determine whether the scheduled maintenance for active systems should be included in the calculation of A_O.
        - This analysis may require M&S to adequately make the determination.
    - Out of reporting systems – those that are not in a operational environment, such as those in scheduled depot maintenance, used for training, attrition losses, or in storage are generally not considered when determining A_O.

4. Validate

Activities: Operational Availability - A_O

- **Understand how the system is planned to be used in service and maintained.**
  - From the CONOPS, OMS/MP, JCIDS requirements, LCSP and other related documents.
- **Obtain the maintenance concept planning factors and design factors related to the calculation of A_O.**
  - These include MCMT, MDT, ALDT, Mean Time Between Failure (MTBF) or related metrics.
  - Ensure that they are consistent with the use and maintenance of the system and the Failure Definitions.
- **Use service specific guidance for the methodology to calculate A_O.**
  - Ensure it is consistent with the definition of A_O, the maintenance concept and planning factors and is traceable to the user requirements within the JCIDS documents.

4. Validate

Activities: Operational Availability - A_O

- **Use service specific guidance for the methodology to calculate A_O (cont.)**
  - M&S using multi echelon modeling provides a more accurate value for A_O than a deterministic equation. In either case, record the inputs to the M&S/equation and the outputs obtained along with a description of the M&S system or a copy of the equation.
- **Compare the calculated value of A_O with the JCIDS threshold value.**
  - Is the calculated value of A_O is equal to or greater than the JCIDS threshold value?
    - o If so, A_O is valid.
    - o If not, A_O is not valid.
      - In this case coordinate this information with your program management.
      - Further analysis may be performed to determine possible solutions.

4. Validate

Activities: Materiel Availability - A_M

- **Obtain the definition of A_M used for the system under development.**
  - Usually from the JCIDS document or other authoritative program acquisition document.
  - Fully understand what is meant by up assets and down assets and how they are defined.
  - Fully understand against what population and timeframe A_M is measured. It is usually the entire fleet over the entire service life.
    - In reporting systems – those that are in an operational environment where they can be called upon to perform a mission, are considered when measuring A_M.
      - Based on the definitions of up and down assets, both scheduled and unscheduled maintenance can affect A_M.
    - Out of reporting systems – those that are not in a operational environment, such as those in scheduled depot maintenance, used for training, attrition losses, or in storage are also considered when measuring A_M.
      - Systems used for training and systems in attrition reserve are generally considered up assets.
      - Systems in reset or scheduled depot maintenance or systems that are lost due to combat damage are considered down assets.
        - » Thus scheduled/preventive maintenance is generally a significant factor in $A_{M.}$.
        - » This analysis may require M&S to adequately make the determination.

4. Validate

Activities: Materiel Availability - A_M

- **Understand how the system is to be used in service and maintained.**
  - From the CONOPS, OMS/MP, JCIDS document, LCSP and other related documents.
- **Obtain the maintenance concept planning, design and operational factors related to the calculation of A_M.**
  - These include usage time/hours per year; expected attrition rates; number of training and pre-positioned assets; and maintenance schedules particularly those that place the system in “down” status as related to A_M such as depot repair/overhaul or reset activities.
  - Ensure that they are consistent with the operation and maintenance concepts of the system.
- **Use service specific guidance for the methodology to calculate A_M.**
  - Ensure it is consistent with the definition of A_M, the maintenance concept and planning factors and is traceable to the user requirements within the JCIDS documents.

4. Validate

Activities: Materiel Availability - A_M

- **Use service specific guidance for the methodology to calculate A_M (cont.)**
  - Determine the up and down assets for the appropriate population and timeframe:
    - o Up assets typically include: CONOPS, Training Systems, Attrition Reserve and Pre-Positioned Assets.
    - o Down assets typically include those down for maintenance at depot level or “reset” type maintenance.
    - o M&S using multi echelon modeling provides a more accurate value for the number of up and down assets than a deterministic equation. In either case, record the inputs to the M&S/equation and the outputs obtained along with a description of the M&S system or a copy of the equation.
  - With the numbers of up and down assets determined, calculate A_M.

4. Validate

Activities: Materiel Availability - A_M

- **Compare the calculated value of A_M with the JCIDS threshold.**
  - Is the calculated value of A_M is equal to or greater than the JCIDS threshold value?
    - o If so, A_M is valid.
    - o If not, A_M is not valid.
      - In this case coordinate this information with your program management.
      - Further analysis may be performed to determine possible solutions.

4. Validate

Activities: Mission Reliability - R_M

- **Obtain the most stringent mission duration, composition, and the definition of success and failure of the mission.**
  - The mission should be based on the CONOPS and OMS/MP.
  - Definitions of success and failure should be consistent with the CONOPs, OMS/MP and the Failure Definitions.
- **Obtain the appropriate mission reliability metric from the JCIDS documents.**
  - R_M may be expressed as a probability of success or a continuous value, e.g., 95% probability of mission success or 100 hours MTBOMF.
  - Failure metric should be in the same as the mission life unit e.g., FHs, miles, etc.

4. Validate

Activities: Mission Reliability - R_M

- **Use service specific guidance and calculate R_M.**
  - Record the assumptions (e.g., inclusion of Government Furnished Equipment (GFE)/Contractor Furnished Equipment (CFE), equations, and models used to determine R_M .
  - In many cases, a reliability block diagram should be developed to validate R_M.
- **Compare the calculated value of R_M with the JCIDS threshold.**
  - If the calculated value of R_M based on the most stringent mission is greater than or equal to the JCIDS threshold value, R_M is valid.
  - If the calculated value of R_M is less than the JCIDS threshold, R_M is not valid. If R_M is not valid:
    - Coordinate this information with your program management.
    - Further analysis may be performed to determine possible solutions.

4. Validate
Activities: O&S Cost Overview

- **O&S cost estimates are complex and based on guidance from CAPE.**
- **O&S cost validation consists of two tasks:**
  - Check that the sustainment KPP related input parameters used in the formulation of the program O&S budget are consistent with the thresholds obtained from the JCIDS documentation and listed in section 3.2 of the RAM-C report.
  - Check that the totals for the program’s O&S budget are equal or less than the thresholds obtained from the JCIDS documentation and listed in section 3.2 of the RAM-C report.
- **If both of these conditions are met, the O&S cost metrics is considered as valid.**

4. Validate
Activities: O&S Cost

- **Obtain the program office baseline O&S cost estimate.**
  - This should have been developed following CAPE guidance along with service specific guidance for cost analysis.
- **List the sustainment KPP related input parameters.**
  - These include logistics reliability, repair time per failure, quantity of systems, and operating hours.
- **Compare the program office O&S cost estimate sustainment KPP related input parameters to the sustainment values obtained from the JCIDS documentation.**
  - If these are consistent, then use the totals from the program cost estimate for comparison to determine validity.
  - If these inputs are not consistent, determine why different values were used and coordinate with the program cost team to correct this and have the program estimates recalculated.

4. Validate

Activities: O&S Cost (cont.)

- **When the sustainment KPP related input parameters used in the program O&S cost estimate are consistent with the JCIDS documentation, compare the calculated program O&S cost estimate to the JCIDS threshold.**
  - If the total from the program O&S cost estimates are less than or equal to the O&S threshold from the JCIDS documentation, the O&S cost values are valid.
  - If they are greater than the O&S thresholds from the JCIDS document, the O&S cost values are not valid.
    - In this case coordinate this information with your program management.
    - Further analysis may be performed to determine possible solutions.

4. Validate
Fill in Outline Guidance

- **Complete Section 4.1 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Provide the definition of A_O as found in the appropriate JCIDS document along with the definitions of uptime and downtime.
  - Describe the rationale for the levels of reliability and MDT obtained from the JCIDS document.
    - Show how the reliability and MDT levels were determined and how they relate to the operation and maintenance of the system.
    - If other input parameters were used in the calculation, e.g., to build up the MDT, list them and provide the rationale for those.
  - Provide the equation or M&S methodology used to calculate A_O including inputs and outputs to the equation or model.

4. Validate
Fill in Outline Guidance

- **Complete Section 4.1 of RAM-C Report.**
  - Table 4.1-1
    - o If scheduled maintenance cannot be neglected, include the associated scheduled maintenance metrics.

Table 4.1-1 A_O Validation (sample aviation values)

JCIDS A_O Threshold	Calculated A_O	Input Parameters[2]		
		MFHBF[1] Threshold	MDT	
			MTTR	ALDT
0.8	0.8	8.4	0.9	1.2

Note:

1. Use appropriate service definitions for failures that influence A_O. In most cases this value of MTBF will not be the same as the logistics reliability value unless all events that place a demand on the supply system also affect A_O.
2. List additional input parameters or assumptions needed for the Ao calculation.

  - Based on the value of A_O calculated, state whether the A_O threshold is valid.
    - o If it is not valid, provide details on the reasons it is not valid along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s).

4. Validate

Fill in Outline Guidance

- **Complete Section 4.2 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Provide the definition of A_M as found in the appropriate JCIDS document along with the definitions of up assets and down assets.
  - Describe the rationale demonstrating the link between reliability, maintainability, Product Support Strategy and A_M.
    - Show how the combination of reliability, maintainability and Product Support relate to the average numbers of up assets and down assets.
    - If other input parameters were used in the calculation, e.g, to determine repair pipeline time, list them and provide the rationale for those.

4. Validate
Fill in Outline Guidance

- **Complete Section 4.2 of RAM-C Report.**
  - Provide the equation or M&S methodology used to calculate A_M including inputs and outputs to the equation or model.
  - Complete Table 4.2-1.

Table 4.2-1 A_M Validation (sample aviation values)

JCIDS A_M Threshold Value	Calculated A_M	A_M Inputs					
		Up Assets				Down Assets[1]	Total Assets
		CONOPS	Op Systems for Training	Attrition Reserve	Pre-positioned Assets	Total Average Annual Down Assets	Total Average Annual Assets
0.65	0.65	102	12	22	20	84	240

Notes:
1. The average number of unavailable assigned assets, based on assumed planned depot, flight-line downs, or shipyard cycles

Based on the value of A_M calculated, state whether the A_M threshold is valid.

- o If it is not valid, provide details on the reasons it is not valid along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s).

4. Validate
Fill in Outline Guidance

- **Complete Section 4.3 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Provide the definition of R_M as found in the appropriate JCIDS document along with the description of the most stringent mission and the definition of success and failure of the mission.
    - o Describe the rationale for determining the most stringent mission.
    - o Provide the mission length of the most stringent mission.
  - If a block diagram was used to calculate R_M, provide a description of the block diagram and rationale for the failure rates used, e.g., how they related to mission failures only.

- **Complete Section 4.3 of RAM-C Report.**
  - Provide the equation or M&S methodology used to calculate R_M including inputs and outputs to the equation or model.
    - Provide any related assumptions, e.g., inclusion of GFE/CFE.
  - Complete Table 4.3-1.
    - For one shot systems, the table may be modified for shots and successes.

Table 4.3-1 Mission Reliability Validation (sample)

JCIDS Mission Reliability Threshold Value	Mission Reliability Inputs		
	Calculated Mission Reliability Value	Mission Duration	Probability[1] of Success or Continuous Value

Note:
1. If JCIDS mission reliability is defined as a probability of success, use the continuous value in this block. If JCIDS mission reliability is defined as a continuous value, use probability of success in this block.

4. Validate
Fill in Outline Guidance

- **Complete Section 4.3 of RAM-C Report.**
  - Based on the value of R_M calculated, state whether the R_M threshold is valid.
    - o If it is not valid, provide details on the reasons it is not valid along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s).

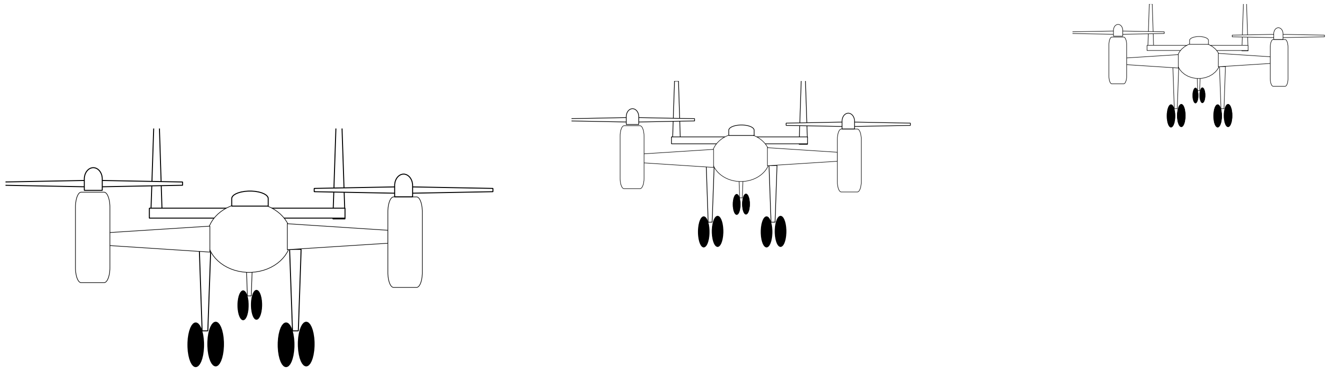
4. Validate
Fill in Outline Guidance

- **Complete Section 4.4 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - List the sustainment KPP related input parameters used in the Program Office baseline O&S cost estimate, e.g., reliability, repair time, quantity of system, operating hours, etc.
    - State if these are consistent with the sustainment values obtained from the JCIDS documents and those metrics provided in section 3.2 of the RAM-C.
    - If they were not originally consistent, discuss what changes were made to make them consistent.
  - Provide the total O&S costs from the program cost estimate and JCIDS document and state whether the O&S cost threshold is valid.
    - The O&S cost threshold is considered valid only if the inputs used in the calculation are consistent with the sustainment KPP metrics for the system and the total of the program cost estimate is less than or equal to the JCIDS cost threshold.
    - If it is not valid, provide details on the reasons it is not valid along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s).

4. Validate
Fill in Outline Guidance

- **Complete Section 4.5 of RAM-C Report.**
  - Summarize the results of the validation assessment, and note any parameters where the calculated value does not support the threshold value.
    - Discuss any coordination within the program and with the requirements manager to refine requirements.
    - Discuss how the issues were resolved and document any unresolved issues.

- **The following section will provide some examples of validating the sustainment parameters on the MQVX-99.**
  - All data was created for this brief and is not representative of any existing or planned system.



4. Validate

A_O example - MQVX-99

- **From the MQVX-99 in work draft CDD, obtain the A_O, MFHBF, MFHBOMF and MCMT thresholds.**
  - It is very important to define specifically which failures "count" towards A_O and the unit of measurement for time.
    - As defined in the in work draft CDD, operating time is measured by FHs. Always use the correct definition of operating time as defined by the JCIDS source documents.
    - MFHBF and MFHBOMF are normally different, and the definition of A_O along with the Failure Definitions should determine which to use. For this system, the value used for R_L is used to determine A_O. For more complex systems the Failure Definitions or similar document would be used to determine which specific failures affect A_O.
    - For MDT, define which repairs are "counted" Repairs at the organizational level are usually counted. Repair of the removed component at higher level may not be counted. For this example, MDT includes repair time and logistics delay time at organizational level.
  - A_O of 0.90 is based on the following:
    - MFHBF = 42 FHs; MCMT= 3.5 hours ; ALDT = 24 hours

4. Validate

A_O example - MQVX – 99 (cont.)

- **Perform the calculation, noting which service specific definition of A_O is being used. The answers can be very different. Examples:**
  - A_O = Uptime/(Uptime + Downtime)
    = MFHBF/(MFHBF + MCMT+ ALDT)
    = 42/(42 + 3.5+ 24)
    = 0.60 < 0.90
    - Using this formula, the system will not meet its requirement that A_O= 0.90.
    - But, the formula, A_O = Uptime/(Uptime + Downtime), is for continuously operating systems with 24/7 operation. The UAV is not this type of system so this is not the proper formula to use.

4. Validate

A_O example - MQVX – 99 (cont.)

- **Perform the calculation, noting which service specific definition of A_O is being used. The answers can be very different. Examples: (cont.)**
  - The formula, $A_O = 1 – (\%\ downtime_{unscheduled}) - (\%downtime_{scheduled})$ is typically used for intermittent use systems such as aircraft. A check of the draft CDD shows that this is the formula to use for the UAV.
    - o While in many cases the scheduled maintenance can be ignored as it is very small or performed during periods not affecting operational availability, there is a requirement to run a battery/propulsion health diagnostics that M&S analysis indicates will increase downtime by an additional 5%.
  - $A_O = 1 – (\%\ downtime_{unscheduled}) - (\%downtime_{scheduled})$

    $= 1 – (MCMT+ ALDT)/K'(MFHBF) - (\%downtime_{scheduled})$

    $= 1 – (0.09 – 0.05)$

    $= 0.86 < 0.90$
  - The system does not meet its requirement that $A_O = 0.90$

(Note: The formula $A_O= 1 – (MCMT+ ALDT)/K'(MFHBF)$ for the unscheduled downtime only is derived from OPNAVINST 3000.12A of 2 Sep 2003, section 3.4 Intermittent- Use Systems, Equation 5: A_O for Intermittent Use (Aircraft) Systems and equates to 0.091 rounded to 0.90 for this example. The math is shown on the following page.)

4. Validate

A_O example – MQVX-99 (cont.)

- **After further research in the CONOPS and discussions with the requirements manager, changes were made in the depth of the on-board diagnostics allowing more portable support equipment to be forward based with the MQVX-99. With these changes, it was determined that the scheduled maintenance could now be performed in periods that would no longer affect the operational availability and thus could be removed from the A_O calculation:**
  - A_O = 1 – (% downtime)
    = 1 – (MCMT+ ALDT)/K'(MFHBF)
    where K' = Total Calendar Time/
    Total Flight Time (in FHs)
    K' = (365*24)/1206 = 7.3
    = 1 – (3.5 + 24)/(7.3*42)
    = 1 – 0.09
    = 0.91 > 0.90

- **A_O is now valid.**
  - In this case a design change to the on-board diagnostics along with a support concept change moving more portable support equipment forward with the UAV allowed A_O to be met.

4. Validate

A_O example – MQVX-99 (cont.)

- **Additional considerations:**
  - M&S using multi echelon modeling provides a more accurate value for A_O than a deterministic equation.
  - Reaching any of the sustainment KPPs/KSAs can involve a complex interplay between design reliability, maintainability, product support strategies and cost.

4. Validate

A_M example – MQVX-99

- **From the Acquisition Strategy for the MQVX-99:**
  - 48 UAVs are to be procured to create 4 squadrons with 12 UAVs each.
  - 9 UAVs are to be procured to cover depot pipeline and other maintenance delay.
  - 6 UAVs are to be assigned for training operators and maintainers.
  - 5 additional assets are to be procured to account for attrition losses.
- **Calculation of these values, shows that the threshold for A_M can be met.**

JCIDS A_M Threshold Value
0.87

Calculated A_M	A_M Inputs					
	Up Assets				Down Assets	Total Assets
	CONOPS	Op Systems for Training	Attrition Reserve	Pre-positioned Assets	Total Average Annual Down Assets	Total Average Annual Assets
0.87	48	6	5	0	9	68

4. Validate
A_M example – MQVX-99 (cont.)

- **Additional considerations:**
  - For our example system, the values in the Acquisition Strategy were developed using multi echelon M&S over the life cycle. Done properly, this will give the most accurate results, given the complex nature of operational and deployment scenarios.
  - A_M is not minimized or maximized.
    - Perhaps by shortening depot repair times through the use of forward deployed depot capability, A_M could be reduced as fewer pipeline assets would be required
    - Conversely, adding additional pipeline assets could allow the use of a single depot while increasing the value of A_M.
    - The “right” answer is the one that provides a capability solution with optimal availability and reliability to the warfighter at an affordable life cycle cost.
  - These are all concepts that can be explored during the sixth step of the RAM-C analysis, Conduct Trade Studies.

4. Validate

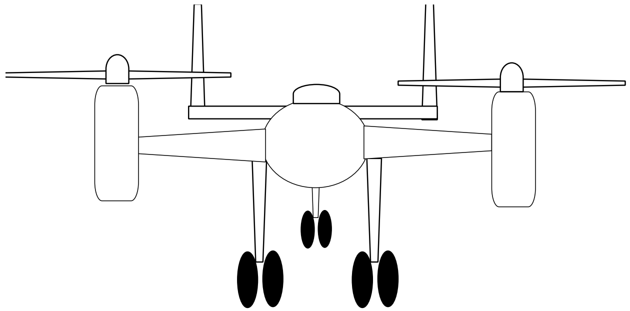
R_M example – MQVX-99

- **From the MQVX-99 in work draft CDD, obtain the R_M threshold and from the CONOPS and OMS/MP, the description of the missions.**
  - R_M may be expressed in % probability that a mission can be completed without an OMF.
  - As with the other sustainment parameters, it is very important to define specifically which failures affect mission success and therefore "count" towards R_M.
  - R_M minimum is 0.98% mission success probability. This is needed to generate the SGR of 2.92 required to complete the missions given the number of UAVs and the other metrics.
    - Rear to forward resupply: The UAV will transport 600 pounds of supplies 50 miles from rear to forward areas and return with 300 pounds. Total flight time is 0.95 hours and 20 flights per day are required.
    - Forward to Extended Area resupply: The UAV will transport 600 pounds of supplies 100 miles from forward to extended areas and return with 150 pounds Total flight time is 1.62 hours and 15 flights per day are required.

4. Validate

R_M example – MQVX-99 (cont.)

- **Perform the calculation.**
  - $R_M = e^{-(\frac{T}{MFHBOMF})}$
  - $\ln R_M = -(\frac{T}{MFHBOMF})$



  - For rear to forward resupply mission with MFHBOMF = 81 and T= 0.95 FHs, the calculated value of R_M = 98.83%.
  - For forward to extended resupply with MFHBOMF = 81 and T = 1.62 FHs, the calculated value of R_M = 98.02%.

- **Since MFHBOMF threshold equals 81 hours, the probability of success for the most stringent mission is above the rationale value of 98%, and thus the UAV can meet the R_M requirement.**

4. Validate
R_M example – MQVX-99 (cont.)

- **Additional considerations:**
  - Only two missions were shown for this system. A real system has many more missions to be considered in order to understand the real failure limits needed to obtain R_M. Carefully review the Failure Definitions along with the CONOPS and OMS/MP to properly make this determination.
  - For most systems, reliability modeling provides a more realistic value of R_M in an operational environment. For the MQVX-99, an M&S was performed to ensure that the necessary SGR of 2.92 could be met given all the other sustainment metrics and support plans. 1000 iterations were run with the average value for the SGR generated being greater than 2.92, which gives confidence that the sustainment metrics are valid.

4. Validate

Cost example – MQVX-99

- **Compare Program Budget Inputs to JCIDS document thresholds.**

	Program O&S Budget Inputs	JCIDS document values	
Logistics Reliability	42	42	MFHBF
Maintenance Burden	5.7	5.7	MMH/FH
MCMT	3.5	3.5	Hours
MDT	27.5	*27.5	Hours
UAV FH per Year	1206	*1206	FH/yr/UAV
Active UAVs	54	*54	UAVs
Years in Service	20	*20	Years

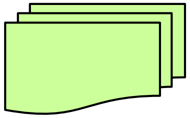
*Note: Some values may not be in JCIDS documents or may be part of the rationale and not a threshold. If not in the JCIDS documents, note source.

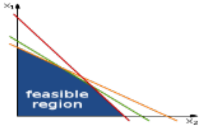
- **Compare O&S budget totals between program budget and JCIDS thresholds.**

	Program Budget (K$s)	JCIDS Threshold (K$s)
Total O&S	**3,381,372.0**	**3,381,372.0**

- **O&S Cost is validated**

RAM-C Analysis Steps
Assess Feasibility



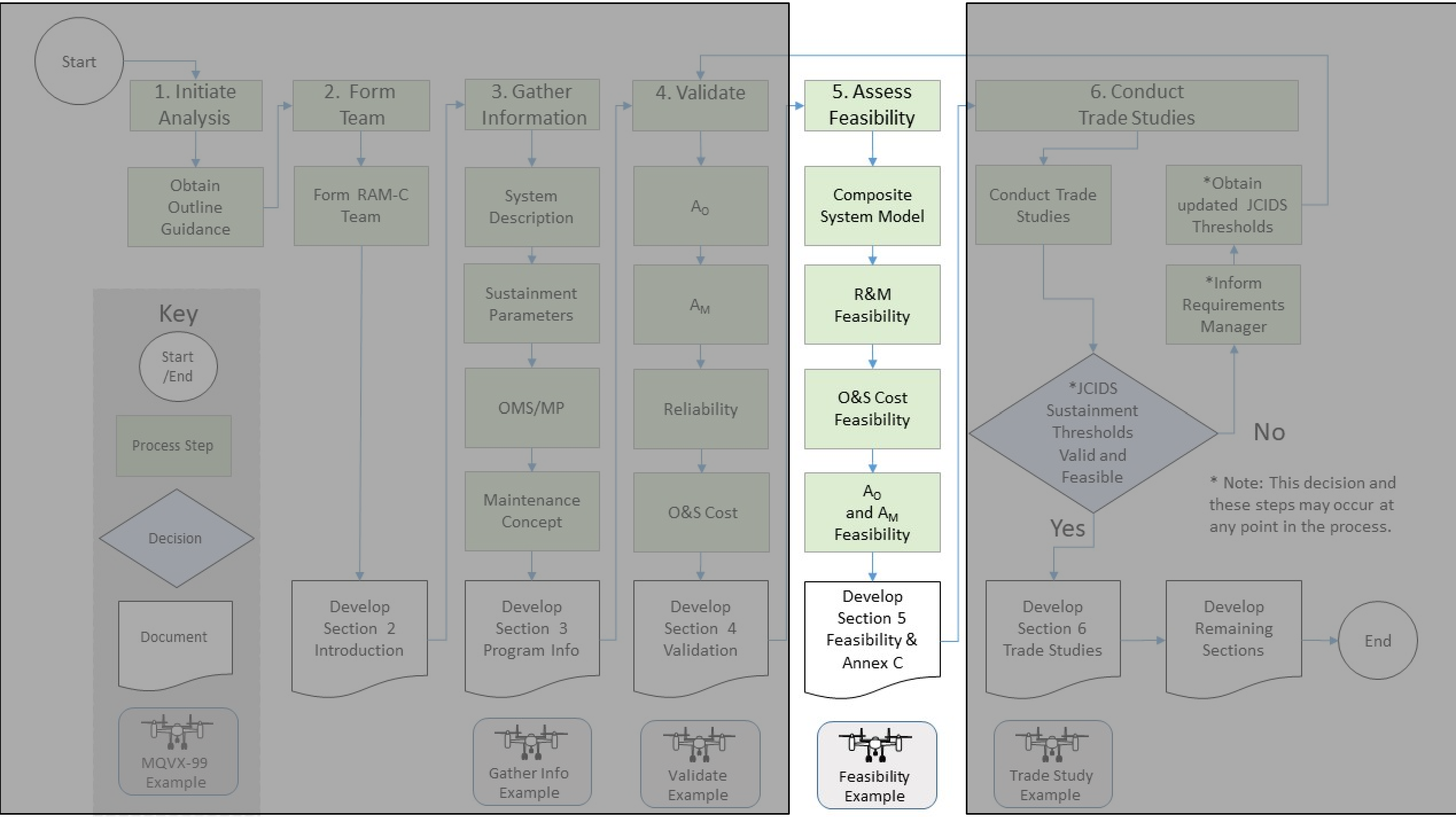


1. INITIATE ANALYSIS	2. FORM TEAM	3. GATHER INFO	4. VALIDATE	5. ASSESS FEASIBILITY	6. CONDUCT TRADE STUDIES

Six Iterative Steps

RAM-C Analysis Steps

5: Assess Feasibility



5. Assess Feasibility
Purpose/Overview

- **What is feasibility and why assess it?**
  - Determines if it's likely that a system can actually be developed with the sustainment characteristics prescribed in the JCIDS documents.
  - Assessed by comparing the sustainment thresholds to adjusted data from existing systems using a composite model.
  - Lowers program risk and helps ensure that the product can be developed within budget and schedule with the understood sustainment characteristics.

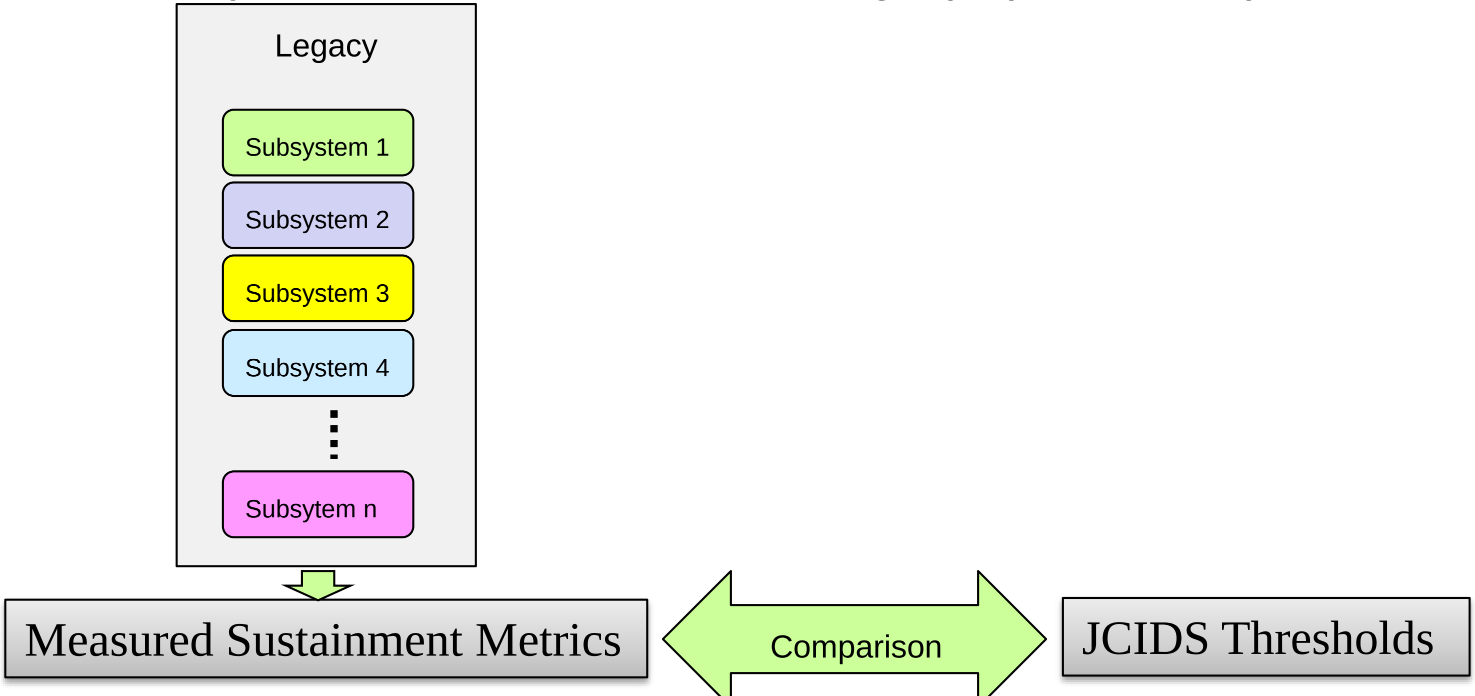
Can we build it?

5. Assess Feasibility
Purpose/Overview

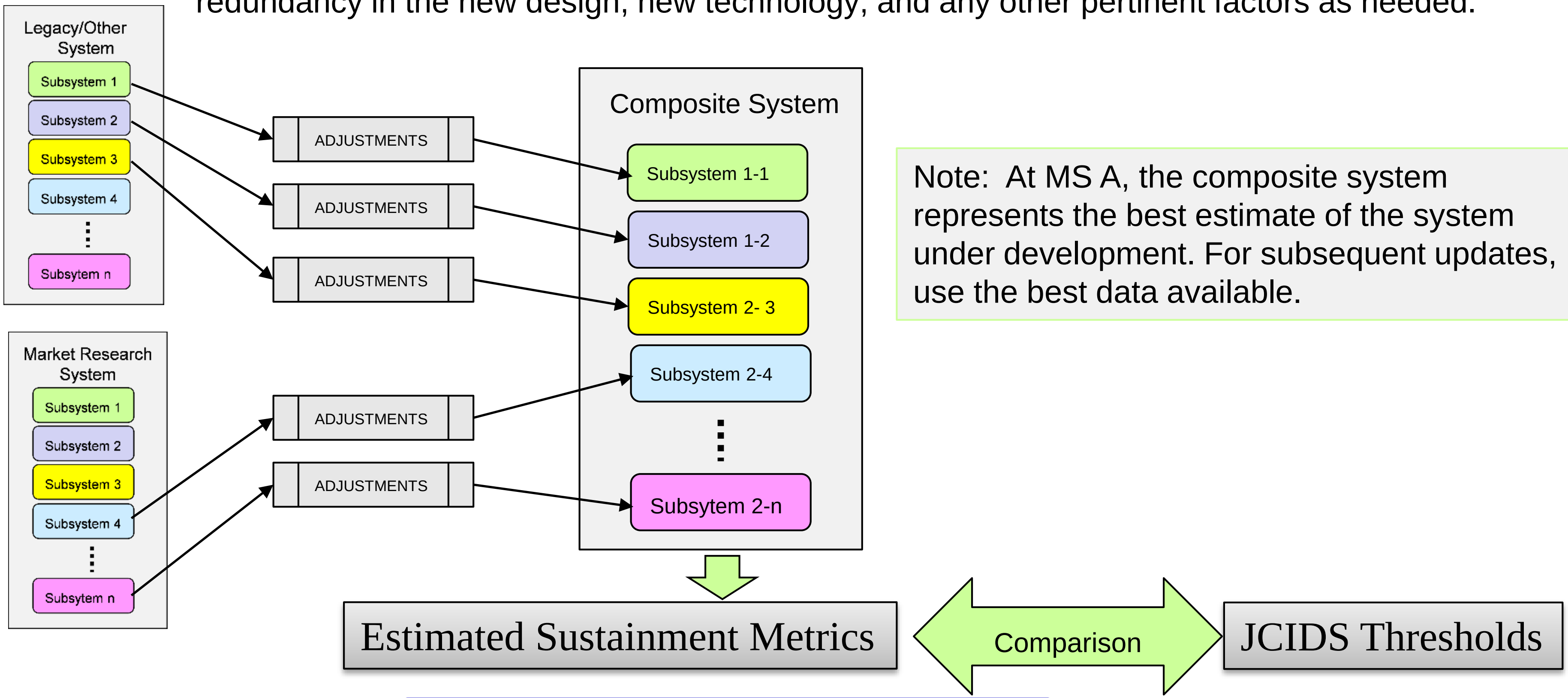
- **If the sustainment parameters are assessed as feasible, they:**
  - Are consistent with the state of the art and technical maturity.
  - Are consistent with the values determined using a composite model of legacy/similar systems adjusted appropriately for differences in operational environments; design, manufacturing and technology; failure definitions; and system maturity.
  - Can likely be used as a basis to develop a system with the desired sustainment characteristics.
- **Feasibility Assessment should be consistent with service specific guidance.**
- **Feasibility is assessed using a composite model made up of sub-systems analogous in design and operation to the new system.**

5. Assess Feasibility
Purpose/Overview

- **Why use a composite model?**
  - A composite model is used to assess the feasibility of meeting the thresholds for the new system. If there was a legacy system completely analogous to the system under development, then one could compare directly the sustainment metrics of the legacy system to JCIDS requirements thresholds for the new system to assess feasibility. Such an exact match in a legacy system rarely exists.

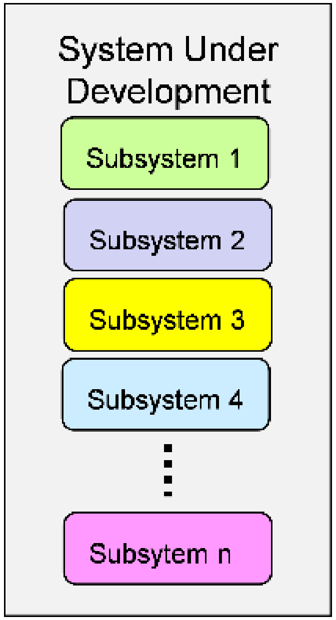


- **When there is no identical legacy system with which to compare:**
  - Develop a “composite” system made of similar subsystems which may come from 2 or more legacy/other systems or market research.
  - Make adjustments for complexity, differences in environments, improved reliability design, redundancy in the new design, new technology, and any other pertinent factors as needed.



Note: At MS A, the composite system represents the best estimate of the system under development. For subsequent updates, use the best data available.

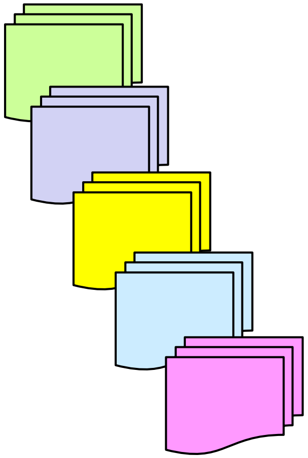
1. **Identify major subsystems at the 2 digit Work Unit Code (WUC) Level.**
   - Develop a listing of the major subsystems of the system under development at the 2 digit WUC level. As an example, for an aircraft, this would include subsystems such as airframes, landing gear, fuel system, etc.



5. Assess Feasibility
Activities - Composite System Model

2. Obtain R&M Data for each subsystem.

- From the 2 digit WUC subsystem level listing, obtain the best available R&M data that would apply to those subsystems. Sources include legacy, similar systems, market surveys and actual data from the system under development. Early in the program, actual data will not be available and data sources should include those subsystems with the closest match in function and operational environment. Note that subsystem data may come from different end items in order to most closely match function and operational environment.
- Legacy and similar system data may be obtained from Visibility and Management of Operating and Support Cost (VAMOSC) and service specific data repositories such as Reliability and Maintainability Information System (REMIS), Core Automated Maintenance System (CAMS), The Army Maintenance Management System (TAMMS-A), Naval Aviation Data Analysis (NALDA), Naval Aviation Logistics Command Management Information System (NALCOMIS), or Maintenance and Materiel Management (3M). Better results are obtained if the data can be separated into similar mission profiles as used in the sustainment metrics development and like life units (e.g., flight-hours, miles, rounds fired, etc.) by a skilled data analyst with experience in the specific data repositories and subsystems.

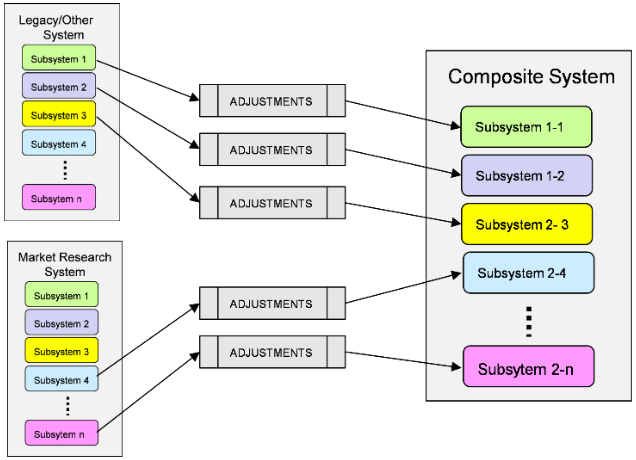


5. Assess Feasibility
Activities - Composite System Model

3. Adjust data as needed for operational conditions, environment, complexity, etc.

– Operational Conditions Adjustment: From the CONOPS OMS/MP, determine the percentages of time the new system is to be in its various operating modes (off road, improved road, transit, etc.). If the R&M data in the previous step was obtained from subsystems with essentially similar operational profiles and times, no adjustment may be necessary. Otherwise, adjust the R&M data to reflect the correct values if the legacy/similar system operated in the operational conditions planned for the new system.

– Make similar adjustments (as needed) for: complexity; factors resulting from improved R&M design, e.g. Failure Mode Effects and Criticality Analysis (FMECA) factors, and Highly Accelerated Life Test (HALT)/Reliability Demonstration Test (RDT) development test factors; differences in manufacturing processes; operational age factors; and differences in S/F ratios.

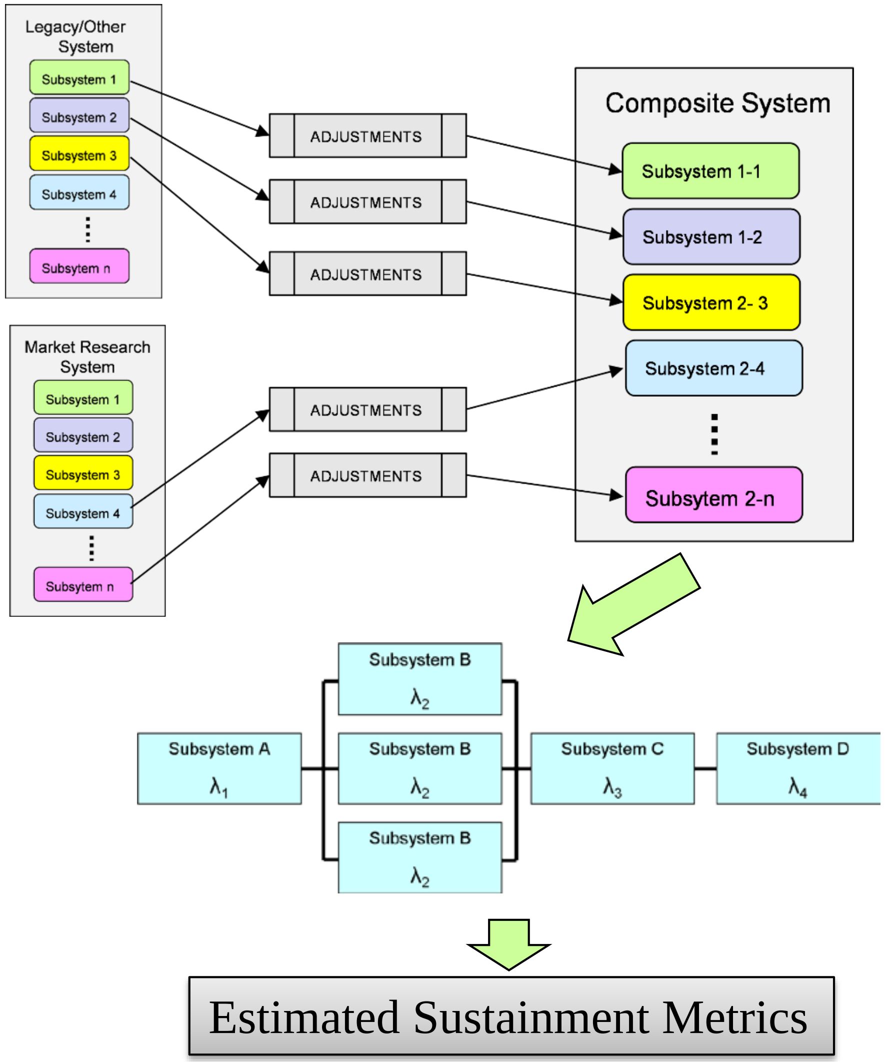


5. Assess Feasibility

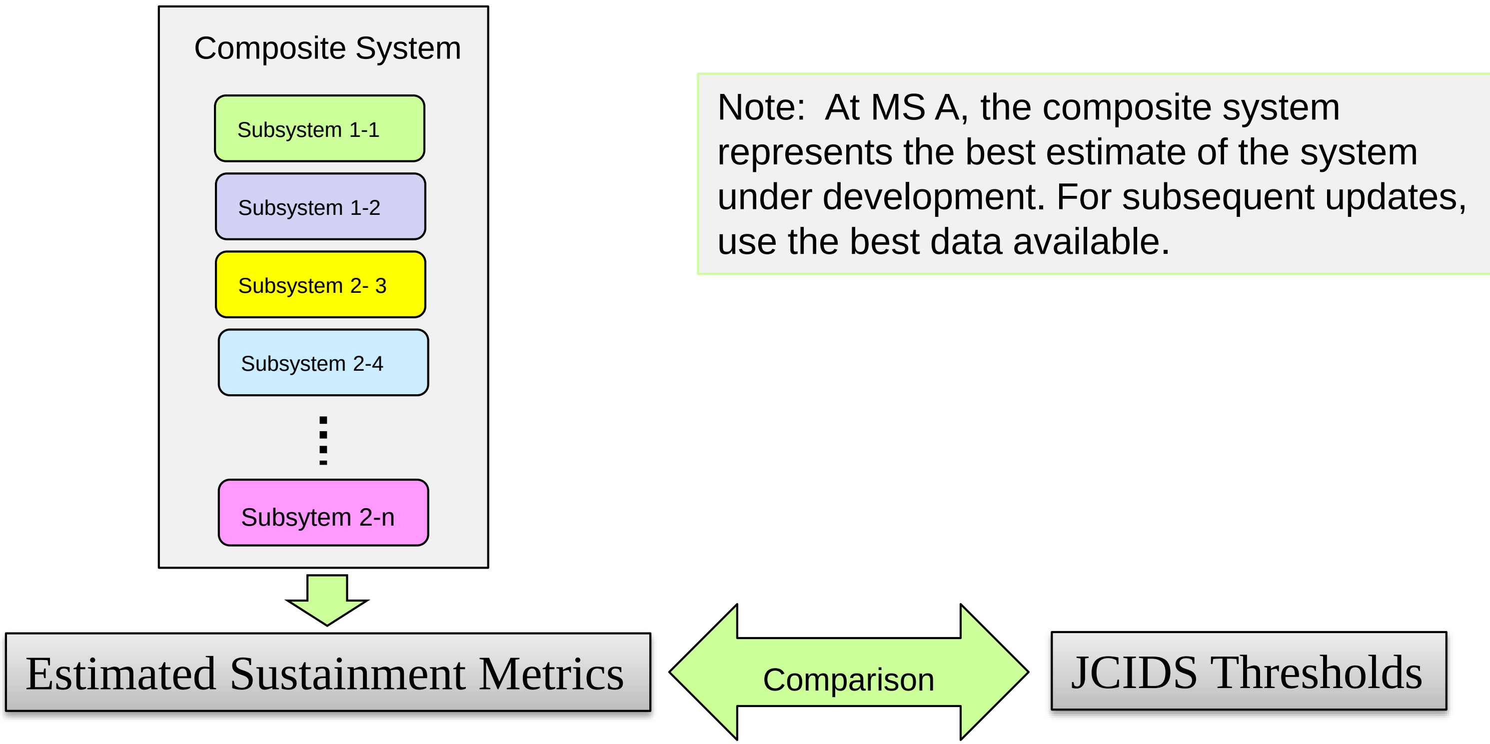
Activities - Composite System Model

4. Develop appropriate composite models and estimate system level metrics.

- Develop a block diagram of the model of the composite system at the 2 digit WUC level.
- Determine the new system sustainability metric values using the adjusted data from the paragraph above. Calculating the totals may require use of the reliability block diagrams and other math models.



5. **Compare the JCIDS thresholds for the new system to the estimated sustainment metrics for the composite system. Determine the feasibility of reaching the JCIDS threshold. If applicable, provide the legacy system values for each metric.**



5. Assess Feasibility

Activities – R&M Feasibility

- **Using the outputs of the composite model, determine the estimated values of the sustainment metrics, e.g., R_M, R_L, Maintenance Burden and Corrective Maintenance.**
  - Ensure that the proper adjustments have been made to account for differences in design, quantities, methods of production, operations and other pertinent areas.
  - Ensure that the units of measurement are consistent with the JCIDS requirements and the operational environment of the system.
  - Record the values at the sub-system level along with the totals for each metric including the methodology to calculate the totals.
  - Record the JCIDS thresholds for these metrics and the Legacy system totals if they exist.

5. Assess Feasibility

Activities – R&M Feasibility

- **Compare the estimated values of the R&M metrics with the JCIDS threshold values.**
  - The JCIDS threshold values are feasible if they are equal to or less demanding than the estimated values from the composite model, e.g.,
    - o JCIDS threshold value for MTBF ≤ composite model value for MTBF
    - o JCIDS threshold value for MCMT≥ composite model value for MCMT
  - Otherwise, they are not feasible.
    - o In this case coordinate this information with your program management.
    - o Further analysis may be performed to determine possible solutions.

5. Assess Feasibility

Activities - O&S Cost Overview

- **O&S cost estimates are based on guidance from CAPE.**
- **Feasibility Assessment will consist of two steps:**
  - Check that the sustainment KPP related inputs used in the formulation of the program O&S cost estimate are equal to or less demanding than the sustainment metric results obtained from the composite model. This would imply that the inputs used are feasible.
  - Then, check that the total for the program's O&S cost estimate is equal or less than the threshold obtained from the JCIDS documents.
- **If both of these conditions are met, the O&S cost metrics are assessed as feasible.**

5. Assess Feasibility
Activities - O&S Cost Feasibility

- **Obtain the Program Office baseline O&S cost estimate.**
  - This should have been developed following CAPE guidance, along with service specific guidance for cost analysis.
- **List the sustainment KPP related input parameters.**
  - These include logistics reliability, repair time per failure, quantity of systems and operating hours.

5. Assess Feasibility

Activities - O&S Cost Feasibility

- **Compare the input parameters to the sustainment metrics obtained from the composite model.**
  - The sustainment KPP related input parameters are feasible if they are equal to or less demanding than the values from the composite model, e.g.,
    - Input value for MTBF ≤ composite model value for MTBF.
    - Input value for MCMT≥ composite model value for MTTR.
  - Otherwise, they are not feasible.
    - o In this case coordinate this information with your program management.
    - o Further analysis may be performed to determine possible solutions.

5. Assess Feasibility

Activities - O&S Cost Feasibility

- **Once the input parameters have been assessed as feasible, compare the program office O&S cost estimate to the JCIDS O&S cost threshold.**
  - If the total from the program O&S cost estimate is less than or equal to the O&S threshold from the JCIDS documentation, the O&S cost threshold is assessed as feasible.
  - Otherwise, it is not feasible.
    - In this case coordinate this information with your program management.
    - Further analysis may be performed to determine possible solutions.

5. Assess Feasibility

Activities – A_O and A_M Feasibility

- **Using the sustainment metric outputs from the composite model, determine the estimated values for A_O and A_M.**
  - Ensure that the proper adjustments have been made to account for differences in design, quantities, methods of production, operations and other pertinent areas.
  - Ensure that the units of measurement are consistent with the JCIDS requirements and the operational environment of the system.
  - For these metrics, analysis may only be possible at the system level. In any case, record the values at the level of the analysis along with the totals for each metric including the methodology to calculate the totals. In many cases multi echelon M&S is required to obtain the most accurate estimates.
  - Record the JCIDS thresholds for these metrics and the Legacy system totals if they exist.

5. Assess Feasibility

Activities – A_O and A_M Feasibility

- **Compare the estimated values of the A_O and A_M with the JCIDS threshold values.**
  - Are the estimated values are greater than or equal to the JCIDS threshold values.
    - o If so, they are assessed as feasible.
    - o Otherwise, they are not feasible.
      - In this case coordinate this information with your program management.
      - Further analysis may be performed to determine possible solutions.

5. Assess Feasibility
Fill in Outline Guidance

- **Complete Section 5.1 of the RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Document the model used for development of the composite model.
    - Include a diagram of the model.
    - Describe how the data was obtained and what modifications were made to the data.
    - Describe the source of the analogous sub-systems and how they relate to the system under development.
    - Document the outputs of the composite model in Table C-1 (see next slide).

- **Complete Annex – C of the RAM-C Report.**
  - Table C-1. Use outputs from the composite model.
    - Note: MFHBA is Mean Flight Hours Between Aborts and MTTR is Mean Time to Repair (MTTR). These are not defined elsewhere in this document.

Appendix C – Composite Model Details

Table C-1 Composite Model Details (Sample aviation WUC)

Subsystem (2-Digit WUC)	Reliability[1]		Maintainability		Total Downtime (MDT)	O&S Costs (3.0)
	Mission Reliability (MFHBA)	Logistics Reliability (MFHBF)	Maintenance Burden (MMH/FH)	Corrective Maintenance (MTTR)		
11 Airframes						
12 Furnishings						
13 Landing Gear						
14 Flight Control/Lift System						
15 Hydraulic Propellers						
22 Engine						
List Remaining subsystems						
Assessed System[2]						
JCIDS Threshold						
Legacy System[3]						

Notes
1. Use appropriate life units (hours, miles, cycles, etc.)
2. Highlight any cell in red if the assessed system value does not meet the JCIDS Threshold.
3. If applicable, enter legacy system data for each sustainment parameter.

5. Assess Feasibility

Fill in Outline Guidance

- **Complete Section 5.2 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Table 5.2-1 R&M Feasibility. Use summary level numbers from the composite model, and Table C-1 Composite Model Details. Add additional metrics such as preventive maintenance as required.
    - o Assessed System line contains the results of the composite model. Include legacy system data in the legacy line if there is a legacy system being replaced.
    - o Highlight any cells in red where the assessed value is less demanding than the JCIDS threshold.

Table 5.2-1 R&M Feasibility (If more than one alternative is possible, insert tables as needed.)

	Reliability[1]		Maintainability	
	Mission Reliability (MFHBA)	Logistics Reliability (MFHBF)	Maintenance Burden (MMH/FH)	Corrective Maintenance (MTTR)
Assessed System[2]				
JCIDS Threshold				
Legacy System[3]				

Notes
1. Use appropriate life units (hours, miles, cycles, etc.)
2. Highlight any cell in red if the assessed system value does not meet the JCIDS Threshold
3. If applicable, enter legacy system data for each sustainment parameter

5. Assess Feasibility
Fill in Outline Guidance

- **Complete Section 5.2 of RAM-C Report.**
  - Based on the values in Table 5.2-1, state if the values are assessed as feasible.
    - o R_M and R_L should be greater than or equal to JCIDS threshold (if the metrics are stated as MTBF), or less than or equal to the JCIDS threshold (if the metrics are stated as a failure rate). The JCIDS values are feasible, if they are equal to or less demanding than the assessed (composite model) values.
    - o Maintenance Burden and Corrective Maintenance should be less than or equal to JCIDS threshold.
    - o If they are not assessed as feasible, provide details on the reasons they are not assessed as feasible along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s).

5. Assess Feasibility
Fill in Outline Guidance

- **Complete Section 5.3 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Table 5.3-1 O&S Cost Feasibility (see next slide for Table).
    - Alternative 1 Estimated O&S Cost Value column is obtained from the program O&S baseline cost estimate. Include Legacy System cost data in the Legacy O&S Cost Value column if there is a legacy system being replaced.
    - Highlight any cells in red where the estimated value is greater than the JCIDS threshold. In the case where only a total value is available for the JCIDS threshold, then only consider the total when highlighting cells.
    - If legacy values are provided, provide a discussion of the source of the data and the differences and similarities between the legacy system and the system under development.
  - Provide sources of information, assumptions and the reliability values used for the estimate.

5. Assess Feasibility
Fill in Outline Guidance

- **Complete Section 5.3 of RAM-C Report.**
  - Table 5.3-1 (Instructions on previous slide)

Table 5.3-1 O&S Cost Feasibility (sample aviation values)
(If more than one alternative is possible, insert columns as needed.)

Cost Element	JCIDS O&S Cost[1] Threshold Value	Alternative 1 Estimated[2] O&S Cost Value	Legacy O&S Cost Value
1.0 Unit Level Manpower		139.4	155.5
2.0 Unit Operations		102.1	143.0
3.0 Maintenance		30.2	59.6
3.1 Consumable Materials and Repair Parts		3.3	6.5
3.2 Depot Level Repairables		10.4	20.5
3.3 Intermediate Maintenance (External to Unit-Level)		5.2	10.3
3.4 Depot Maintenance		8.2	16.2
3.5 Other Maintenance		3.0	6.2
4.0 Sustaining Support		98.1	107.7
5.0 Continuing System Improvements		32.6	56.3
6.0 Indirect Support		38.9	50.8
Total[3]	423.7 (BY 2013$)	471.4 (BY 2013$)	632.6 (BY 2013$)

Notes
1. Highlight any cell in red if the assessed system value does not meet the JCIDS Threshold
2. Include the type of dollars and the units

5. Assess Feasibility
Fill in Outline Guidance

- **Complete Section 5.3 of RAM-C Report.**
  - Based on the values in Table 5.3-1, state if the values are assessed as feasible.
    - The inputs to the program O&S baseline cost estimate should be assessed as feasible AND the program O&S baseline cost estimate total should be less than or equal to the JCIDS threshold value.
      - If so, the O&S cost threshold is assessed as feasible.
      - If it is not assessed as feasible, provide details on the reasons it is not assessed as feasible along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s). Discuss any input parameters that were found to not be feasible and provide details on how they were or are to be corrected.

5. Assess Feasibility

Fill in Outline Guidance

- **Complete Section 5.4 of RAM-C Report.**
  - Use information gathered by following the earlier steps, and additional details from the Outline Guidance.
  - Complete Table 5.4-1 A_O and A_M Feasibility. Use values determined in earlier analysis under feasibility.
    - o "Estimated Value" comes from the calculations made using the outputs of the composite model. Include Legacy System data if there is a legacy system being replaced. Highlight any cells in red where the estimated value is not equal to or greater than the JCIDS threshold.

Table 5.4-1 A_O and A_M Feasibility (sample)

	JCIDS Threshold Value	Estimated Value[1]	Legacy Value
A_O			
A_M			

Note
1. Highlight any cell in red if the estimate value does not meet the JCIDS Threshold

5. Assess Feasibility
Fill in Outline Guidance

- **Complete Section 5.4 of RAM-C Report.**
  - Based on the values in Table 5.4-1, state if the values are assessed as feasible.
    - o A_O should be greater than or equal to JCIDS threshold.
    - o A_M should be greater than or equal to the JCIDS threshold.
      - If so, they are feasible.
      - If they are not assessed as feasible, provide details on the reasons they are not assessed as feasible along with a reference to any analyses performed and a discussion of any communications with management to resolve the issue(s).

5. Assess Feasibility
Fill in Outline Guidance

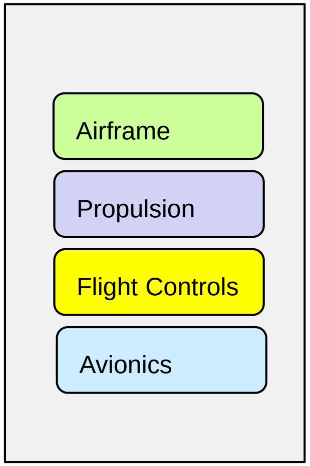
- **Complete Section 5.5 of RAM-C Report.**
  - Summarize the results of the RAM-C feasibility assessment.
    - o Identify any issues with specific sustainment parameters.
    - o If the parameters are not feasible:
      - Discuss any analyses conducted to resolve the issue.
      - Discuss any coordination within the program and with the requirements manager to refine requirements.
    - o Discuss how the issues were resolved and document any unresolved issues.
      - Discuss any communications with the requirements manager and any changes made to JCIDS thresholds. Provide this information in the RAM-C report.

5. Assess Feasibility
Composite Model Example - MQVX-99

1. Identify major subsystems at the 2 digit WUC Level.

- Develop a listing of the major subsystems of the new system at the 2 digit WUC level. As an example, for an aircraft, this would include subsystems such as airframes, landing gear, fuel system, etc.

- For the MQVX-99, we will use the following simplified listing of subsystems:
    - o Airframe
    - o Propulsion/Electrical
    - o Flight Controls
    - o Avionics



5. Assess Feasibility
Composite Model Example - MQVX-99

2. Obtain R&M Data for each subsystem:

– For the class example, we'll use the following two ***FICTIONAL*** systems:
  - o The MQV-89 Tilt Rotor UAV, which is very similar to the MQVX-99 except it used a conventional propulsion system.
  - o The MQ-93 UAV, which is a dual engine fixed wing UAV which uses a very similar quantum ionic plasma battery electric propulsion system. This system has recently been improved and tests show a 10% reduction in failure rate due to improved motor contactors.

	Total Logistics Failure Rate *(failures/FH)*	MFHBF	UNSCHEDULED OMF Failure Rate *(failures/FH)*	MFHBOMF	MMH/FH	MCMT *(hours)*	MDT *(hours)*
MQV-89 Tilt Rotor UAV							
Airframe	0.0097	103	0.0034	296	2.0	3.4	22.1
Propulsion/Electrical	0.0191	52	0.0159	63	5.6	4.8	25.8
Flight Controls	0.0041	244	0.0019	533	0.9	3.3	62.7
Avionics	0.0014	714	0.0009	1143	0.4	2.3	31.3
	0.0343	29	0.0221	45	8.9	4.4	29.4
MQ-93 Fixed Wing UAV							
Airframe	0.0090	111	0.0031	319	1.9	2.5	20.6
Propulsion/Electrical	0.0092	109	0.0071	140	2.7	3.8	22.1
Flight Controls	0.0038	263	0.0015	667	0.9	3.7	63.4
Avionics	0.0021	476	0.0016	615	0.6	2.1	30.5
	0.0241	41	0.0134	75	6.1	3.3	28.8

5. Assess Feasibility

Composite Model Example - MQVX-99

3. Adjust data as needed for operational conditions, environment, complexity, etc.

- For the class example, we're going to only make adjustments to one sub-system, the propulsion system on the MQ-93. Differences in props and gearboxes are not considered in this analysis and we're only going to consider a limited set of metrics.
- Recent design improvements projected to cut failures by 10% have not yet shown up in fielded data as installation of new contactors is just beginning.
  - A review of the affected failures show that all of the reduction in failures affect Operational Mission Failures, so it will have a greater than 10% reduction in OMF failure rates. Based on analysis of failures, OMF failure rate for the propulsion sub-system will fall from 0.0071 to 0.0060 failures/FH.
  - A review of the affected failures show that MMF/FH will fall by 10% from 2.7 to 2.4 but MCMT will not change as the failed contactors are repaired at a higher maintenance level and the time to remove and replace remains the same. MDT falls as spares are available on site more often.

			UNSCHEDULED				
	Total Logistics		OMF				
	Failure Rate	MFHBF	Failure Rate	MFHBOMF	MMH/FH	MCMT	MDT
Adjusted MQ-93 Fixed Wing UAV	*(failures/FH)*		*(failures/FH)*			*(hours)*	*(hours)*
Airframe	0.0090	111	0.0031	319	1.9	2.5	20.6
Propulsion/Electrical	0.0083	121	0.0060	167	2.4	3.8	15.8
Flight Controls	0.0038	263	0.0015	667	0.9	3.7	63.4
Avionics	0.0021	476	0.0016	615	0.6	2.1	30.5
	0.0232	43	0.0122	82	5.8	3.3	26.8

5. Assess Feasibility
Composite Model Example - MQVX-99

4. Develop appropriate composite models for sustainment metrics and estimate system level metrics.

– For our simplified example, we will use the field data from the MQV-89 Tilt Rotor UAV for the Airframe, Flight Controls, and Avionics subsystems; and the **<u>adjusted</u>** data from the MQ-93 Fixed Wing UAV for the Propulsion sub-system.

– We will also assume a series reliability model for this class example.

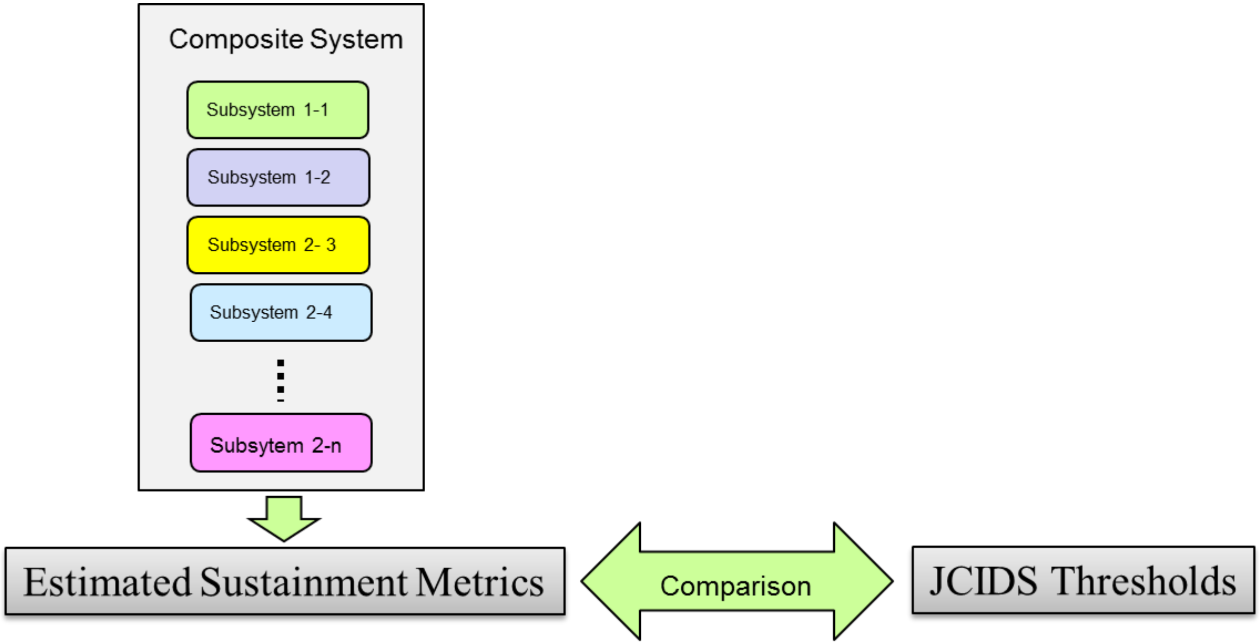
	Total Logistics Failure Rate *(failures/FH)*	**MFHBF**	**UNSCHEDULED OMF Failure Rate** *(failures/FH)*	**MFHBOMF**	**MMH/FH**	**MCMT** *(hours)*	**MDT** *(hours)*
Airframe	0.0097	103	0.0034	296	2.0	3.4	22.1
Propulsion/Electrical	0.0083	121	0.0060	167	2.4	3.8	15.8
Flight Controls	0.0041	244	0.0019	533	0.9	3.3	62.7
Avionics	0.0014	714	0.0009	1143	0.4	2.3	31.3
	0.0235	**43**	**0.0121**	**83**	**5.7**	**3.5**	27.5

Data from MQV-89 Tilt Rotor UAV
Adjusted Data from MQ-93 Fixed Wing UAV

5. Assess Feasibility

Composite Model Example - MQVX-99

5. Compare the sustainment metrics from the composite system to the JCIDS thresholds for the new system. Determine the feasibility of reaching the JCIDS threshold. If applicable, provide the legacy system values for each metric.



5. Assess Feasibility

Composite Model Example - MQVX-99

	Reliability[1]		Maintainability		Total Downtime (MDT) *hours*	O&S Costs (3.0) *FY 2035 M$s*
Subsystem (2-Digit WUC)	Mission Reliability (MFHBOMF)	Logistics Reliability (MFHBF)	Maintenance Burden (MMH/FH)	Corrective Maintenance (MCMT) *hours*		
Airframe	296	103	2.0	3.4	22.1	765.3
Propulsion/Electrical	167	121	2.4	3.8	15.6	654.8
Flight Controls	533	244	0.9	3.3	62.7	323.5
Avionics	1143	714	0.4	2.3	31.3	110.5
Assessed System[2]	83	43	5.7	3.5	27.5	1,854.0
JCIDS Threshold	81	42	5.7	3.5	n/a	n/a
Legacy System[3]	n/a	n/a	n/a	n/a	n/a	n/a

Notes
1. Use appropriate life units (hours, miles, cycles, etc)
2. Highlight any cell in red if the assessed system value does not meet the JCIDS Threshold
3. If applicable, enter legacy system data for each sustainment parameter

- **For these values, the MQVX-99 would be assessed as feasible. Other values would be analyzed in a similar manner.**

5. Assess Feasibility

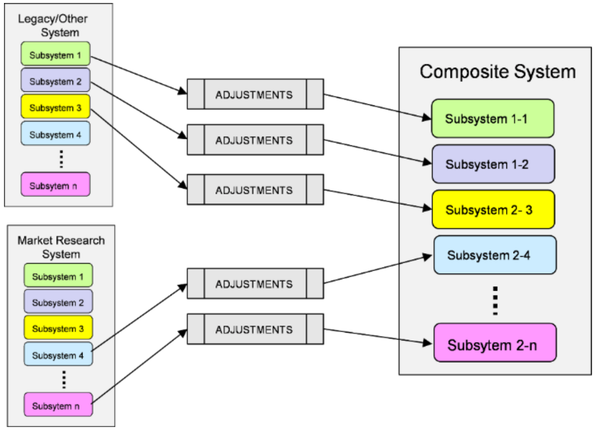
Composite Model Example - MQVX-99

- **Additional considerations:**
  - To simplify this example only 4 sub-systems were considered at a high level. For a complex system, it is likely that many more sub-systems would have to be included.
  - The propulsion system was taken from the fixed wing MQ-93 with a simple adjustment for improved reliability. Since the MQ-93 is a fixed wing aircraft and the propulsion system is to be installed on a tilt rotor aircraft, additional analysis would be required.
    - Since the propulsion system includes the props and gearbox, the data would have to be adjusted for these components or perhaps the props and gearbox data from the MQ-89 (the tilt rotor aircraft) could be used along with the other data from the MQ-93 propulsion system to build up a composite propulsion sub-system. Composite systems can be built up lower than the 2 digit WUC level as needed.
    - Since the MQVX-99 will operate in vertical lift mode, transition mode and forward flight mode, additional adjustments may be required for systems like the propulsion system coming from an aircraft which only operates in forward flight mode.

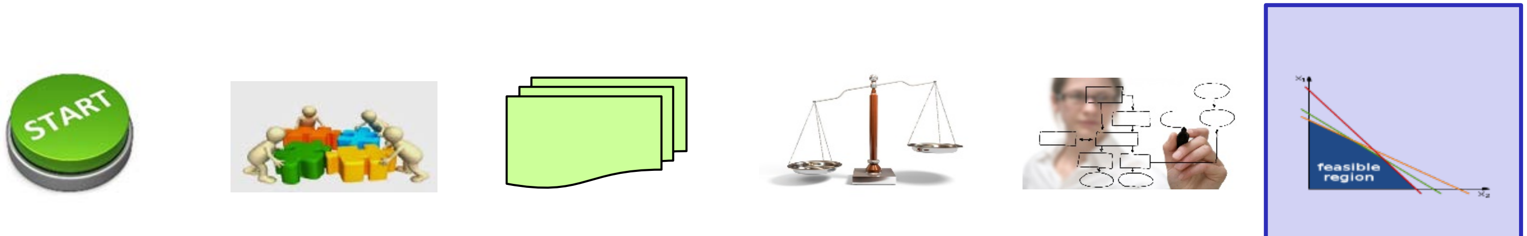
5. Assess Feasibility

Composite Model Example - MQVX-99

- **Additional considerations (continued):**
  - One assumption used in this class example was that the systems from which data was gathered had equivalent S/F ratios, so no further adjustments were needed for S/F ratio differences.
    - While the legacy data will have the total failures within the data, it will likely be counting them against FHs. A system with a higher S/F ratio will accrue more hours of operation than might be indicated by just the FHs, e.g., a system with a 1.4 S/F ratio, showing 2 failures per 1000 FHs, would actually be failing at rate of 2 failures per 1400 operating hours (1.4 x 1000).
    - If the data comes from systems with different S/F ratios, further adjustments will need to be made. To get an accurate estimate at the system level, the conversion from FHs to operating hours may be required.
    - These adjustments may also be required as reliability allocations are made down to the sub-system levels and translation made into contractual values.



RAM-C Analysis Steps
Conduct Trade Studies

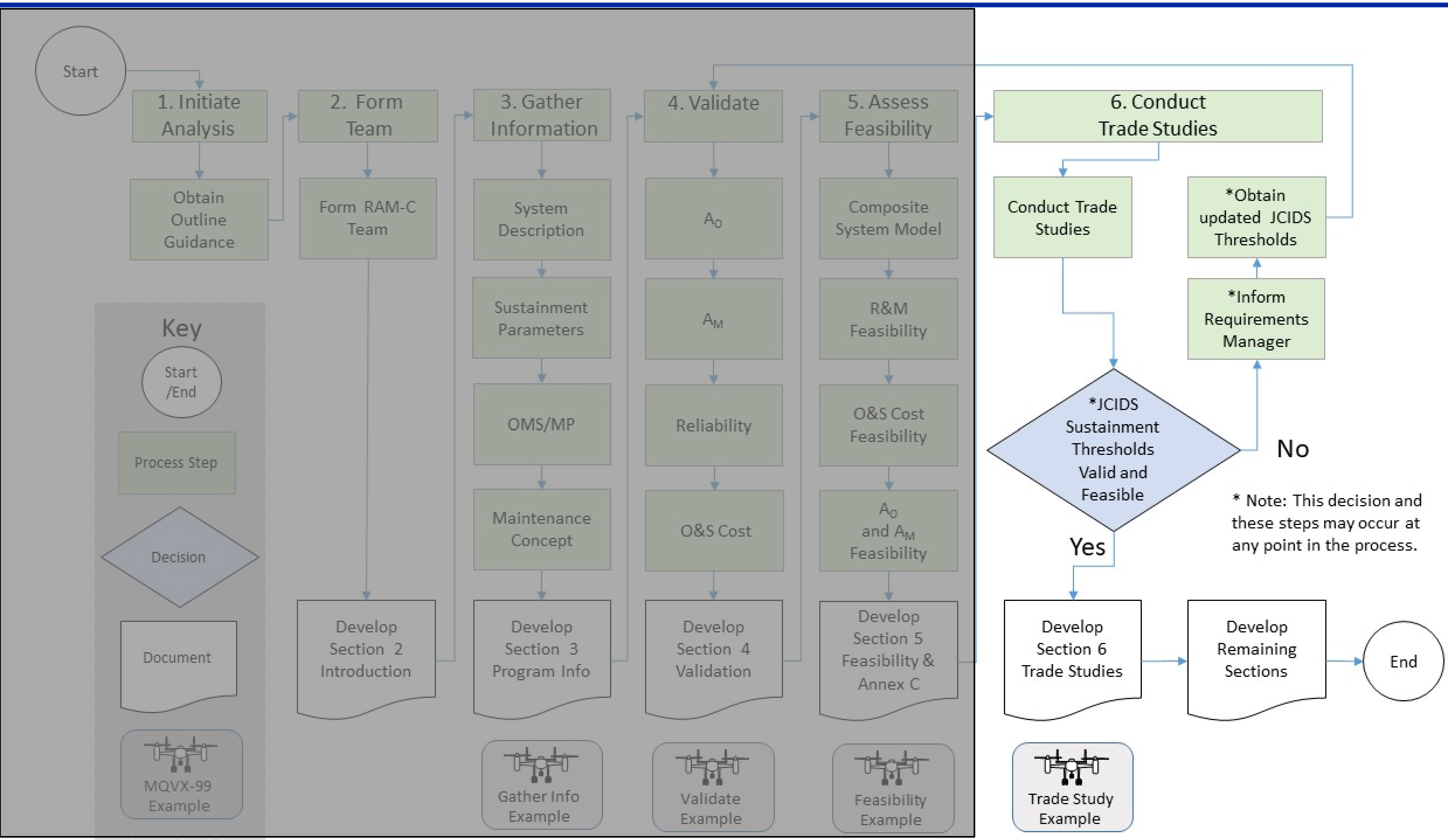


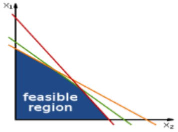
1. INITIATE ANALYSIS → 2. FORM TEAM → 3. GATHER INFO → 4. VALIDATE → 5. ASSESS FEASIBILITY → **6. CONDUCT TRADE STUDIES**

Six Iterative Steps

RAM-C Analysis Steps

6. Conduct Trade Studies





6. Conduct Trade Studies

Purpose/Overview

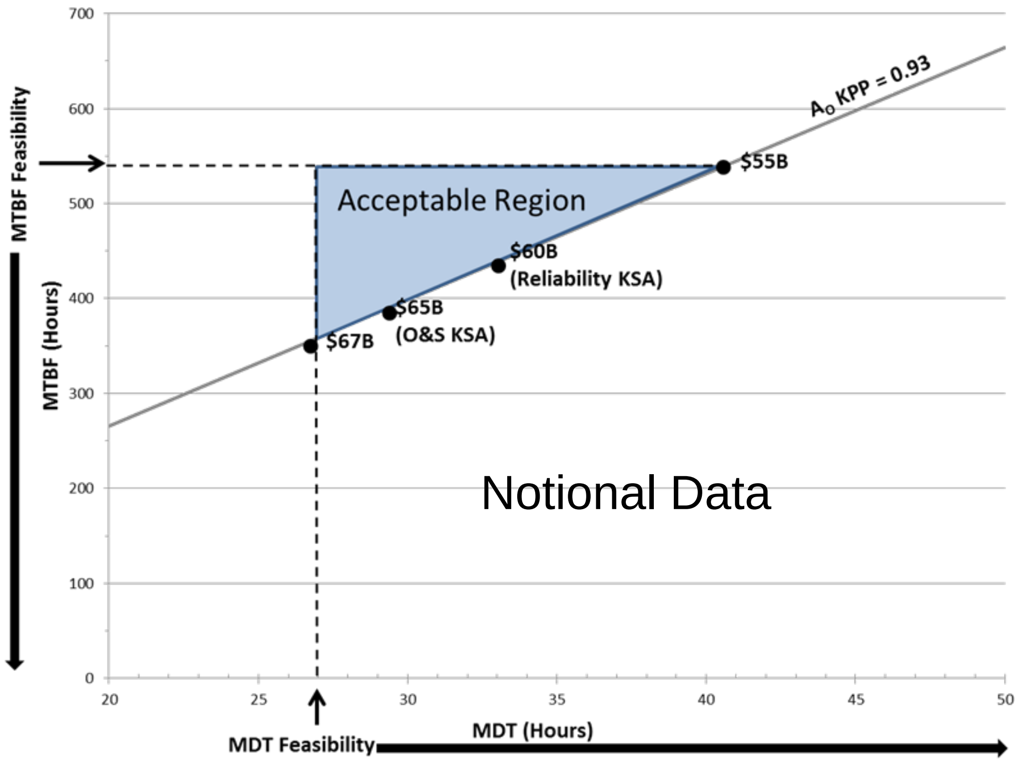
- **Trade studies document how the program's decisions were influenced by sustainment parameters.**
  - The focus of the trade studies in the RAM-C report is on the trades made between sustainment parameter thresholds.
  - Conduct trade studies if any of the sustainment parameters are not feasible, to address readiness degraders or cost drivers, or as the result of other program decisions that affect the sustainment parameters.

6. Conduct Trade Studies
Activities

- **Perform the following types of trade studies as required:**
  - Performance Analyses: Conducted to evaluate reliability as a function of mission performance characteristics. The R&M engineer should plot reliability functions for each of several possible alternative definitions of “acceptable” performance. The CONOPS and Failure Definitions are used to determine “acceptable” performance.
  - Maintainability Analyses: Conducted to evaluate reliability vs maintainability under different design concepts and life cycle cost objectives for specified levels of availability.
  - Availability Analyses: Evaluates R&M trade-offs for several “acceptable” levels of availability and for several alternative approaches to availability assurance, e.g., design redundancy, pre-mission system operability testing, and preventive maintenance.
  - Life Cycle Cost Analyses: Evaluates the cost impact of R&M performance at several levels versus the cost of maintenance and support in the deployment phase. The objective of cost analysis at this stage is to identify R&M and sustainment options that have the largest potential impact of life cycle costs.
  - Schedule/ Risk Analyses: Evaluates the technical risks and schedule requirements associated with R&M performance objectives for alternatives considered in the trade studies.

6. Conduct Trade Studies
Activities

- Provide current options under consideration and how sustainment parameters affect availability and costs.
- Record any planned trade studies and the reasons for the trade studies.
- Record where results of trade studies performed led to recommended changes in sustainment parameters.
- Example graphic is shown on the next slide. Graphic may be modified for different variables being traded or duplicated for multiple configurations as required if feasible regions change.



- **Graphically illustrates the range of R&M parameters (MDT includes MCMT) that will satisfy A_O and O&S Cost.**
- **Trade space is bounded by MDT feasibility (lower bound) and reliability feasibility (upper bound).**
- **Four different possible solution pairs (with associated costs) are shown on the A_O = 0.93 line.**
- **Acceptable solution pairs, can appear anywhere within the shaded "Acceptable Region" area.**

This along with the Composite Model is "essentially" the RAM-C analysis.

6. Conduct Trade Studies

Fill in Outline Guidance

- **Complete Section 6 of RAM-C Report.**
  - Summarize the results of all RAM-C trade studies.
    - Document the issues that led to the trade study with the affected sustainment parameters.
    - Document the findings and recommendations of the studies.
      - Use graphs and tables as needed to present the related data.
    - Document the actions taken because of the studies.
    - Document any planned additional studies.

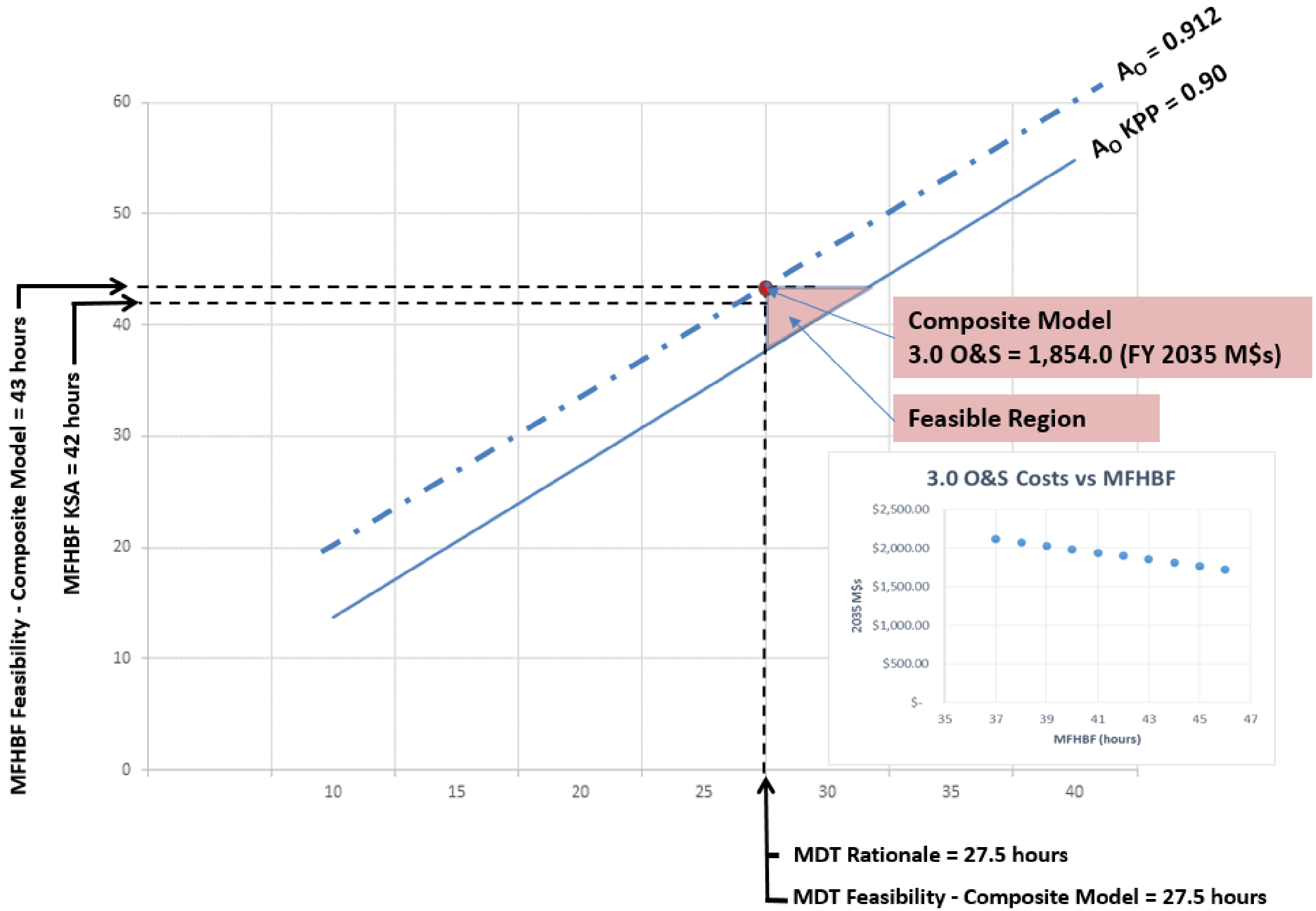
6. Conduct Trade Studies

Trade Study Example - MQVX-99

- **The composite model analysis indicates that the MQVX-99 is feasible and exceeds requirements.**
  - The following chart displays the trade space that is available based on the composite model for trade studies if desired.
    - The trade space is the shaded triangle:
      - Above the A_O=0.90 line,
      - To the right of the MDT = 27.5 line, and
      - Below the MFHBF = 43 line.
    - All values within the triangle will meet the KPP requirement of A_O = 0.90 or greater.
    - Note that values of MFHBF > 37.7 will allow an MDT > MDT rationale value 27.5 while still meeting the A_O KPP requirement.
  - 3.0 O&S Costs in FY 2035 M$s are also displayed for various MFHBF values near the values of the feasible area.

6. Conduct Trade Studies

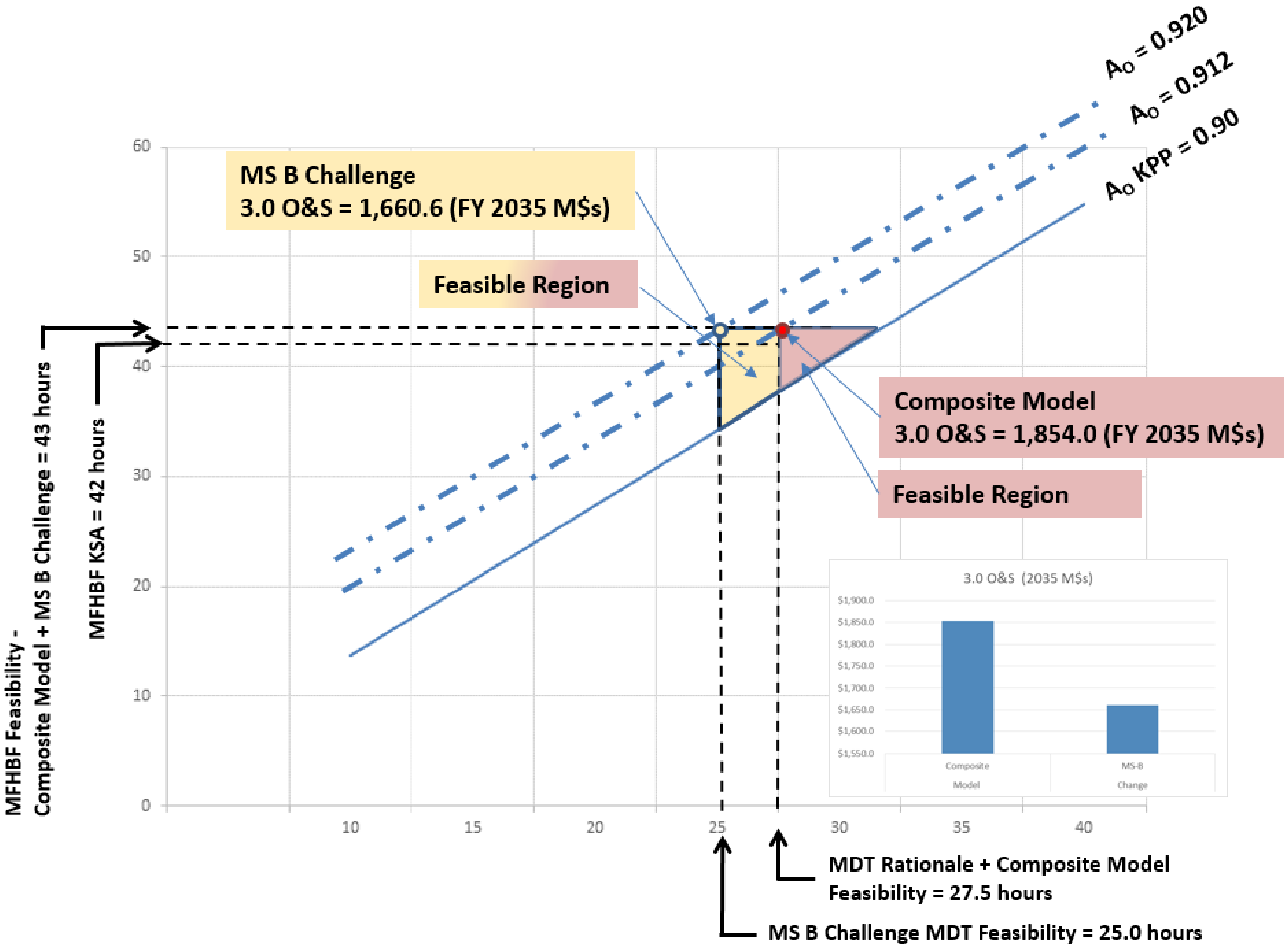
Relationship between Sustainment Metrics and 3.0 O&S Costs Example – MQVX-99

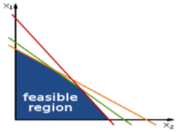


- **As the program approaches MS B, the program is challenged to reduce O&S costs through the use of non-material solutions.**
  - During the Level of Repair Analysis, the program found several high cost items that could be repaired at organizational or intermediate level which would lower costs and reduce the MDT to 25 hours.
  - The following chart displays the trade space that is available based on the MS B challenge feasibility:
    - The trade space is the expanded two colored shaded triangle
      - Above the A_O=0.90 line,
      - To the right of the MDT = 25.0 line, and
      - Below the MFHBF = 43 line.
  - 3.0 O&S Costs in FY 2035 M$s for the composite model and the MS B Challenge are also displayed.

6. Conduct Trade Studies

MS B Challenge Example - MQVX-99





6. Conduct Trade Studies
MS-B Challenge O&S Budget Example - MQVX-99

	Budget by CAPE Category	MQVX -99 Composite Model (FY 2035 M$)	Milestone B Challenge (FY 2035 M$)
1.0	**Unit Level Manpower**	**$ 56.7**	**$ 65.2**
2.0	**Unit Operations**	**$ 271.9**	**$ 271.9**
3.0	**Maintenance**	**$ 1,854.0**	**$ 1,660.6**
	3.1 Consumable Materials and Repair Parts	$ 202.6	$ 230.6
	3.2 Depot Level Repairables	$ 638.5	$ 484.5
	3.3 Intermediate Maintenance	$ 325.4	$ 370.4
	3.4 Depot Maintenance	$ 503.4	$ 391.6
	3.5 Other Maintenance	$ 184.2	$ 183.5
4.0	**Sustaining Support**	**$ 736.5**	**$ 765.9**
5.0	**Continuing System Improvements**	**$ 449.6**	**$ 449.6**
6.0	**Indirect Support**	**$ 12.7**	**$ 12.7**
		$ 3,381.4	**$ 3,225.9**
	3.0 Budget by 2 Digit WUC		
	Airframe	$ 765.3	$ 685.4
	Propulsion/Electrical	$ 654.7	$ 586.5
	Flight Controls	$ 323.5	$ 289.7
	Avionics	$ 110.5	$ 98.9
		$ 1,854.0	**$ 1,660.5**
	Savings		**$ 193.5**

Complete Remaining Sections

Fill in Outline Guidance

- **Complete Sections 1 and 1.1.**
  - When all other sections have been completed and any remaining issues resolved:
    - Section 1 – Summarize the purpose from Section 2.1.
    - Section 1.1 – Extract the KPPs, KSAs and APAs and present in Table 1.1-1. Identify (highlight in red) and discuss any thresholds that are not feasible.

Table 1.1-1 Sustainment KPPs (sample aviation parameters and values based on continuous usage)

Draft CDD, CDD or CPD			*Feasibility Results*	
Parameter		**Threshold**	**Composite Model Estimate**	**Predecessor (Legacy) System**
KPP	Materiel Availability	0.65	0.67	0.58
KPP	Operational Availability	0.80	0.80	0.73
KSA	Mission Reliability	46	40	18
KSA	Logistics Reliability	3.5	4.2	2.5
APA	Maintenance Burden	9.0	8.0	15
APA	Corrective Maintenance	0.5	0.5	1.0
KSA	O&S Cost	$423.7M	$471.4M	$722.6M

Complete Remaining Sections

Fill in Outline Guidance

- **Complete Section 1.2 Summary.**
  - Summarize if the JCIDS thresholds are valid and assessed feasible.
    - o Identify any significant issues and discuss efforts toward resolution.
    - o Summarize notable changes since the previous RAM-C (if applicable).
    - o Provide a summary of any trade studies and display the acceptable region for the R&M parameters.
    - o Refer the reader to the appropriate section of the RAM-C for additional information.

Complete Remaining Sections
Fill in Outline Guidance

- **Complete Section 2.1 and 2.2.**
  - Section 2.1 Purpose - Provide a brief overview of the purpose of the report along with the JCIDS documentation it supports.
  - Section 2.2 Changes – List changes to the RAM-C in Table 2.2-1.

Table 2.2-1 RAM-C Update Record

Revision Number	Date	Description of Changes	Approved By
001	1/1/15	Updated OMS/MP required a re-assessment of mission reliability	XYZ

Complete Remaining Sections
Fill in Outline Guidance

- **Complete Annexes A and B.**
  - Annex A – Acronyms
  - Annex B
    - o List program documents with date and version number in Table B-1 along with identifying the sections used to complete the RAM-C analysis.

Table B-1 Resource Documents (sample documents)

Document	Date/Version	Relevant Sections to RAM-C
CDD		
CONOPs		
OMS/MP		
AoA Study Plan		
AoA Guidance		
AoA Report		
Acquisition Strategy		
SEP		
LCSP		
Etc.		

Complete Remaining Sections

Fill in Outline Guidance

– Annex B (cont.).
  - o References - List sources and references for calculations, policy and any other analysis used in the RAM-C.
  - o Tools – In Table B-2 Identify the tools used in the RAM-C analysis.

Table B-2 RAM-C Tools

Tool	Purpose

Complete Remaining Sections
Fill in Outline Guidance

- **Complete Cover Page.**
- **Complete Table of Contents.**
- **Complete List of Tables and Figures.**
- **Complete Signature Page.**
  - Ensure that Engineering, Product Support and Business Financial areas are all included.

Attributes of an Effective RAM-C

Attributes of An Effective RAM-C

Overview

- JCIDS sustainment parameters are validated and feasible and meet the requirements of the JCIDS endorsement guide.
- Program Office R&M Engineer, Product Support Specialist, and Cost Analyst are involved.
- Sustainment KPPs/KSAs/APAs support the OMS/MP, CONOPS, and maintenance concept.
- The R&M metrics and Cost KSAs support the A_O and A_M KPPs ("the math works") and are consistent with mission and sustainment needs indicating that the parameters are valid.
- Model of the composite system is developed and based on comparison data and current state of the art, and feasibility is determined.
- A trade analysis is conducted to illustrate trade space between R&M metrics within the feasible region showing the relationship of these metrics with A_O and O&S costs.
- Conducted early enough to influence sustainment related decisions. Provides a history of those decisions. Not an afterthought, but a driver of program decisions.

Attributes of An Effective RAM-C
Overview

- Shows collaboration with requirements developers where issues arise during the analysis.
- Uses the best information available at the time the RAM-C is written with an understanding of the accuracy of the information based on the program acquisition phase.
- Verifies that the definitions of failure for each Sustainment KPPs/KSAs/APAs are included in the draft CDD, the CDD and CPD.
- Demonstrates comprehensive analysis of the best information available. Analysis techniques used are appropriate to the information available and acquisition phase (analogy, parametric, engineering, M&S).
- Demonstrates an understanding of the options available within the trade space created within the feasible region and shows how the program used this to make better program sustainment decisions.

Attributes of An Effective RAM-C

JCIDS Sustainment KPP Endorsement Guide Excerpts

- **Availability KPP**
  - Materiel Availability Metric
    - Is there evidence of a comprehensive analysis of the system and its planned use, including the planned operating environment, operating tempo, reliability alternatives, maintenance approaches, and supply chain solutions leading to the determination of the materiel availability value? Are the analysis assumptions documented?
    - Is the total population of systems being acquired for operational use documented, including those in storage or used for training?
    - Are specific definitions provided for failures, mission-critical systems, and criteria for counting assets as “up” or “down”? Are the failure rate values supported by analysis?
    - Does the metric clearly define and account for the intended service life of the total inventory, from initial placement into service through the planned removal from service?
    - What is the overall sustainment CONOPS? Is it consistent with Support for Strategic Analysis products, including Service and joint concepts, CONOPS, design reference missions, etc. being supported? Is it traceable to the original capability requirements, or agreement with the warfighting community? What alternatives were considered? Have surge/deployment acceleration requirements been identified and are they factors in development of the Materiel Availability metric?
    - Is failure/down-time defined? Is planned downtime (all causes) identified and included? Does analysis data support the downtime? Are data sources cited? How does the downtime value compare with downtimes for analogous systems?

Attributes of An Effective RAM-C

JCIDS Sustainment KPP Endorsement Guide Excerpts

- **Availability KPP**
  - Operational Availability Metric
    - Is there evidence of a comprehensive analysis of the system and its planned use, including the planned operating environment, operating tempo, reliability and maintenance concepts, and supply chain solutions leading to the determination of the value? Are the analyses documented?
    - Are specific definitions provided for failures, mission-critical systems, and criteria for counting assets as “up” or “down”? Are the values for failure rates supported by analysis?
    - Is scheduled downtime which affects the CONOPS identified and included? Does the analysis package support the downtime? Are data sources cited? How does the downtime value compare with that experienced by analogous systems?
    - Is downtime caused by failure addressed? Are the values used for failure rates supported by the analysis? Is there a specific definition established for failure?
    - Is the administrative and logistics downtime associated with failures addressed (e.g. - recovery time, diagnostics time, movement of maintenance teams to the work site, etc.)?
    - For complex systems and systems of systems, is the operational availability defined at the appropriate system level? Is it consistent with Operational Availability and Reliability requirements?
    - What is the overall sustainment CONOPS? Is it consistent with Support for Strategic Analysis products, including Service and joint concepts, CONOPS, design reference missions, etc. being supported? Is it traceable to the original capability requirements, or agreement with the warfighting community? What alternatives were considered? Have surge/deployment acceleration requirements been identified and are they factors in development of the Materiel Availability metric?

Attributes of An Effective RAM-C

JCIDS Sustainment KPP Endorsement Guide Excerpts

- **Reliability KSA**
  - Mission and Logistics Reliability
    - Has the reliability metric been established at the system level? Is it traceable to the original capability requirements, or other performance agreement?
    - Does the analysis clearly provide criteria for defining relevant failure?
    - Does the analysis clearly define how time intervals will be measured?
    - Does the analysis identify sources of baseline reliability data and any models being used? Is the proposed value consistent with comparable systems? Are sources of data and processes to track reliability across the life cycle identified?
    - Is the reliability value consistent with the intended operational use of the system (i.e., the CONOPs)?
    - Is the reliability value consistent with the sustainment approach as presented in the operational availability metric?
    - Is the reliability value improved relative to previously fielded or analogous systems? If lower reliability is proposed, what improvements are gained in other areas to make the trade-off valuable to the warfighter?
    - For single-shot systems and systems for which units of measure other than time are used as the basis for measuring reliability, does the package clearly define the units, method of measuring or counting, and the associated rationale?

Attributes of An Effective RAM-C
JCIDS Sustainment KPP Endorsement Guide Excerpts

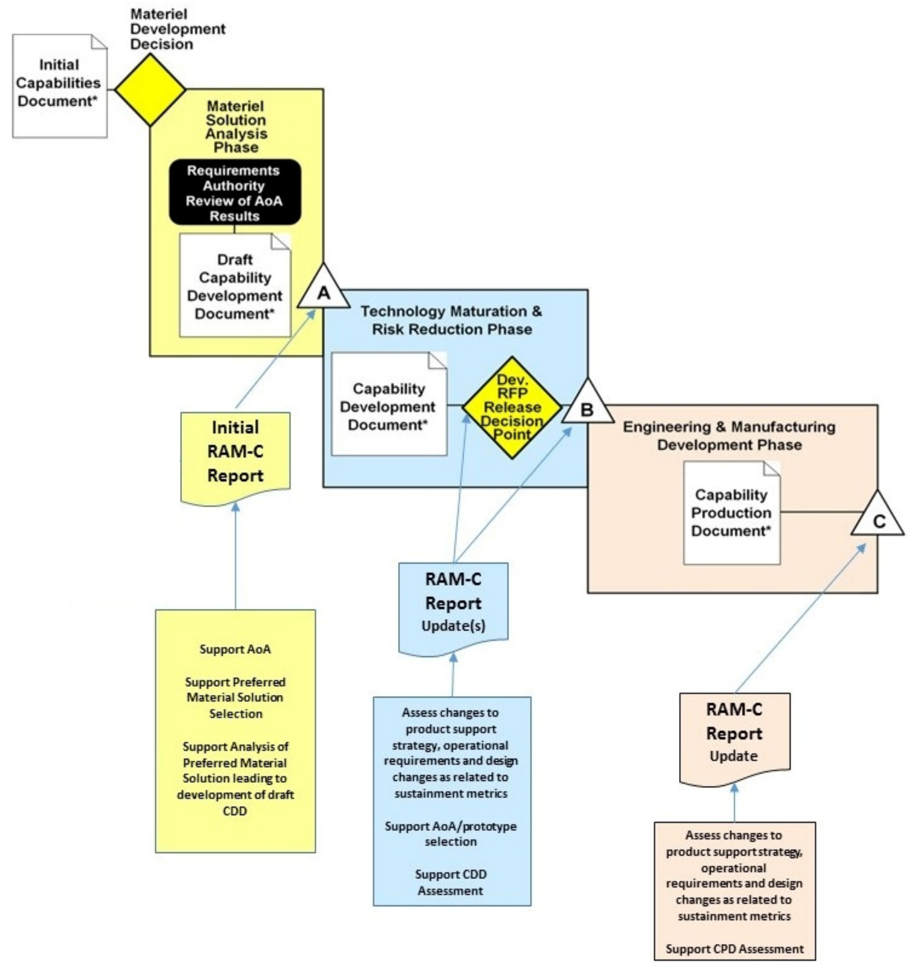
- **O&S Cost KSA**
    - Has the O&S cost goal been defined for the system?
    - Does the analysis utilize the CAPE O&S cost element structure? Are there costs included in the O&S Cost KSA that fall outside of the CAPE O&S cost element structure? If so, have those costs been explained in sufficient detail?
    - Is the documentation for the O&S cost estimate of the objective value supplied and available in the KM/DS system? If so, is it to an appropriate level of detail to adequately explain the estimate values?
    - Is the cost model consistent with the assumptions and conditions being used for materiel availability and materiel reliability?
    - Is the cost metric traceable to the original capability requirements, or agreement with the warfighter?
    - Are all required costs included, regardless of funding source or management control?
    - Were applicable environmental issues considered in the development of the O&S cost estimate?
    - Is the O&S Cost KSA data consistent with the capability solution's life cycle cost estimate, CARD and/or the CAPE independent cost estimate if available for comparison?
    - Is the threshold value for the O&S Cost KSA calculated as 10% higher than the objective value?
    - Has the annual cost of a system (or systems for munitions and networks) been provided as part of the rationale?

Summary

Summary

- **This briefing has been focused on a RAM-C report that was due at MS A.**
- **If you have finished your MS A RAM-C, congratulations!**

- **But you're not through yet.**
  - An updated RAM-C attached to the SEP is required at the Development RFP Decision Point, MS B, and MS C as shown as new information is obtained.



For Additional Information

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Acronyms

3M	Maintenance and Materiel Management
ALDT	Administrative and Logistics Delay Time
A_M	Materiel Availability
A_O	Operational Availability
APA	Additional Performance Attribute
BIT	Built In Test
CAMS	Core Automated Maintenance System
CAPE	Cost Assessment and Program Evaluation
CARD	Cost Analysis Requirements Description
CDD	Capability Development Document
CFE	Contractor Furnished Equipment
CONOPS	Concept of Operations
CPD	Capability Production Document
FH	Flight Hour
FMECA	Failure Mode Effects and Criticality Analysis
GFE	Government Furnished Equipment
HALT	Highly Accelerated Life Testing
ICD	Initial Capabilities Document
JCIDS	Joint Capabilities Integration and Devlopment System
KPP	Key Performance Parameter
KSA	Key System Attribute
LCSP	Life Cycle Sustainment Plan
M&S	Modeling and Simulation
MCMT	Mean Corrective Maintenance Time
MDT	Mean Down Time
MESM	Mission Essential Subsystems Matrix
MFHBA	Mean Flight Hours Between Aborts

Acronyms
(Continued)

MFHBF	Mean Flight Hours Between Failure
MFHBOMF	Mean Flight Hours Between Operational Mission Failure
MMH/FH	Maintenance Man Hours/Flight Hour
MP	Mission Profile
MS	Milestone
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
NALCOMIS	Naval Aviation Logistics Command Management Information System
NALDA	Naval Aviation Data Analysis
O&S	Operating and Support
OMF	Operational Mission Failure
OMS	Operational Mode Summary
OMS/MP	Operational Mode Summary/Mission Profile
R&M	Reliability and Maintainability
RAM-C	Reliability, Availability, Maintainability and Cost
RDT	Reliablity Development Testing
REMIS	Reliability and Maintainability Information System
RFP	Request for Proposal
R_L	Logistics Reliablility
R_M	Mission Reliability
S/F	System On to Flight Hour
SEP	Systems Engineering Plan
SGR	Sortie Generation Rate
TAMMS-A	The Army Maintenance Management System
UAV	Unmanned Aerial Vehicle
VAMOSC	Visibility and Management of Operating and Support Cost
WUC	Work Unit Code