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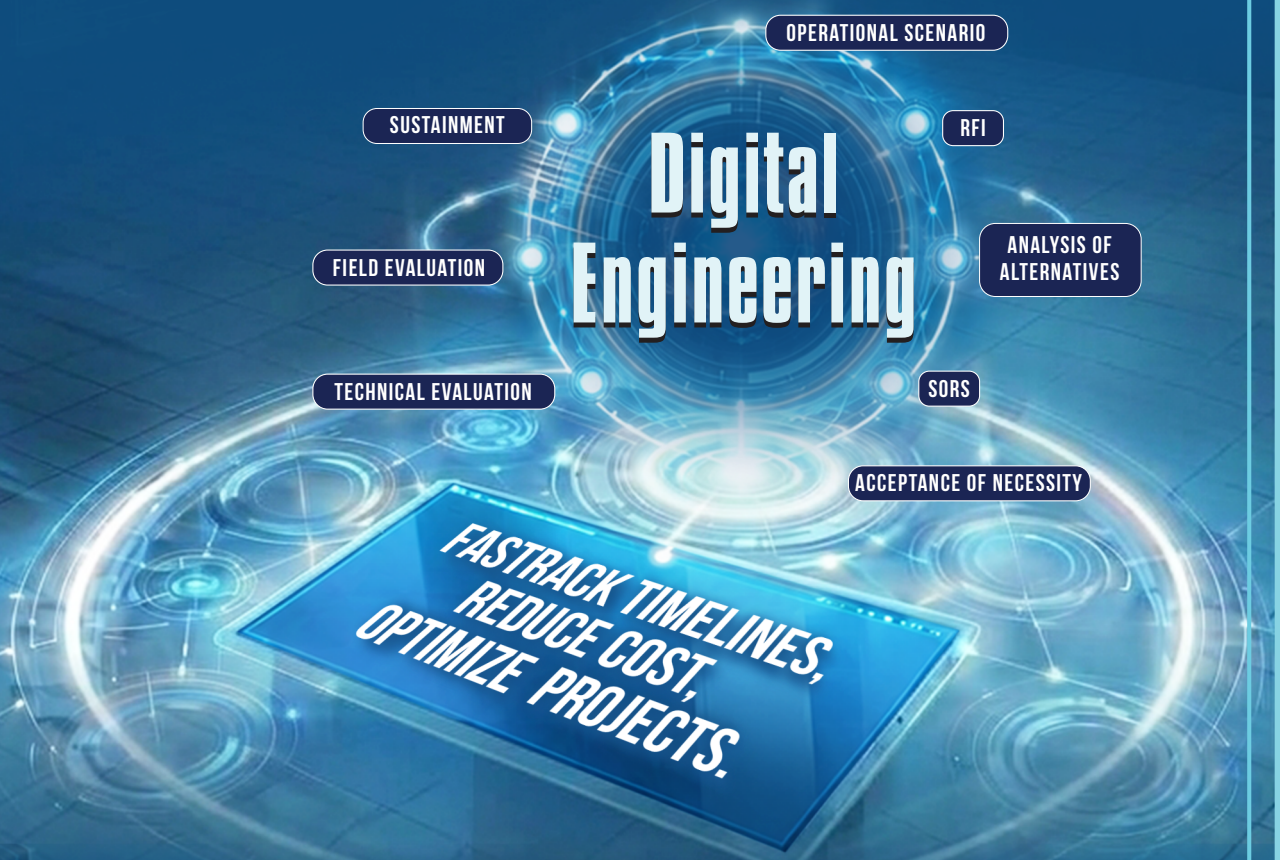


# WHITE PAPER ON MODEL- BASED ACQUISITION

## INTEGRATION OF DIGITAL ENGINEERING IN DEFENCE ACQUISITION PROCEDURE: A GAME CHANGER FOR CAPABILITY DEVELOPMENT

### Study Team


| | |
|---|---|
| Maj Gen Pawan Anand, AVSM, PhD, (Retd) | Director CETANB, USI of India & Principal Investigator |
| Maj Gen Abhay Dayal, AVSM, VSM, PhD, (Retd) | Project Lead |
| Brig Vivek Verma, PhD, (Retd) | Project Coordinator |
| Gp Capt Pranay Dixit VM (Retd) | Project Member |
| Mr Prem Andrade | Project Technology Lead |
| Mr Atul Borkar | Project Technology Member |
| Mr Hardik Asawa | Project Technology Member |
| Mr Ishan Patel | Project Technology Member |

(Estd. 1870)

# Centre for Emerging Technologies for Atma Nirbhar Bharat (CETANB)

## USI of India, New Delhi


USI of India, Rao Tula Ram Marg (Opposite signal Enclave), Post Bag No.8, Vasant Vihar PO, New Delhi- 110057

Website: anbi@usiofindia.org / www.usiofindia.org

01120862316 (Direct) / 01120862320 (Exch) (Extn- 218) / +91 8826480239 (Mob)

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# List of Abbreviations

- **ASoT** – Authoritative Source of Truth
- **DAP** – Defence Acquisition Procedure
- **DRDO** – Defence Research and Development Organisation
- **DPSUs** – Defence Public Sector Undertakings
- **GSQR** – General Staff Qualitative Requirements
- **HQs** – Headquarters
- **IDE** – Integrated Digital Environment
- **IPR** – Intellectual Property Rights
- **MBSE** – Model-Based Systems Engineering
- **MBAcq** – Model-Based Acquisition
- **Mil std** – Military Standard
- **MoD** – Ministry of Defence
- **R&D** – Research and Developmentp
- **RFI** – Request for Information
- **RFP** – Request for Proposal
- **SQR** – Staff Qualitative Requirements
- **STANAG** – Standardisation Agreement

# Definitions

**Authoritative Source of Truth (ASoT):**
A single, integrated digital model that serves as the definitive reference for all stakeholders across the entire system lifecycle, from concept and design to deployment and sustainment. Thus, ensuring consistency, accuracy, and traceability of information.

**Digital Thread:**
A seamless framework that links data to design, decisions, and the development of artefacts across all phases of the system lifecycle - testing, deployment, and sustainment - enabling end-to-end traceability of decisions, configurations, and performance metrics across stakeholders and ensuring lifecycle assurance, auditability, and mission readiness.

**Digital Twin:**
A dynamic, virtual representation of a physical system that mirrors its real-time behaviour and system health and can be used to simulate, monitor, and optimise performance throughout its operational life. It can also be used to support predictive maintenance, mission rehearsal, and performance optimisation, especially for legacy-modern hybrid fleets and indigenously developed systems.

**Integrated Digital Environment (IDE):**
A collaborative ecosystem enabled by interoperable tools, shared data, and streamlined workflows that support cross-functional integration and real-time decision-making across the defence value chain—including Services HQs, R&D institutions, production agencies, and field units.

**Model-Based Acquisition**
**(MBAcq)** of defence hardware is a modern approach that leverages digital models and simulations throughout the entire defence acquisition lifecycle. Instead of relying solely on traditional documents and text-based specifications, model-based acquisition uses digital engineering, modelling and simulation as primary means of communication and analysis among all stakeholders—defence agencies, contractors, and suppliers.

**Model-Based Systems Engineering (MBSE):**
An engineering approach that uses digital models to define, analyse, and validate system requirements, architecture, design, and performance throughout the development lifecycle, fostering faster development of indigenous platforms and mission systems with traceable compliance to GSQRs and operational doctrines

# Executive Summary

## Integration of Digital Engineering in Defence Acquisition Procedure: A Game Changer for Capability Development

### Context & Challenge

- India's defence acquisition procedure has evolved over the last two decades ensuring integrity and stability for an essentially foreign based equipment profile. Technological developments demand a faster pace and Atma Nirbhar Bharat is now centre-stage, The current procedure is document-centric process and largely subjective. Ambiguous perspectives of requirement definition for complex military systems hinder traceability and delay defect detection, resulting in project delays and higher costs.
- Digital Engineering (DE) is increasingly permeating all domains of human endeavour, offering opportunities to enhance efficiency, objectivity, and cost-effectiveness.
- India, at the threshold of major technological advancements and defence manufacturing growth, must modernise its acquisition ecosystem to remain globally competitive.

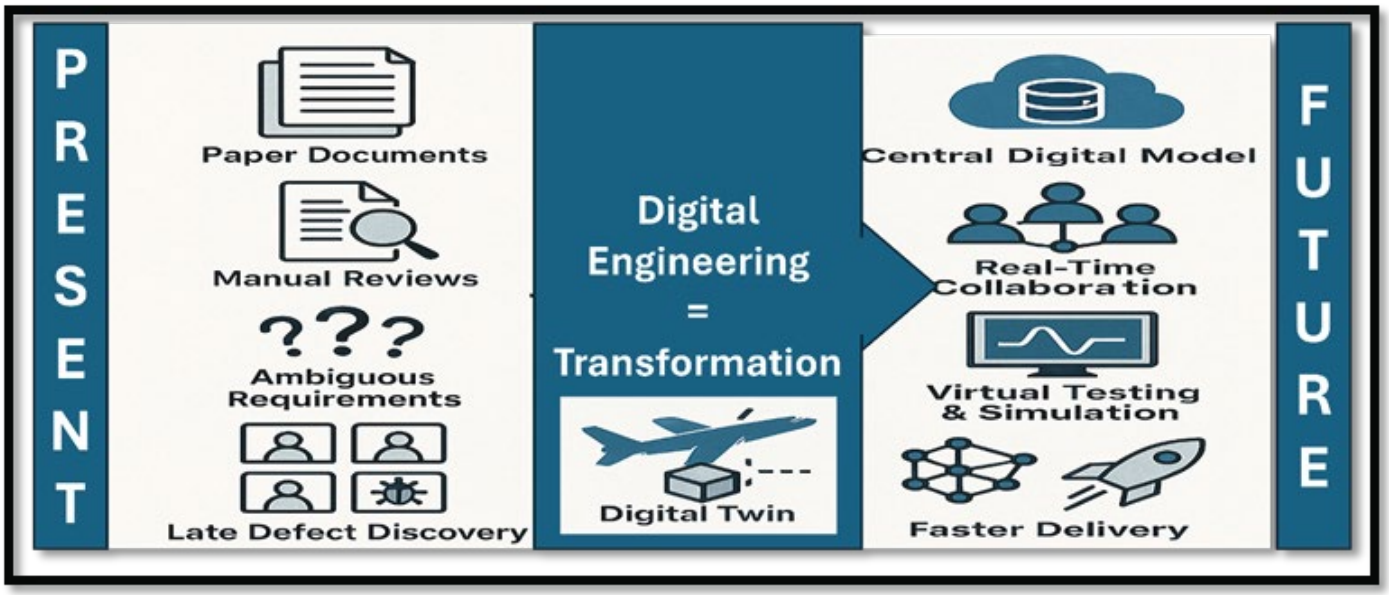



*Figure 1: From Paper to Platform- Transformation in the Acquisition Process through Digital Engineering*

### Global Benchmarks

International case studies (US Air Force T-7A Red Hawk, B-21 Raider, Australian Air Combat Program) demonstrate MBAcq's ability to accelerate schedules, reduce rework, and foster collaboration. These successes provide a blueprint for India's transformation, and zrovide an opportunity to be early movers.

### Objective

To introduce MBAcq into the Indian Defence Acquisition Process as a structured, digital, and objective methodology that augments existing procedures, reduces acquisition timelines, and enhances vendor participation.

### Scope of Application

Best suited for Buy Indian (IDDM), Buy Indian, Make & Innovation, and Design & Development (D&D) categories. Applicability to Foreign OEMs with ToT depends on the willingness to share APIs/ICDs.

## Solution: Model-Based Acquisition (MBAcq) Workflow and Process

MBAcq leverages DE, integrated models, and simulation throughout the acquisition lifecycle (refer to Figures 2 and 3). This approach replaces static documents with dynamic, authoritative digital models, enabling:

- Consistent, traceable data across stake holders.
- Early verification and validation through simulation.
- Seamless collaboration between government, industry, and R&D labs.
- Accelerated design-to-deploy cycles for critical capabilities.

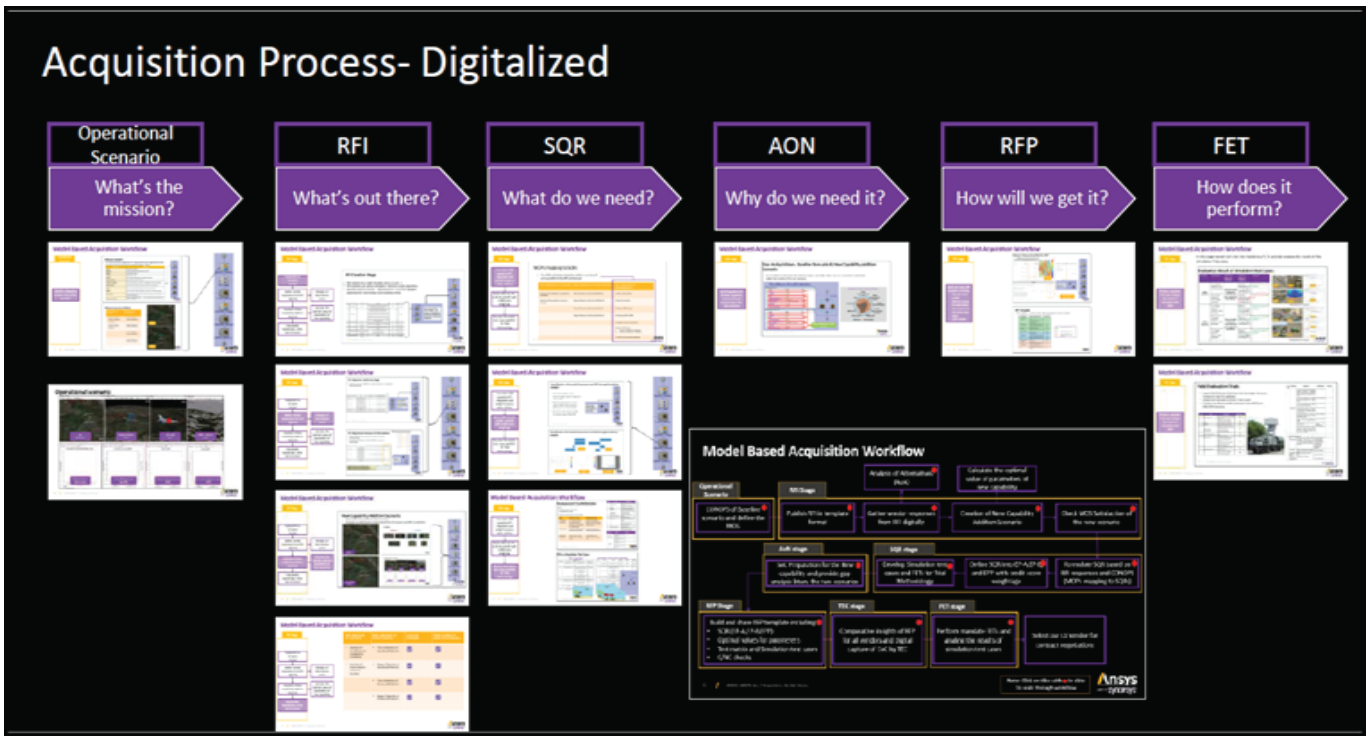



*Figure 2: Digitalised Acquisition Process- Summary (For details refer Pages 44 to 49 of the White Paper)*
*Source: Courtesy Prem Andrade*

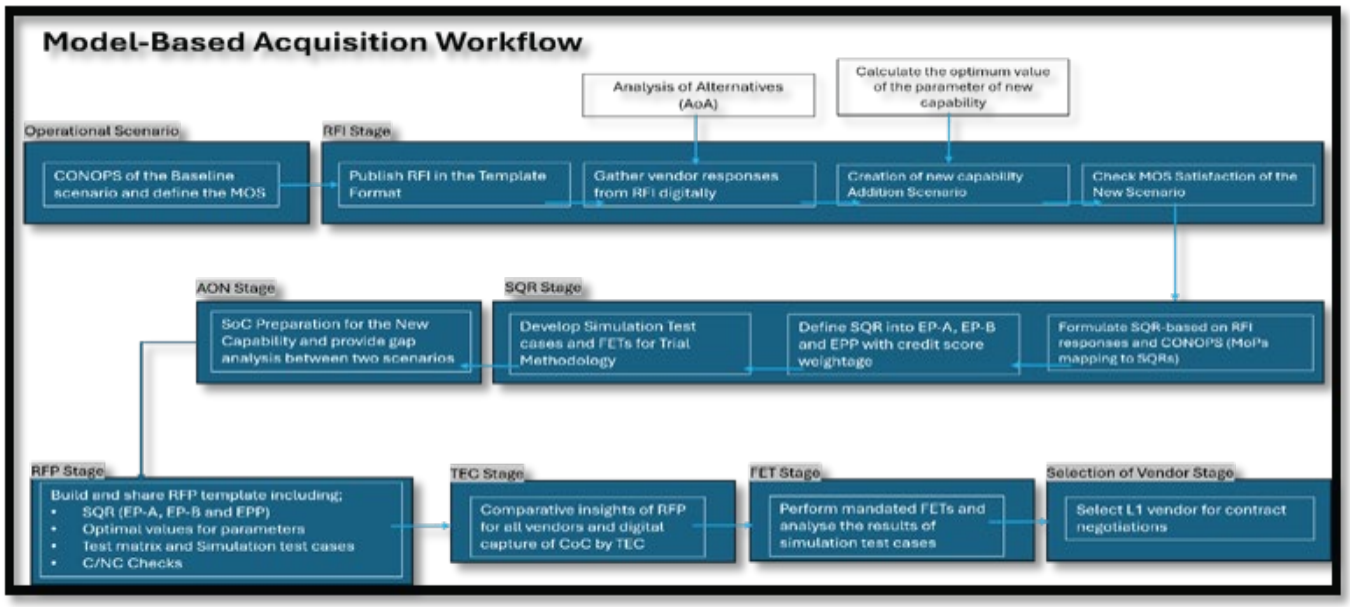



*Figure 3: MBAcq Workflow incorporating Digital Engineering*

## Recommendations

**Change Management**

- Conduct workshops and training to build stakeholder confidence.
- Use pilot projects to demonstrate efficiency gains before scaling.

**Functional Recommendations Across Acquisition Stages**

- **RFI Stage:** Digital questionnaires ensuring uniformity and clarity; faster compliance matrix preparation.
- **SQR Formulation:** Use CONOPS + RFI responses; derive realistic SQRs aligned with MoS, MoE, and MoP.
- **RFP Stage:**
  - Introduce ***Objective Architecture Description (OAD)*** to digitise parameters, KPPs, and metadata.
  - Use ***Architecture Acquisition Guidance (AAG)*** as a standardised digital template.
  - Retain DAP 2020 RFP format in digital form.
- **Techno Commercial Bids:** Continue two-envelope system; require digital twin submission in technical bid; NCNC basis for model development.
- **Technical Evaluation (TEC/EUT):** Replace initial physical EUT with digital twin submissions; conduct simulations; physical prototypes only from compliant vendors.
- **Trials Stage:** Digital trials first, followed by limited physical validation trials; reduces cost/time and encourages vendor participation.
- **Subsequent Stages:** GS Evaluation, L1, Contract Negotiation, CFA Approval, Contract Signing - minimal changes.

**Financial Incentives**

- Initially NCNC basis for digital twin development.
- Later, consider grants/delegated financial powers akin to Make I prototype funding.

## Strategic Benefits

**MBAcq strengthens India's Atma Nirbhar Bharat roadmap by accelerating digital adoption and generating thought leadership in the development of cutting-edge technologies.**

- **Reduces Ambiguity:** Formal models ensure all stakeholders share a common understanding
- **De-risks Indigenous Programs:** Early flaw detection and virtual testing lower costs and improve predictability
- **Democratizes Access:** MSMEs and startups can participate via "virtual integration," fostering innovation Strengthens Atma Nirbhar Bharat: Builds a robust, self-reliant defence industrial base

## Implementation Roadmap

**A phased strategy is recommended:**

- Pilot & Enablement: Launch pathfinder projects and build core digital engineering teams
- Scale & Standardise: Integrate MBAcq into DAP 2025, expand training, and develop standardised digital assets
- Digital First: Mandate model-based approaches for all major acquisitions, supported by secure digital infrastructure

## Policy Recommendations

- Update DAP 2025 to mandate digital models and open standards
- •Upskilling program for select armed forces personnel of all directorates, particularly those related to acquisition and procurement.
- Offer upskilling options to industry partners.
  Recommend adoption by other ministries and if required / feasible launch a National Digital Engineering Enablement Program

## Conclusion

MBAcq is not just a technical upgrade—it is a strategic enabler for India's defence modernisation and self-reliance. By embedding MBAcq principles into DAP 2025, India can build an agile, innovative, and collaborative defence ecosystem that delivers cutting-edge capabilities validated through simulation and ready for mission success within a compressed time frame. The digital resource reservoir will enable future doctrine development and product deployment, addressing current capability and capacity gaps. A phased adoption through pilot projects, supported by training and financial incentives, will ensure smooth transition and long-term success.

# Chapter 1: Introduction

## Current Acquisition Framework – Strengths and Limitations

The Defence Acquisition Procedure 2020 (DAP 2020) was introduced with the primary aim of streamlining the procurement of weapons and equipment for the Indian Armed Forces, promoting self-reliance in defence manufacturing, and enhancing transparency. DAP 2020 represents a significant advancement over earlier versions of the Defence Procurement Procedures, delivering a responsive and flexible framework for the efficient procurement of military hardware and software throughout their entire life cycle

*Key Emphasis: DAP 2020 is a cornerstone for India's aspiration towards self-reliance and technological advancement in defence procurement.*

**Evolution and Policy Alignment**. The provisions of DAP 2020 have been revised on multiple occasions to make the process more inclusive and aligned with evolving Government policies. These revisions aim to encourage indigenisation and the 'Make in India' initiative, while ensuring a level playing field for both the Indian private sector and Public Sector Units (PSUs).

**Strengths of DAP 2020.**

- **Indigenisation Focus:** Increased Indigenous Content (IC) requirements and Positive Indigenisation Lists foster a domestic defence ecosystem.
- **Innovation Promotion:** Procedures have been tailored to promote innovative solutions and indigenous technology development.
- **Inclusive Framework:** The process accommodates both private industry and PSUs, enhancing competition and efficiency.

*Key Insight: The deliberate emphasis on innovation and indigenisation serves as a vital lever for India's strategic autonomy.*

**Limitations.**

- While DAP 2020 has introduced several positive changes, it continues to face significant challenges. Addressing these shortcomings—such as **protracted timelines and multi-layered organisational decision-making**—can further improve efficiency and responsiveness in the procurement process.
- **Precedence in Using Trials by Simulations in Acquisition.**
- Field Evaluation Trials (FET) are the longest phase of the defence procurement cycle. As per the proposed timelines laid down in **Appendix L to Chapter II of DAP 2020**, the trial duration has been **allotted 16-24 weeks, extendable to 36 weeks** if winter trials are involved. This duration is almost 34% of the proposed timeline for the entire procurement cycle, which is 106 weeks.
- A focus on the reduction of the time duration of trials can bring in better time efficiency in the overall procurement. As per **Para 44 and 68 of Chapter II of DAP 2020**, provision of **trials by simulation is accepted**. The same has not been put in place on a major scale, possibly due to a lack of technology and infrastructure focused on simulation. The integration of DE and the use of simulations in lieu of physical testing for certain Qualitative Requirements (QR) have been identified as transformative opportunities for future iterations.

With technology advancement in the field of DE and the adoption of simulation-based techniques by various armed forces of the world, there is a felt need to adapt simulation-based trials. It will bring a paradigm shift to the existing defence acquisition process, enabling us to remain ahead of the curve and support the capability development of our armed forces.

*Key Insights: Technological advancements and cost optimisation in DE, over the last few years, have enabled the use of DE applications in defence procurements.*

## Current Challenges.
## The Primacy of the Document in the Indian Context

A strictly document-driven acquisition system is essentially process-centric and ultimately loses its outcome-centricity. The very goals enshrined in DAP-2020—fostering public-private collaboration, encouraging innovation, and speeding up procurement timelines— are actively undermined by our continued reliance on purely paper-based processes and physical field-based evaluations. The key challenges identified are:-

- **Legacy process Ill-equipped to Handle the Software-Integration Bottleneck.** A modern fighter jet is a flying network, a modern warship, a floating data centre. The capability of these platforms is defined less by their physical characteristics and more by the millions of lines of code that integrate sensors, weapons, and data links. A static document is an inadequate tool for spiral development of complex software/ systems.
- **A Document-centric Approach Suppresses Collaboration.** A natural language RFI/RFP, regardless of how detailed and deliberate, is inherently open to interpretation. This ambiguity causes friction and misunderstanding at every interface: between the SHQ that defines the need, the DRDO labs that design the technology, the Defence Public Sector Undertakings (DPSUs), or the private entity that manufactures or supplies the platform or critical subsystems. Different interpretations lead to misaligned efforts, costly rework, and a culture of blame when integration fails. It hampers the seamless public-private partnership (PPP) that DAP-2020 rightly envisions.
- **Perceived Risk and Inflation in the Cost of Indigenous R&D.** India has made significant investments in flagship programs like the Light Combat Aircraft (LCA) Mk2, the Advanced Medium Combat Aircraft (AMCA), and next-generation naval and land systems. In a document-driven world, critical design flaws such as radar and electronic warfare (EW) suite incompatibility or a new airframe structural weakness are often discovered only during physical prototyping and testing. Finding and fixing a flaw at this late stage is exponentially expensive and time-consuming than correcting it on a digital drawing board.
- **Protracted Timelines:** Lengthy trials and decision-making processes delay critical capability acquisition.
- **Technology Obsolescence:** Delays can lead to procured technology becoming outdated by the time of induction.
- **Dependence on Physical Trials:** Excessive reliance on physical trials persists due to historical cost and technological limitations associated with simulation.

*Key Emphasis: Accelerate the adoption of DE and simulation to drive procurement agility and reduce timelines.*

**Stakeholder Perspectives.** The think tank's engagement with stakeholders—including users, DRDO, DPSUs, and private industry—reveals a consensus on the need for reform. The environment feels that technological readiness for simulation and its cost-prohibitive nature in the past have led to this aspect not being undertaken on a major scale so far, resulting in extensive reliance on physical trials. The most prominent concern is the extended duration of trials, which not only delays procurement but also risks technological obsolescence. Stakeholders advocate greater emphasis on certification and simulation, where feasible, to streamline the process and enhance responsiveness.

*Key Emphasis: Simulation and certification, if implemented robustly, can significantly reduce procurement bottlenecks.*

*Table 1: DAP 2020 – Strengths and Limitations*

| | |
|---|---|
| Promotion of indigenisation via Indigenous Content (IC) and Positive Indigenisation Lists | Protracted timelines for trials and multi-layered decision-making |
| Encouragement of innovation and inclusion of the private sector | Excessive reliance on physical trials due to past technological and cost barriers |
| Responsive and flexible procurement framework | Potential for technology obsolescence during the procurement cycle |
| Para 44 and 68 of Chapter II of DAP 2020, provision of trials by simulation is accepted | Not been put in place on a major scale, possibly due to a lack of technology and infrastructure focused on simulation. |

*Key Emphasis: As India prepares to update its defence acquisition framework, integrating DE and open standards will be crucial to sustaining the momentum of modernisation*

## Statement of Problem

India's defence acquisition faces hurdles from procedural inertia and cultural resistance. Processes are still paper-based, disjointed, and with fractured traceability. System flaws are often hidden until costly physical prototypes are put to the test. Cultural barriers—risk aversion, preference for legacy systems, and reluctance to innovate—further hinder progress. These issues hinder the goal of building a vibrant, self-reliant defence ecosystem under Atma Nirbhar Bharat.

The fundamental question, therefore, is: Are India's procurement processes built on a foundation of paper and sequential reviews, truly fit for the purpose of building a sovereign, 21st-century defence industrial base at the speed of relevance?

*Key Insight: Understanding the digital dawn is the essential first step in preparing for the new era of acquisition. It should be driven by the dual imperatives of managing modern complexity and complying with official policy by embracing change.*

## Why DE as Policy Response?

DAP 2020, the document has been the bedrock of our acquisition process. The meticulously detailed Statement of Case (SoC), the exhaustive Services Qualitative Requirements (SQRs), and the voluminous contracts have been the backbone of our acquisition. However, as we pivot from being one of the world's largest importers to an ambitious designer and exporter of complex weapon systems, the cracks in this legacy foundation are becoming dangerously apparent. As President Biden said, 'we are living in a decisive decade.' Hence, sticking to this old model in the new era is both inefficient and a direct threat to our strategic ambitions.

DE offers a robust answer to India's acquisition challenges. Globally, countries such as the US, the UK, and France have integrated model-based approaches into their defence procurement policies, achieving greater transparency, speed, and collaboration. These nations have demonstrated that DE streamlines stakeholder communication, reduces integration errors, and accelerates deployment cycles—all critical for maintaining strategic advantage.

*Table 2: Comparison between Traditional Paper-Based Procedure and Digital Model-Based Procedure*

| Feature | Traditional (Document-Based) | Digital (Model-Based) |
|---|---|---|
| Source of Truth | Paper documents, prone to ambiguity | Dynamic digital models, unambiguous |
| Stakeholder Access | Limited, often restricted | Universal, real-time collaboration |
| Integration Risks | High, due to manual cross-referencing | Low, with virtual integration and simulation |
| Global Practice | Declining, replaced by model-based in leading nations | Standards in the US, UK, and France |

Three powerful forces are converging at this moment to create a critical, and likely perishable, window of opportunity for India.

- **The Strategic Clock is Ticking:** The nature of modern conflict is defined by speed: the speed of information, of decision-making, and of capability deployment. In a contested region, the decade-long development cycles of the past are a strategic liability. Our adversaries are not waiting. We no longer have the luxury of time; we must achieve technological overmatch through agility. The traditional, linear acquisition process is fundamentally too slow for this new reality. The imperative to accelerate our "design-to-deploy" cycle is not merely an efficiency goal; it is a matter of national security.
- **Strengthening the Atma Nirbhar Foundation:** The Atma Nirbhar Bharat initiative is more than a policy; it is the active construction of a new national defence ecosystem. New public-private partnerships are forming, new supply chains are being established, and new investments are being made. The crucial question is what foundation this new structure will be built upon. If it is built on the old, fragmented, document-centric processes, we will create a new generation of silos and bake in the inefficiencies of the past. The time is ripe to instil a common digital language and a collaborative, model-based framework, while the foundation is still being strengthened.
- **The Digital Tools Are Ready and Proven:** For years, Model-Based Engineering was a niche, high-cost endeavour with a steep learning curve. That is no longer the case. Over the last five years, the enabling technologies: simulation software, cloud computing platforms, and AI-driven analysis tools have matured, become more accessible, and have been proven effective in major international defence programmes. The risk of adoption has also dramatically decreased. The question has shifted from "if" this technology works to "how" we can best implement it.

*Key Insight: The technological barriers to DE have fallen, and adoption risks have decreased dramatically. Large-scale digital transformation is now a practical and achievable goal for the first time.*

## Technology Advances and Global Trends

This document-focused approach faces growing pressure from rapid technology and policy mandates, with governments demanding change. The U.S. Department of Defence's Digital Engineering Policy, like DoD 5000.97, mandates shifting from documents to digital models as the primary source, highlighting a strategic move toward more agile, accurate, and integrated acquisition for national security.

- **The Maturation of Digital Modelling:** The concept of modelling is not new, but the languages, tools and simulations used have taken a massive leap forward. This allows diverse teams to describe their part of the system in a computationally precise way, enabling automated model validation and creating a truly single, coherent digital description of the entire system.

- **The Practicality of the Digital Twin:** The Digital Twin, once a sci-fi idea, is now vital in engineering, created via IoT and sensors. It offers real-time virtual replicas of assets like ships or jets, helping predict failures, test updates, and optimise performance in ways previously impossible.
- **The Power of the Compute:** The sheer volume of compute of these complex models and their Digital Twins would have been unmanageable a decade ago. The rise of high-performance compute and scalable storage allows multiple stakeholders to collaborate on the exact same model in real-time, breaking down the traditional information silos that have plagued large programs.
- **Strategic Integration of Artificial Intelligence (AI):** AI is a core part of national strategy, with countries establishing AI policies to boost adoption. In acquisition, AI provides capabilities such as generative design, predictive analytics, and automated complex model verification, enabling engineers to focus on higher-level tasks.

These technologies are woven together by the Digital Thread, an unbroken, authoritative data trail that connects every stage of a system's life —from the initial requirement to the design model, the manufacturing plan, operational data from its Digital Twin, and eventual retirement. It is this thread that ensures the "single source of truth" mandated by policies such as DoD 5000.97. It is not just a slogan but a functional reality.

For the acquisition professional, the implication of these trends is profound. The technological groundwork has been laid for a fundamental shift away from reviewing static, disconnected documents toward interacting with a dynamic, integrated digital model of a system.

**Model-Based Acquisition (MBAcq)** of defence hardware is a modern approach that leverages digital models and simulations throughout the entire defence acquisition lifecycle. Instead of relying solely on traditional documents and text-based specifications, model-based acquisition uses digital engineering, modelling and simulation as primary means of communication and analysis among all stakeholders—defence agencies, contractors, and suppliers.

*Key Insight: The global technological trends, the rise of the digital twin, the power of the cloud and the maturation of AI are not distant phenomena to be observed from afar.*

## The Model-Centric Advantages for India

Adopting the paradigm of MBAcq would directly address the core goals of Atma Nirbhar Bharat and the modernisation objectives of DAP-2020 as highlighted below: -

*Table 3: MBAcq Advantages to Meet the Atma Nirbhar Goal of India*

| Traditional Weakness (Document-Centric) | Model-Based Acquisition Advantage | Relevance to India's Goals |
|---|---|---|
| Ambiguous Requirements | Rigour & Precision: Formal models eliminate ambiguity, ensuring all stakeholders share a common understanding. | Dynamic digital models, unambiguous |
| Late Defect Discovery | Early Verification & Validation: "Test before you build" through high-fidelity, Multiphysics simulation. Flaws are found and fixed in the virtual world when the cost is negligible. | De-risks ambitious indigenous programs (e.g., AMCA, new naval platforms), making them more predictable and successful. Builds national confidence. |
| Fractured Traceability | Integrated Digital Thread: Creates a seamless digital link from requirement to design, analysis, and operations. Integrated Digital Thread: Creates a seamless digital link from requirement to design, analysis, and operations. | Enables a robust modular approach and connects requirements to simulation-based evidence for compliance and certification. |
| High Barriers to Entry | Democratised Access: A clear digital model enables MSMEs and startups to see exactly how their components fit, enabling "virtual integration." | Accelerates ecosystem growth by lowering the risk and cost forsmaller players to innovate and contribute to major national programs. |

## Model-Based Acquisition (MBAcq) - A Blueprint for an Atma Nirbhar Future

MBAcq is not merely a new technology to be procured; it is a new methodology to be adopted to bring in speed, efficiency and responsiveness in the existing defence acquisition procedure. It offers a direct and powerful solution to the specific challenges hindering India's self-reliance journey. By shifting the "source of truth" from a stack of documents that suffer from ambiguity, limited access for all stakeholders, and poor acceptability due to multiple versions, cross-references, etc., to precise, dynamic digital models that can fundamentally re-engineer our acquisition process for greater success.

**Benefits of MBAcq.**

- **It Creates a Common Language for Collaboration.** A central digital model of a system becomes the unambiguous, common language for all stakeholders. A private MSME developing a component can see exactly how its part fits and interacts with the larger system being built by a DPSU. A DRDO lab can test its new sensor against a high-fidelity digital model of the aircraft it's destined for, long before a physical prototype is developed. This breaks down silos, fosters genuine collaboration, and creates the integrated industrial ecosystem at the core of Atma Nirbhar Bharat.

*Key Insight: Helps to develop standardised digital modelling protocols for all defence projects.*

- It De-risks Ambitious Indigenous Design. MBAcq is, at its heart, a powerful risk-reduction strategy. By enabling continuous virtual testing and simulation and "testing before you build", it allows our engineers and designers to identify and resolve thousands of potential flaws in the virtual world, when the cost to fix them is negligible. This makes complex, "clean-sheet" indigenous designs far more manageable, predictable, and ultimately, successful. It builds national confidence in our own research, design and development capabilities, shifting the focus from risk aversion to bold innovation.

*Key Insight: Investments in advanced simulation centres will support innovations and indigenous design validation.*

- **It Accelerates the "Design-to-Deploy" Cycle**. In our contested geopolitical landscape, speed is a strategic weapon. The ability to rapidly develop, field, and upgrade capabilities is critical. MBAcq's digital thread links design directly to operational platforms, enabling rapid software updates, new system integration, and performance optimisation. This ensures platforms remain state-of-the-art throughout their lifecycle.

*Key Insight: Digital thread methodologies enable rapid prototyping against predefined performance benchmarks, accelerating deployment cycles.*

- **It Accelerates and Democratizes Ecosystem Growth**. Traditional document-based methods impose high costs and risks on small enterprises. Model-Based Acquisition offers clear digital models, enabling virtual integration, reducing risks and costs, and encouraging a diverse, innovative defence sector. This approach fosters a network of agile, specialised companies, moving toward a self-reliant and innovative national defence industry. The path to an Atma Nirbhar Bharat in defence is paved with immense challenges, but the greatest of these are not technical; rather, they are procedural and cultural. To fully realise the vision of DAP-2020, augmented by technological advancements and the refinement of Government policies in the interim, towards ease of doing business and the provision of a level playing field to the defence industry, it is a bare essential requirement to encapsulate all these in the revised DAP.

# Chapter 2: What is MBAcq

## What is MBAcq: From Document to Digital

MBAcq is a fundamental re-engineering of how we define, develop, procure, maintain, sustain, upgrade, and eventually phase out complex systems. For the teams shaping the future of the Defence Acquisition Procedure (DAP-2025), understanding this paradigm shift from first principles is essential.

## Redefining the "Source of Truth"

- At its absolute core, Model-Based Acquisition is built on a single, revolutionary principle: shifting the authoritative source of truth from a collection of static documents to integrated digital models.
- In the traditional, document-centric world we know, the system's technical baseline is defined by a library of disparate artefacts: the SQR, the System Specification, Interface Control Documents (ICDs), test plans, and contracts.
- The documents are an imperfect, often inconsistent, and manually synchronised attempt to communicate that mental model.
- **MBAcq inverts this.** The primary engineering effort shifts from writing system documentation to building and maturing a digital model of the system. These models, a rich, data-centric, and machine-readable representation of the system's requirements, architecture, and behaviours, become a binding source of truth. Documents are not eliminated; their role is transformed: they become auto-generated reports, or "views," of the authoritative models, ensuring consistency, accuracy, and efficiency by default through a central point for data access and updates. This single change has profound and cascading benefits across the entire acquisition lifecycle.
- With increased focus and priority on indigenous categories such as Buy (Indian IDDM) and Buy (Indian), the applicability of MBAcq is more so compared to lower categories of acquisition, primarily as it involves designing and development from scratch, where the benefits of such a system can contribute to the maximum.

*Key Insight: The only place where a truly holistic, integrated understanding of the system exists is in the minds of the acquisition agencies. The understanding is adversely affected by the frequent moves of key officials handling a protracted acquisition case. MBAcq provide a binding source of truth for acquisition agencies that is discernible.*

## MBAcq in the Procurement Process

For the DAP-2020 review team, the critical question is how this translates into the practical, legal world of RFPs and contracts. The international community, through bodies like the **OMG MBAcq User Group**, has developed a standardised approach. Instead of paper-based RFI and RFPs, the government issues a model-based package. This digital package contains two key parts:

- **The Objective Architecture Description (OAD):** This is the model created by the government programme office. It digitally captures the specific requirements, operational context, Key Performance Parameters (KPPs), Test Methodology Plan and other important metadata for the system being acquired. It essentially identifies and digitises the Critical, essential and desirable parameters.
- **The Architecture Acquisition Guidance (AAG):** This is a reusable, standardised model template that provides the process for the acquisition itself in a digital format. It includes predefined patterns for how bidders can propose their solutions and how their models will be evaluated against contractual sections. This will also include digital artefacts of standards to be followed, as well as the different annexures that the vendor has to provide, which will be available in a digital format *(eg, Annexure that captures the percentage of indigenous content)*

*Key Insight: Industry bidders receive parts of the digital package at different stages, allowing them to populate models with their design and submit responses. This creates a clear, traceable link from the government's requirement to the contractor's proposal and evaluation criteria. It de-risks source selection by reducing ambiguity compared to traditional document proposals.*

## Case Studies and Impact

The theoretical advantages of Model-Based Acquisition and Digital Engineering are validated by a growing body of evidence from major global defence and aerospace programs. These real-world use cases demonstrate not just the feasibility but the transformative impact of adopting a model-centric approach. For Indian policymakers, these examples provide a clear blueprint of what is possible.

*Object Management Group® Standards Development Organisation (OMG® SDO) is an international (27 countries), membership-driven (230+ organisations) and not-for-profit consortium.*

### Use Case: Accelerating Development & Analysis

- **The U.S. Air Force T-7A Red Hawk:** Developed jointly by Boeing and Saab, this trainer aircraft was designed and built in a fully digital environment. The initial results were staggering: the program went from concept to first flight in just 36 months, with an 80% reduction in assembly hours for major components. This demonstrates the raw power of digital engineering to accelerate development timelines, a critical advantage in a contested geopolitical environment .
- **The B-21 Raider - A "Born-Digital" Pathfinder:** The B-21 Raider program stands as the U.S. Air Force's premier example of a "born-digital" acquisition, serving as a pathfinder for the successful implementation of a model-based paradigm on a highly complex and classified program. From its inception, the bomber was designed and built using a comprehensive digital thread and an authoritative digital twin. This approach allowed engineers to perform extensive virtual testing and design validation, significantly maturing the system before the first physical aircraft was ever built. The digital thread extends directly to the factory floor, where advanced manufacturing techniques link production directly to the master design models. While specific metrics are not public, the Air Force and Northrop Grumman have consistently cited the B-21's digital approach as a key factor in mitigating production risk, improving build quality, and creating a sustainable platform designed for rapid, model-based upgrades, making it a benchmark case study for future acquisitions .
- Royal Australian Air Force: Air Combat Program (ACP)
  - Concept and velopment Analysis. The ACP has established a process for analysing wide-ranging mission characteristics, including modelling relevant red and blue systems-of-systems and force employment (CONEMP) design concepts to complete missions. These concepts are validated using computational simulations. This process supports the ongoing requirement to reassess Air Combat capability preparedness in response to identified emerging threats or in response to calls from the Joint Force Authority to design force employment options for missions based on the ADF Theatre Concept.

The Red Hawk, a joint effort between Boeing and Saab, is the first Air Force aircraft to use digital design tools to allow it to move from computer screen to first flight in 36 months." *https://www.af.mil/News/Article-Display/Article/3014351/first-t-7a-red-hawk-rolls-out/* -
"Through the digital ecosystem, the Northrop Grumman team has realised a 50% reduction in time to certify software in the lab. Similarly, flight test teams are validating aircraft performance in real time rather than days of post-mission processing and analysis. This speed and efficiency power a robust flight test cadence."
*https://www.northropgrumman.com/what-we-do/aircraft/b-21-raider/need-to-know &*
*https://news.northropgrumman.com/b-21-raider/b-21-highlights-strong-performance-through-innovative-technology*

- The ACP intends to modernise this process by using digital engineering practice, so that every capability gap, opportunity, as well as capability investment decision can be readily demonstrated with authorised data in a repeatable fashion, and traceable across all layers of SoS architectures .

## Use Case: Reforming the Acquisition Process & Growing the Ecosystem

The U.S. Army's Optionally Manned Fighting Vehicle (OMFV) : The U.S. Army's OMFV used a revolutionary approach by awarding contracts for digital concept designs instead of a traditional RFP. These models facilitated collaboration among the Army, industry, and soldiers to define requirements and analyse survivability, mobility, and thermal signatures through simulation. This de-risked the program, fostered innovation, and exemplified the leveraging of MBAcq for public-private partnerships, as envisioned by Atma Nirbhar Bharat.

## Use Case: Proving the Return on Investment (ROI)

- **Northrop Grumman's "Digital Pathfinder" (Model 437):** In a company-funded project to validate its digital ecosystem, Northrop Grumman designed and built an aircraft wing using a complete digital thread connecting design through simulation-driven manufacturing and advanced assembly. The results provided a clear business case for the approach: engineering rework was reduced to less than 1% (compared to an industry average of 15-20%), and the overall timeline was reduced by 50%.
- **These international examples underscore a consistent theme:** when implemented with strategic intent, MBAcq delivers tangible results. It accelerates schedules, manages complexity, reduces rework, and can even transform the collaborative dynamic between government and industry. These are not just engineering improvements; they are strategic advantages that directly align with India's highest defence modernisation priorities

**Benefits and Challenges of MBAcq:-**

- MBAcq is not a panacea; it cannot fix flawed programmatic assumptions.
- It requires significant upfront investment in training and a profound cultural shift.
- However, the evidence is clear: for managing the complexity of 21st-century systems and certifying their performance, it is the only viable path forward.

*Key Insight: For India, this is more than a technical upgrade. It is a strategic enabler for achieving true self-reliance. By embedding the principles of Model-Based Acquisition into the next revision of DAP-2020, we can lay a digital foundation for a more agile, innovative, and collaborative defence ecosystem, capable of delivering the cutting-edge capabilities our nation requires, validated by simulation and ready for the mission.*

# Chapter 3: Acquisition Journey and Scope for DE Inclusion in DAP

## Phase-wise scope for introducing Digital Engineering

This chapter examines in detail how a model-based approach can assist the current stages of the acquisition process for major capability acquisition. Namely, how will digital artefacts play a role in defining the:-

- Operational Scenario in which the acquired capability has to perform.
- How can the response to the RFI be digitally consumed?
- How can SQRs be refined and formulated by digital analysis?
- How can digital artefacts assist the Acceptance on Necessity Stage?
- How can the RFP and its technical evaluation be assisted through model-based evaluation?

We will look at each stage systematically with an approach that can be scaled and reused across acquisition and also can be easily adapted to the Defence Acquisition Process as it evolves.

## Request For Information (RFI) Stage

We will look at how model-based acquisition can impact both the RFI creation stage as well as looking at responses.

**RFI Creation Stage.**

- DAP 2020 envisions the RFI stage to explore the suitability of products available to meet the Operational Requirements (ORs) of the Services, and to formulate SQRs, maintenance philosophy, as well as other contractual provisions.
- This is a **very important stage to establish the correct capability that could be acquired for a given operational scenario** and thus gives the ability to correctly capture and refine the service qualitative requirements (SQRs).
- It is **important at this stage to focus on "what needs to be achieved" and not over-constrain "how" it will be achieved**. This will enable vendors to propose technologies and solutions that the Service HQ might not have considered.

*Key Insights: There is a need to capture the following points: (a) What mission context will this acquisition be required to perform? This involves capturing the Concept of Operation (CONOPS) of the system being acquired. (b) What are the metrics that can be used to define the mission's Measure of Success (MoS), Measure of Effectiveness (MoE) and Measure of Performance (MoP) of the acquisition?*

Digital Mission Engineering gives us the ability to define Operational Requirements of an RFI in a dynamic manner, considering the System of Systems. We can define the CONOPS digitally and based on that generate Operational Requirements. The SQRs can be scientifically derived by tracing the path from MoS to MoE to MoP.

This digital operational scenario would serve as a critical reference to the acquisition agencies throughout the acquisition process, from evaluating responses to RFIs, demonstrating SoC, generating a matrix for FET, ability to look at the sensitivity of essential parameters and enhanced performance parameters to mission success and so on.

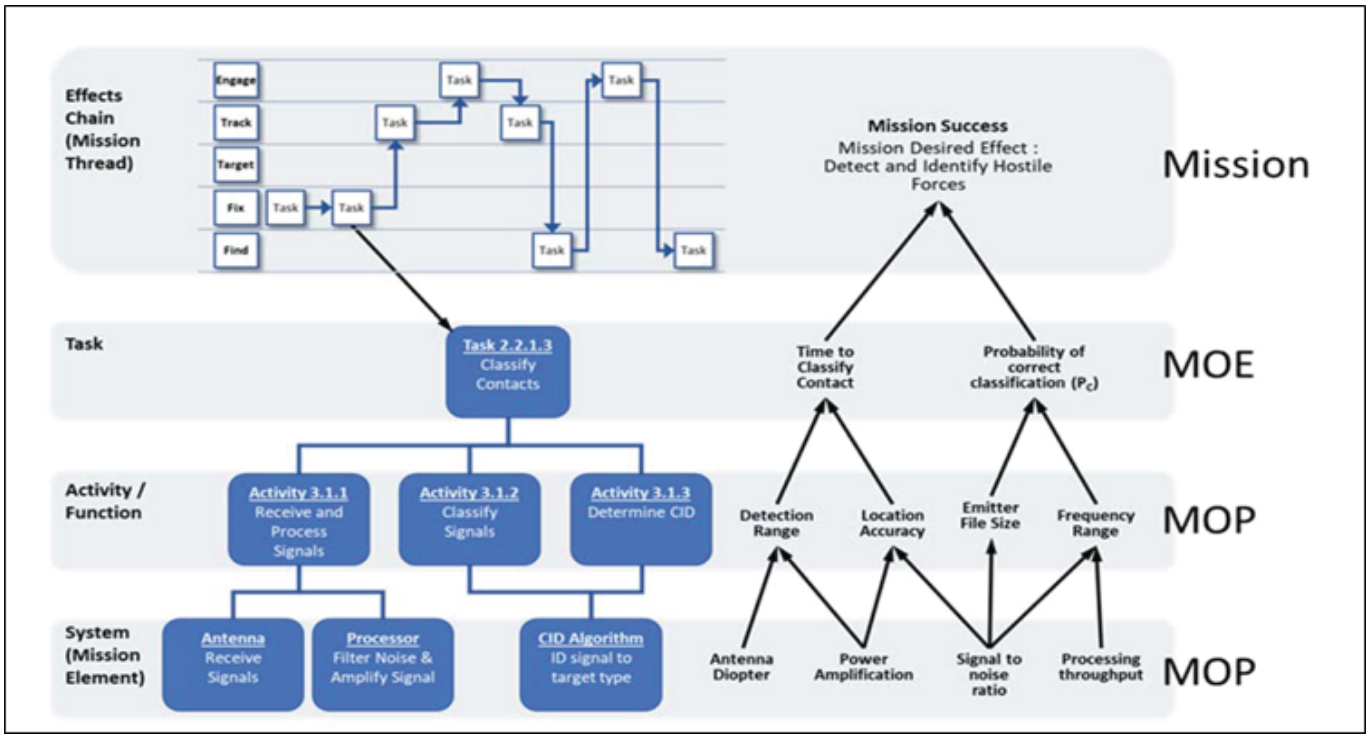



*Figure 4: MoS to MoE to MoP- From the U.S. Mission Engineering Guide*

The very fact that the operational scenario is digital makes it a dynamic artefact to be adapted for any change during the acquisition process to quickly evaluate the impact of the change.

This operational digital artefact can be exposed in the RFI at different levels based on the sensitivity of the operation considered, as well as the ability of the responders to the RFI to consume this digital artefact.

*Key Insight: It is envisaged that initially, this digital operational scenario artefact will be with the Acquisition agencies only. However, responses to the RFI will be sought in a digital format that can be easily consumed and verified within the digital operational scenario.*

## RFI Response Stage

The response to an RFI should shift from a document-based response (refer to Figure 5) to an additional digital response. At the start, the digital artefact can be a simple Excel sheet (refer to Figure 6).

| Parameter | System Description | Vendor to Specify |
|---|---|---|
| | and Secondary Detection Range of Radar to be at least **300 kms or more**. | **maximum range** |
| | (a) Maximum detection ranges for following RCS with a Probability of Detection (PD) of 0.9:-<br>(i) RCS of 2 $m^2$ or less.<br>(ii) for Low RCS (RCS ≤0.2 $m^2$). | **Vendor to specify** |
| | (b) Minimum detection ranges for following RCS with a Probability of Detection (PD) of 0.9:-<br>(i) RCS of 2 $m^2$ target.<br>(ii) for Low RCS target (RCS ≤0.2 $m^2$ ). | **Vendor to specify** |
| **Capability** | Ability to resolve target in four dimensions (4D) namely Range, Azimuth, Height and Doppler Velocity. | **Vendor to Confirm** |
| **Radar Mode** | Rotation and Stare Mode. | **Vendor to Confirm** |
| **RPM** | Antenna rotation rate. | **Vendor to specify** |
| **RPM Change** | Track Maintenance will be provided (within ± 45° from bore sight for staring to rotation mode and vice versa). | **Vendor to Confirm** |
| **Target Update rate** | Target update rate in Rotation and Stare mode. | **Vendor to specify** |
| **Target Tracking capability** | **Target Tracking capability** in Rotation and Stare mode. | **Vendor to specify** |

*Figure 6: Document- Based Response to RFI*

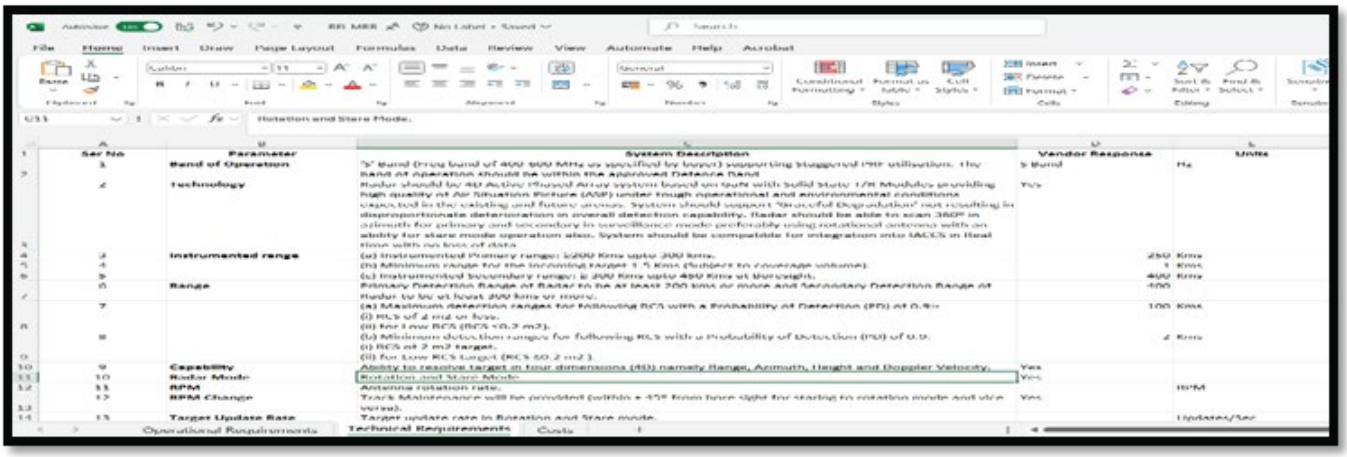


*Figure 5: Excel-Based Digital Response to RFI*

To enable consistent responses, the Excel sheet will be a template that will need specific inputs to be entered against certain criteria. With drop-down menus and specified units of measurement, it would help standardise vendor responses. There will be space to add additional context and comments so that the quantitative inputs can be understood correctly. This will enable consistent inputs, units and definitions across responses.

After all the digital responses to the RFI are received, the acquisition agency will be able to

- **Visualise the trade space for each SQR** by looking at key features (Figure 6).
- **Identify Trends, Correlations and Anomalies.** Once the various responses to the RFI are fed into the digital scenario, they can be viewed holistically in a visual format. It will be easier to identify trends in responses, correlations between parameters, and, very importantly, anomalies or aberrations that can be quickly checked and updated.
- **Gap Analysis (Comparative Analysis of Specifications, including Global Capability).** This trade space exploration will also enable us to visually see and examine the gap between what was sought in terms of attributes of planned SQRS versus what is available based on the responses, as well as certain global capabilities that exist.

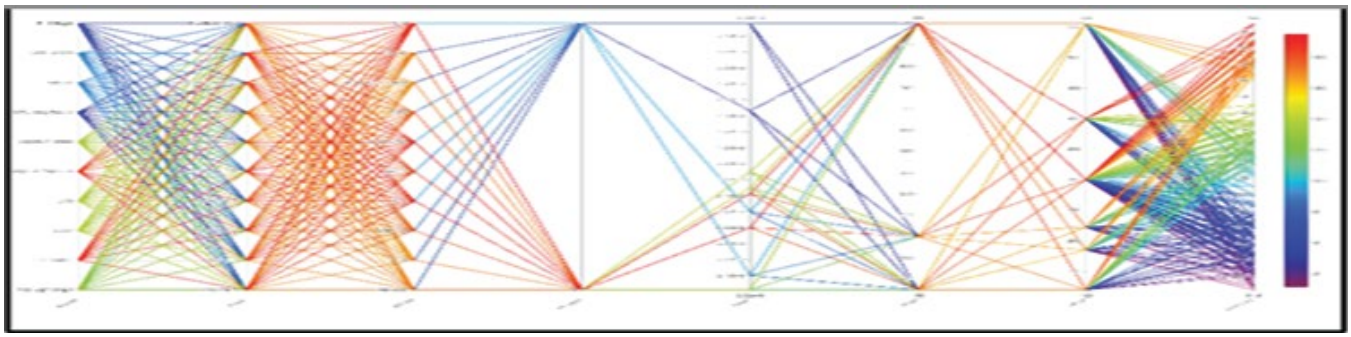


*Figure 7: Digital Artefact*

- **Carry out Multi-Objective Optimisation to uncover Pareto Front**. Depending on the need, weights can be assigned to determine the optimal capability and fine-tune and refine the SQRs. These weightages can be based on performance parameters, Costs, Time to acquire, Maintainability, Indigenisation ability, and so on. A multi-objective optimisation can then be carried out to determine the Pareto front, enabling the identification of optimum points to be studied further (refer to Figure 8).

*Figure 8: Define weightages and generate a Pareto front to view optimum points*

**Ability to refine SQRs.** It generates:-

- **Essential Parameters**. Based on the optimal point selected in the previous study, the essential parameters related to operational, technical, maintainability, and ergonomic aspects can be determined and included in the RFP.
- **Enhanced Performance Parameters and credit scores weightage**. Similarly, we can determine which enhanced performance parameters to consider based on their impact on the mission. Also, a sensitivity study can be conducted with respect to mission metrics to determine the proportion of credit weightage to be assigned to each enhanced performance parameter.

**Ability to Redefine the Operational Scope Given the Responses Received**. The initial operational scenario might have been created based on prior understanding of available capabilities. However, upon receiving responses to the RFI, the operational scenario may be expanded to enhance the mission objectives. This will be easily verifiable in a digital mission context, and an augmented operational scenario could be envisaged and included in the RFP.

**Ability to Answer Vendor Questions Quickly by Doing an Operational Analysis**. Often, one notes that the response to RFI will have elements that have been proposed that are new, beyond the bounds specified, or a configuration that is different from expected. At the same time, the vendor might claim that it meets the RFI's intrinsic objective. The traditional response we have seen to this is that "the vendor can propose an alternative and needs to show that it meets the need". While this is understandable given the constraints of time, the ability to verify, and so on, it is not desirable, and, in a way, delaying a check that will need to happen further down the road will cause potential iteration and delay for all parties. A digital operational analysis will make it relatively easy to check which alternative is being suggested and whether it meets the overall mission objectives. This will catch any challenges that will emerge later.

## SQRs Stage

The framing of the SQRs post-RFI stage forms a critical part of the acquisition process. As per the DAP 2020, the following points are important. In *blue italics* **under those points are how the model-based system will add value:**

- **The SQRs that need to be realistic, achievable and verifiable and must avoid ambiguity of any type**
  *By digitally connecting the SQRs to the operational digital scenario, we can ensure traceability from the MoS to the MoE to the MoP and to the SQRs. This will help to ensure that the SQRs are realisable and verifiable as they have already been digitally tested in a mission. Also, ambiguity is avoided by seeking very specific inputs with consistent definitions and units so that the digital operational scenario can consume them.*

- SQRs must not be tailored from or for a particular product or service and must result in the procurement of the items that best meet the requirements of the Services.
  *This can be digitally verified by capturing "what" needs to be done, not "how" it should be done, thereby keeping the trade space and/or design space large. This will give additional flexibility to propose alternate possibilities of potentially superior technology to surpass mission success needs.*
- The SQRs would be based primarily on operational, technical, maintainability, ergonomic and enhanced performance parameters.
  *This will be digitally discovered by deriving it from the Use Case/Mission and its impact on different aspects of the system, including performance, maintainability, and so on. As described earlier, there will be a digital thread linking the Mission Parameters to the Operational Parameters and, finally, to the System Parameters.*
- The parameters of SQRs, which are generated through the RFI process, are classified as: Essential Parameters A (validated at FET), Essential Parameters B and Enhanced Performance Parameter (EPP) (Influences Credit score multiplier 0.9-1).

These SQR parameters can be digitally established through a sensitivity analysis of the various parameters on digital mission success. This will help classify Essential Parameters A and Essential Parameters B. The EPP can also be determined and evaluated digitally. The credit score multiplier can be assigned based on the weight assigned to each enhanced performance parameter. This can be done in a scientific and traceable manner by linking it to sensitivity to mission success.

## Acceptance of Necessity (AoN) Stage

As per the DAP 2020, when the size and nature of the acquisition reach a certain size, the Defence Acquisition Council (DAC) accords approval for AoN. The DAP suggests that, to seek AoN, the SHQ will conduct detailed internal consultations and prepare a SoC. Also, it states that a copy of the approved SQR/JSQR, along with the "Comparative Analysis of Specifications" for similar products available globally, will be submitted for AoN.

The SoC in itself is quite a detailed document, which needs to articulate clearly how the mission is currently undertaken, what the gaps are, how this deficiency of capability cannot be overcome by only a change of doctrine without any material addition, how this new capability will mesh with our current capability, how it will be maintained, and so on. DAP 2020 also refers to simulation-based trials that can be captured in the SoC for approval by the AoN, where FETs are not possible.

A model-based approach provides a unique ability to give a clear perspective on all these concepts. It can be shown at a high level to stakeholders who might be more interested in "what" can be achieved through some clear visualisation of the mission, as is, and the mission to be with this new capability. At the same time, it can also cover the "how" in detail, demonstrating the impact of the SQRs on the mission, examining what-if scenarios, available courses of action enabled by this new capability, and so on. It can also clearly show how this new capability compares with what is available globally.

## SoC Preparation Stage

Let us examine how MB Acq can influence both the SoC and the Comparative analysis as part of the AoN. It is possible to digitally capture the following in SoC to give more context and insight to DAC:

**How is the Mission Currently Undertaken?:** Today's battlefield is a congested, constricted, and contested system-of-systems environment (refer to Figure 9). To truly see capability or gaps, the acquisition must be evaluated in the complete mission scenario where all layers of assets are captured for both the blue and red forces. It is also important that the capability is tested under various what-if conditions, and that courses of action emanate. Digital Mission Engineering provides an excellent platform for capturing various CONOPS.

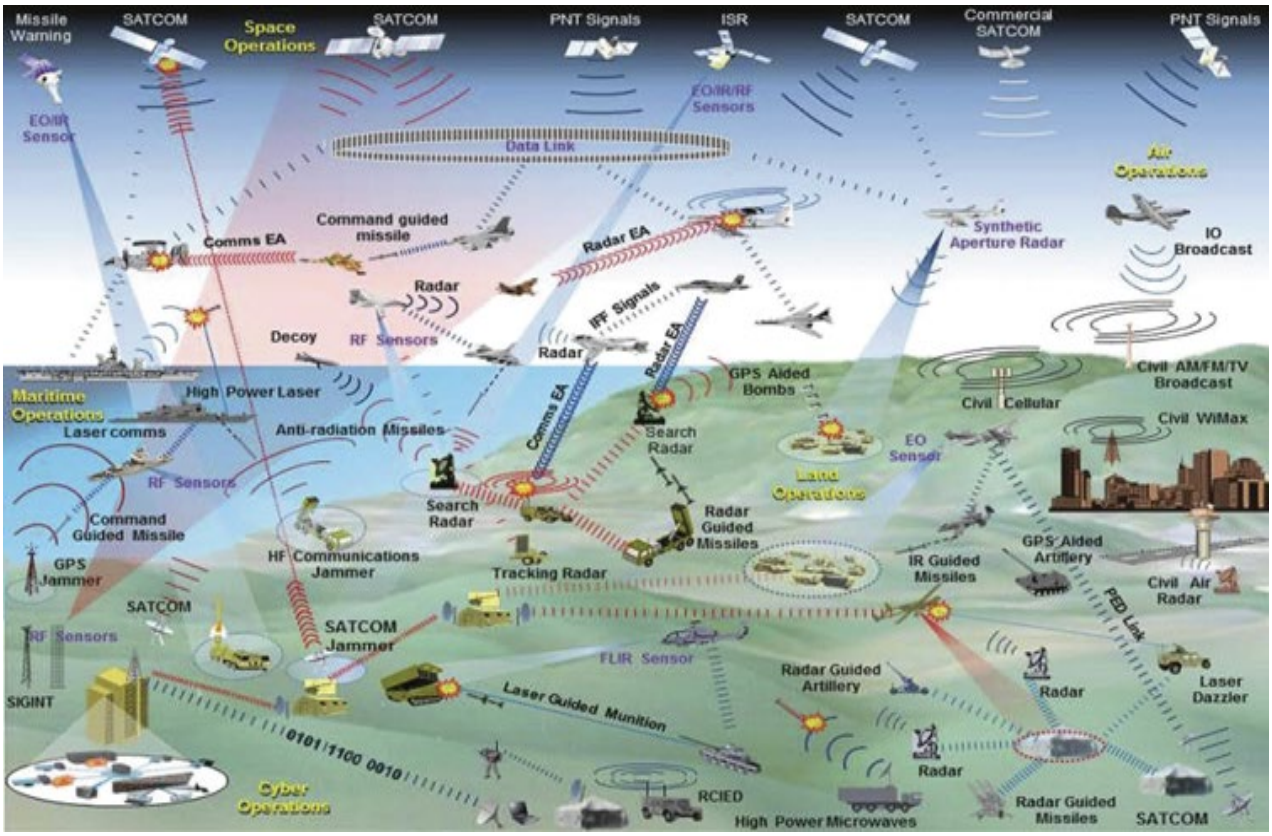



*Figure 9: Depiction of Congested, Constricted and Contested Multi-Domain Environment*

**Highlight gaps and challenges in meeting Mission Metrics.** It is possible to demonstrate digitally that a change in doctrine alone cannot overcome the void and the need for a Material solution. We can quantify the impact by first optimising mission metrics (for instance, time to detect an intrusion) by changing doctrine and seeing the best metric we can achieve with current assets.

**Demonstrate digitally what the new Material solution is proposed, showing.** We can then add the new capability we are looking to acquire digitally in the CONOPS and then see how these metrics change.

**Comparative Analysis of Specifications Study.** Using a digital approach, we can capture the following in Comparative Analysis of Specifications by:-

- Create Spider Gap Analysis Chart of Specifications.
- Comparing globally available specifications with currently achievable specifications.
- Digitally show the comparative capability of adversaries for a similar mission, both in offence and defence.
- Determine metrics at each level of MoS, MoE and MoP.
- Determine derived metrics of advantages/disadvantages for all operational scenarios:
- Different locations/ terrain/ altitudes
- Different weather conditions
- Different Concept of Operations/Courses of Action

## Request for Proposal (RFP) Stage

At the RFP Stage, similar to the RFI stage, we can shift from a pure paper submission-based approach to also include digital artefacts. Here are some ways in which a model-based approach at the RFP stage can make the process more insightful as to what the final capability acquired.

The compliance table that needs to be submitted as part of the RFP should be captured in Digital form, including quantitative data of both Essential Parameters A and B, and EPP captured digitally to calculate credit scores

The Trial Matrix, which will be part of the RFP's Trial Methodology, can be derived from the Digital CONOPS. The mandatory test points to be carried out in Field Tests can be listed, and optional test points can also be suggested for simulation.

The Physical Demo expected in the Field can be articulated clearly in the RFP scope by providing an animation/simulation of the test procedure that is desired, in addition to the documented field test, so that there is no ambiguity as to what a successful field test in the RFP is.

## Evaluation of Technical Offers Stage

- The Technical Evaluation Committee (TEC) can digitally evaluate vendors' technical responses.
- Compliance Matrix, along with EPP digitally evaluated for all vendors in the context of the digital mission:
  - The digital Models used to check the validity of parameters supplied by Vendors.
  - Comparative insights created of different metrics (MoP>MoE>MoS)
- Digital Reference Missions and Analysis are used for Vendor interaction where there is ambiguity in response
  - To modify technical details based on submissions to be in line with the mission input format
  - Contextualise and refine SQRs without dilution
- Digital capture of Certification of Conformance (CoC) along with test standards and test results, graphs and accredited lab certifications
  - Key characteristics of these tests captured digitally to be consumed for analysis
  - Ensure the supplied performances are realistic and meet mission success parameters

## FET Stage

- The physical and digital Trial Methodology, as defined in the RFP, can form the basis of the FET stage. The
  - Ministry of Defence (MoD) is looking to reduce the time of field evaluation trials, which can often take a couple of years, by using simulations. This can be envisaged by:
  - Use Mission and Digital Engineering to establish Test Methodology Plan.
    - Derive tests and parameters based on Mission Success.
    - Share with Vendors Trial Matrix plus Mission Success Criteria.

    Identify supporting simulation test plans.
  - Identify simulation plans that can be done instead of test trials.
  - Having the ability to ingest FETs back into the design reference mission to check for validation.
  - Ability to calculate the variance of test results between field tests and simulation to verify and certify simulation results.

## Operations and Beyond

- MBAcq and DE play a critical role in post-acquisition as well. The digital models of the asset in various forms and fidelity play a critical role in digitally looking at how:
  - It is deployed by using the models as part of the war gaming scenarios.
  - The digital artefacts, like geometry, radar cross section, thermal signatures, and electronic signatures, can be used to be able to perceive these assets by our sensors as well as understand what our adversaries an detect.
  - It helps us to create a prognostic health model of our assets based on their telemetric readings to under stand the state of health of the asset. It could assist with the product's lifecycle management.
  - It helps us to get insight into how to plan as a result of downtime, safe operation and so on.
  - The digital artefacts can also be evaluated for upgradation and to check the impact that will have on the mission scenario.

  In short digital assets not only help in acquisition but also in safe operation and serve as the foundation for seeing how the asset can be upgraded further as well as decide end of life for the asset.

# Chapter 4: Key Challenges in Implementing MBAcq

## Setting the Context: Challenges in Implementation

Switching from paper-based methods to Model-Based Acquisition (MBAcq) is a major change that promises to deliver projects faster, at a lower cost, and with better results. However, this is not a simple technical upgrade; it is a major shift in how people work and think, and it comes with significant challenges. For India's defence acquisition leaders and the team revising the DAP, it is critical to plan for these hurdles. Ignoring them can lead to failed projects, wasted money, and new risks for our country's most important programs.

The section below explains the "how" of making the switch to MBAcq by focusing on the biggest challenges: Intellectual Property (IP) rights, cybersecurity, data format compatibility, and managing the people involved.

The acquisition process begins with the RFI stage, proceeds through the development of SQRs, and ends with the issuance of the RFP. The entire process is conducted manually and often struggles to capture, represent, and interpret data effectively, resulting in delays and increased subjectivity.

The subjectivity and ambiguity induced in the RFI – RFP process manifest at the stage of evaluation of technical bids. At the trial stage, the challenges multiply due to the vast scope and reliance on physical testing or any other specified trials. The challenges compound when an indigenous product, developed for the first time, suffers multiple failures during trials, necessitating its return to the assembly table or even the drawing board at times.

It is felt that these challenges can be mitigated to a great extent if DE tools are employed from the very start of an acquisition project. In a departure from the capabilities available with the Indian industry a few years back, the capability and physics of creating a Digital Twin now exist at an affordable cost, which could undergo proving of QRs as well as trials by simulation to arrive at the most appropriate solution for development and use by the armed forces.

## Intellectual Property (IP) Rights

Creation and possession of Intellectual property (IP) is one of the key aspects of creating an indigenous defence ecosystem. IP affords ownership of a product and paves the way for its upgrades and modifications in future versions. DAP 2020 lays down the primacy of creating IP in indigenously designed, developed, and manufactured equipment, and encourages the purchase of IP rights for technology and equipment purchased from foreign OEMs.

Para 3 of Chapter 3 of DAP 2020 specifies that “To enable Indian industry to leap frog to higher or complex technology, cases where Indian companies either hold the IPR, including where it has been acquired from the foreign companies, or have the ownership of the design of the main system/equipment, will be deemed to be indigenously designed and developed.”

A product designed and aided by indigenous DE support would also fall in this category with its IP residing in India, thereby giving a boost to indigenously designed, developed and manufactured weapons and equipment for the armed forces.

In the old, document-based world, it was easy to identify a company's Intellectual Property - the design drawings, the software code, and the technical manuals. In a model-based world, IP gets much more complicated. It's not just the final design; it's also in the reusable model parts, the unique simulation methods, and the structure of the whole system model.

**Our current contracts are not designed to handle this new type of digital IP.** The main idea of MBAcq is to have a single, integrated digital model that the government can access. This creates a problem for companies that need to protect their secret designs and methods, which are now part of that model. This leads to the following tough questions:

- Who owns the final model? When many companies (such as a prime contractor, an engine maker, and an electronics supplier) add their private models to a single large system model, who owns the final, combined product?
- How do we protect the "secret sauce"? How can a company share a detailed model of its component (e.g., a radar) for a system-wide simulation without revealing the secret design features it spent years and a lot of money developing?
- What are the government's rights? What does "Government Purpose Rights" mean for a digital model that is always changing? Can the government use the model to figure out how a component is made, or share it with a rival company for future upgrades?

*Key Insight: As companies fear losing control of their IP, they may be unwilling to share their best models, thereby defeating the whole purpose of MBAcq.*

**Policy Ideas for DAP-2020:**

- To make MBAcq work, the IP sections of defence contracts need a major update.
- **Create Different Levels of Data Rights**: Make new categories for digital models. For example, "Black Box" models could be used for system-level simulations without showing how they work inside. "White Box" models would show everything.
- **Write Clear Contracts:** The next DAP must have standard contract templates for MBAcq that clearly state who owns what, what the usage rights are, and how different types of models will be protected.
- **Use Secure Digital Workspaces**: Require the use of secure, government-controlled online environments. Companies can "plug in" their secret models for analysis in this space without having to hand over their core IP.

*Key Insight: This challenge is universally recognised. The U.S. DoD Digital Engineering Strategy explicitly requires acquisition strategies to "address the approach for acquiring and managing the necessary data a nd model rights." Australia's Digital Engineering Strategy highlights collaboration with industry as a core goal, a process that hinges on establishing clear IP frameworks. The Object Management Group (OMG) MBAcq User Group contributes to the solution by standardising the structure of model-based RFPs, creating a framework for clearly and consistently defining data rights and IP deliverables.*

## Cybersecurity & Data Protection

- Having a "single source of truth" is a double-edged sword. It helps manage the project, but it also consolidates the entire plan for a weapon system in a single digital location, making it a very valuable target for spies, hackers, and cybercriminals. A security breach is no longer about stealing one drawing; it's about stealing the system's entire digital DNA.

  The digital thread connects dozens of organisations, which creates many more opportunities for cyberattacks. The risks are serious:

  - **Data Theft (Spying)**: Our enemies are very interested in stealing the main system model. A successful attack could give them the complete design and performance details of a new fighter jet or warship before it's even built.
  - **Data Damage (Sabotage):** Even more dangerous is the risk that an enemy could secretly change the model. They could insert a hidden flaw, such as changing a material's strength or adding a secret bug to the software, that isn't caught in virtual tests but causes a major failure in the real world.

*Key Insight: As companies fear losing control of their IP, they may be unwilling to share their best models, thereby defeating the whole purpose of MBAcq.*

**Policy Ideas for DAP-2025:**

- **Require a "Zero Trust" Security Model**: The main rule must be "never trust, always verify." Every user and every device trying to access the digital thread must be constantly checked and approved.
- **Create a Defence Acquisition Digital Environment**: By enhancing GeM or setting up an independent environment, the government should build a secure, private cloud for all model-based procurements.

Cybersecurity is a foundational pillar of all allied digital strategies. U.S. DoD 5000.97, "Digital Engineering," mandates that the digital ecosystem must "protect critical program information from compromise." NATO's Digital Transformation Strategy emphasises that its digital initiatives must include robust cybersecurity and cyber defence aspects. This shows a clear international consensus that the benefits of digital engineering are only achievable if the underlying digital infrastructure is secure by design. We shall have to design such robust cybersecurity protocols to ensure data autonomy.

## Interoperability & File Formats

A digital thread is only as strong as its weakest link. For information to flow smoothly from one stage of a project to the next (e.g., from design to manufacturing), the software tools used at each stage must be able to communicate seamlessly with one another.

The world of digital engineering has many different software tools from various companies for design, simulation, and project management. These tools often use their own special file formats, which causes two big problems:

- **Vendor Lock In**: If a main contractor uses one company's software, it can force all smaller partners to buy the same software. This makes it hard for new or smaller companies to join the project and runs counter to the goal of growing India's defence industry.
- **Data Translation Mistakes**: When data is converted from one special format to another, information can be lost or changed. This breaks the digital thread and forces engineers to re-enter data by hand, which brings back the exact inefficiencies and mistakes that MBAcq is supposed to fix.

**Policy Ideas for DAP-2025:**

- **Require Open Standards**: To create a fair system where everyone can work together, the DAP should require the use of open, neutral standards for all digital work.
- **Make Interoperability a Key Factor in Procurement**: When choosing a contractor, the government should ask them to prove that their tools can share data using these open standards. The data provided by different sub-vendors/contractors must 'speak' to each other's data formats.
- **Support a "Best Tool for the Job" Approach**: Policy should encourage teams to use the best software for a specific task, no matter which company makes it, as long as it uses open standards. This encourages competition and better tools.

*Key Insight: Interoperability is a primary goal for all allied defence organisations. NATO's Digital Transformation Strategy is fundamentally about ensuring interoperability across the 32 member nations, which is impossible without common standards. The U.S. DoD Strategy likewise focuses on establishing an "enabling infrastructure and environment" that supports data sharing. This global emphasis shows that mandating open standards is the internationally accepted solution to the problem of vendor lock-in and data silos.*

## Stakeholder Management & Cultural Change

The best digital tools are useless if people don't want to use them or don't know how. The biggest challenge in switching to MBAcq is not about technology; it's about people.

The defence acquisition world has been built on documents for decades. Changing this culture is a huge task. Key impediments in its implementations are:

- **Resistance to Change:** This is probably going to be the biggest challenge in bringing such change. There will be pushback from certain sections across all stakeholders.
- **The Skills Gap:** Most people working in defence today do not have the needed skills in digital modelling and data management. There is a major shortage of "digital engineers."

**Policy Ideas for DAP-2025:**

- **Leadership Must Drive the Change:** Leaders must demand the change, but they must also provide massive support for training and development.
- **Start a National Training Program:** India needs a national plan to train thousands of people in digital engineering across the Services, DRDO, DPSUs, and private companies. This should be a key goal for all defence organisations.
- **Use "Pathfinder" Programs:** Choose a few important but manageable projects to be the first to use the new methods. Give them the best people and support, and then share their success stories widely to show everyone the value of the new approach.
- **Carefully Pilot execution:** The initial pilot could simply be bringing in RPF in digital forms, like the example used in this report, to enable data comparison and benchmarking and accelerate TEC processes.

*Key Insight: The human element is explicitly recognised as the most critical factor in every major defence digital strategy. Australia's Digital Engineering Strategy lists "Transforming Culture and Workforce" as its very first goal. This international consensus is clear: technological change will fail without a corresponding, and equally well-resourced, investment in people, training, and change management.*

## Change Management - A Phased Implementation Strategy for MBAcq

The challenges of implementing MBAcq are serious. They affect every part of the acquisition process, from contracts and cybersecurity to training and industrial policy. But these challenges can be overcome with smart planning, dedicated investment, and strong leadership.

The scope and complexity of these challenges can appear daunting. Attempting to solve all of them simultaneously across an entire enterprise would be a high-risk endeavour. The following section outlines a phased implementation strategy, a practical roadmap designed to de-risk this digital transformation by allowing organisations to build capabilities, secure early wins, and scale success in a manageable and sustainable manner.

**Phase 1: Pilot & Enablement**

- The primary goal of this initial phase is to prove the value of Model-Based Acquisition (MBAcq) within the Indian context, de-risk the broader transformation, and build a small, highly skilled core team of experts who will become the champions for the new approach. This is a phase of learning and demonstrating tangible benefits on a controlled scale.

**Key Activities:**

- **Select Pathfinder Programs: Identify 2-3 pilot projects.** They should be moderately complex subsystems or new component developments where the benefits of a model-based approach can be clearly measured. An example could be the development of a new avionics suite for an existing aircraft.

- **Form a Core Digital Engineering Team**: Create a small, dedicated, and empowered team comprising personnel from the relevant Service, DRDO, a DPSU, and select private industry partners. This team will be intensively trained in the necessary tools and methodologies (e.g., SysML).
- **Develop a Pilot "Model-Based RFP":** Work with the legal and contracting teams to create a trial model-based contract for the pilot project. This will help identify the practical challenges in adapting current contractual language.
- **Measure and Document Everything:** The most important activity is to carefully measure the outcomes. Track metrics like the reduction in requirement-related queries, the number of design errors caught early, and the time saved compared to a similar traditional project.

*Expected Outcome: At the end of this phase, the MoD of Defence will have a proven business case, supported by data from a real Indian project, that demonstrates the value of MBAcq. It will also have a small cadre of trained "digital champions" who can lead the next phase of the transformation.*

**Phase 2: Scale & Standardise**

- Take the lessons, processes, and expertise from the successful pilot phase and begin to scale them across a wider range of programs. The focus shifts from proving the concept to creating the standardised processes, infrastructure, and workforce needed for broader adoption. This is where policy changes in the Defence Acquisition Procedure (DAP) become critical.

**Key Activities:**

- **Incorporate MBAcq into DAP**: Based on the lessons from the pilot phase, introduce specific clauses and annexures that define the requirements for model-based deliverables, data rights, and interoperability standards (like SysML and STEP AP242).
- **Establish a National Training Program:** Setup a COE and launch a large-scale upskilling initiative. The goal is to create a curriculum to train and certify hundreds of engineers, program managers, and contracting officers across the entire defence ecosystem.
- **Develop Standardized Digital Assets:** Create a library of reusable model templates for contracts, system requirements, and common architectural patterns. This will prevent each new project from having to start from scratch.
- **Expand to More Complex Programs:** Apply the now-proven MBAcq methodology to larger and more complex new programs. The goal is to have a significant portion of new "Make-I" and "Make-II" projects utilizing a model-based approach for their initial design phases.
- **Build Common Digital Infrastructure:** Begin investing in the secure, common digital environment where government and industry can collaborate on models without compromising security or IP.

*Expected Outcome: This phase will result in a repeatable, standardised process for conducting MBAcq. The defence ecosystem will have a growing pool of skilled digital engineering professionals, and the necessary policy frameworks will be in place to support a model-based approach as a standard business practice.*

**Phase 3: Digital First**

- To make the model-based approach the default, we require a standard operating procedure for all new complex defence acquisitions in India. The mindset of the entire ecosystem shifts from "document-centric" to "digital first," where the model is universally recognized as the single, authoritative source of truth.

**Key Activities:**

- **Mandate "Digital First" for New Programs:** For all new major capital acquisitions, the default approach will be model-based. A document-based approach would require a special justification. The digital model becomes the primary legal and contractual artifact.

- **Enterprise-Wide Digital Thread:** The common digital infrastructure is now mature and connects all major stakeholders, enabling a seamless flow of data from the initial concept design in a DRDO lab to the manufacturing floor of a DPSU and the maintenance depots of the Services.
- **Leverage the Ecosystem for Advanced Capabilities:** With a mature digital ecosystem in place, the focus can shift to more advanced applications. This includes the widespread use of high-fidelity Digital Twins for predictive maintenance of fielded platforms, and the use of AI and machine learning to analyze models for
- automated design validation and optimization.

  **Continuous Improvement:** The process is now self-sustaining. Data from ongoing programs is used to continuously refine the standardized models, training programs, and digital tools, ensuring the Indian defence acquisition system remains at the cutting edge.

*Expected Outcome: A fully transformed, agile, and efficient acquisition ecosystem that can deliver advanced capabilities to the war fighter faster and more affordably. India will have established a true sovereign digital industrial base, fully realizing the vision of Atma Nirbhar Bharat in the digital age.*

# Chapter 5: Recommendations

**Adoption of MBAcq.** Digital Engineering (DE) is permeating every walk of human endeavour. It is an opportune moment to identify and incorporate DE into the Indian Defence acquisition process to make it more cost and time-effective, as well as more objective. Considering the need for technologically complex, system-of-systems military hardware and the need to remain abreast of technological advancements worldwide, it is but natural to graduate from archaic, subjective processes. Adopting MBAcq could be one such step in the positive direction.

**Initial Adoption to Augment Existing Process.** Employment of DE for defence acquisition in the initial stages is expected to augment, rather than replace, existing acquisition procedures.

**Suitability for Buy Indian (IDDM) and Buy Indian Categories.** Since data and knowledge of input-output protocols, as documented in Interface Control Documents (ICDs) and Application Programming Interfaces (APIs), are mandatory for creating a digital twin, the tools and techniques proposed by MBAcq in this paper would be suitable for use in the Buy Indian (IDDM) and Buy Indian Categories. In addition, it can be gainfully used in Make & Innovation and D&D projects. In acquisition cases involving collaboration with foreign OEMs (FOEMs) and Transfer of Technology (ToT), the FOEMs' willingness to transfer APIs and ICDs as part of the ToT would determine their suitability for the MBAcq.

**Training of Acquisition Functionaries.** MBAcq would introduce changes to existing processes to improve efficiency and reduce costs, both in time and economic terms. This would entail the existing acquisition ecosystem to adapt to the changed procedure. Accepting an alternate system and managing this change are the biggest challenges the implementation of the MBAcq process is likely to face. Deliberations and training of all functionaries can overcome this.

Some functional recommendations at every stage of the acquisition process are enumerated as under: -

- **RFI Stage.** The RFI questionnaire would entail digital responses to a curated set of questions, ensuring uniformity of responses and measurement units. There will be sufficient scope to include additional inputs that the participating industry partners wish to include. This will minimise ambiguity and misinterpretation of the system requirements, capture vendor responses with fidelity, and hasten the industry scan and the preparation of the compliance matrix.
- **SQR Formulation Stage.** The CONOPS of the system being acquired, defined during the preparation of the Statement of Case for the accord of AoN, coupled with the RFI responses, would provide a practical set of QR. These QRs, once weighed against the mission's MoS, MoE, and MoP matrices, would yield realistic SQRs.
- **RFP Stage.** As elaborated in the paper, the Objective Architecture Description (OAD), which essentially identifies and digitises the Critical, essential and desirable parameters, also digitally captures the specific requirements, operational context, Key Performance Parameters (KPPs), Test Methodology Plan and other important metadata for the system being acquired, will form a major input document. Simultaneously, the Architecture Acquisition Guidance (AAG), a reusable, standardised model template that provides the acquisition process in a digital format and includes predefined patterns for how bidders can propose their solutions and how their models will be evaluated against contractual sections, would provide essential RFP inputs. This will also include digital artefacts outlining the standards to be followed, as well as the different annexures that the vendor must provide in digital format, which will capture the percentage of Indigenous Content (IC). Based on these objective inputs, an RFP will be formulated. The essential aspects of the RFP, as covered in the RFP Format laid down in Schedule I to Chapter II of DAP 2020, will be retained in the digital RFP document prepared.

- **Submission of Techno Commercial Bids.** There will be minimal changes at this stage, as the two-envelope bid system for technical and commercial bids will continue. The technical bid would, however, in addition to the laid-down format, include the modalities of submission of a digital twin/ digital model of the equipment for analysis. The commercial bid would also include the cost of developing the digital model. The development of the digital model would, however, continue on a No Cost, No Commitment (NCNC) basis.
- **TEC and Submission of Equipment Under Trial (EUT).** There would be the first major change in the existing process at this stage. Instead of a physical EUT, all compliant vendors would submit a digital twin of the equipment. This digital model will be put through extensive simulation and testing as part of the technical evaluation by an enhanced TEC, comprising representatives from the Service HQ, DRDO, and technical experts from the services or other government or nominated civil agencies. Opportunity would be provided to vendors, at the discretion of the TEC, to carry out minor tweaks or corrections to input/output parameters that do not meet the required standards. The vendors whose digital models meet the specifications will be declared compliant by the TEC. The successful/compliant vendors would thereafter submit the physical prototypes.
- **Trials Stage.** Since major technical parameters would have been ascertained through simulation on the digital twin, the scope of physical trials would be greatly reduced to 'limited validation trials' of parameters that cannot be tested on the digital model and must be physically tested. This two-stage trial process, i.e. a digital trial as part of the TEC and a physical trial subsequently, will have multiple advantages. It will be extremely economical for the vendors as the parameters of the digital model would have been ascertained for their compliance during the TEC; multiple iterations for the physical prototype would not be required. The exorbitant cost of a physical prototype from scratch would be eliminated, encouraging more vendors to participate in preparing and testing the digital model. In addition to being economical, this process will drastically reduce trial time.
- **Subsequent Stages.** The subsequent stages of GS Evaluation, opening of the commercial bids, declaration of L1, Contract Negotiation, CFA Approval, and signing of the contract would have minimal changes and would continue as hitherto. The workflow for MBAcq is at Appendix A and details that need to be incorporated in DAP is at Appendix B.

**Small Pilot Projects.** It is also recommended that, to examine the efficacy of the MBAcq process and to adapt to the learning curve, small pilot projects be undertaken initially through this method, while simultaneously processing the same through the conventional process. This will bring out meaningful comparisons and suggest steps for process improvement. Success in the pilot projects would automatically instil confidence in its further implementation and expansion of scope.

**Financial Incentive.** While the preparation of the Digital Twin has been suggested to be on an NCNC basis to encourage participation from more vendors, delegation of financial powers and payment of a grant for the making of the digital twin, on the lines of prototype development in the Make 1 process, may also be considered at a subsequent stage.

**A Targeted Approach to Policy Implementation is recommended:**

- Announce a National Digital Engineering Strategy that addresses the Complex Defence Acquisition and program management. The US 'Digital Engineering Strategy 2018' , the UK 'Digital Strategy for Defence 2021', Australia's Defence Digital Strategy and Roadmap 2024 and NATO 'Digital Transformation Implementation Strategy (2024)' can help in navigating this policy.
- Introduce "Digital MBAcq" policy/chapter/framework in DAP 2025.
- Mandate Digital System Model for new programs, RFP framework, define standards, and Data strategy
- Launch National Digital Engineering Enablement Program

## Conclusion

MBAcq strengthens India's Atma Nirbhar Bharat roadmap by accelerating digital adoption and generating thought leadership in the development of cutting-edge technologies.

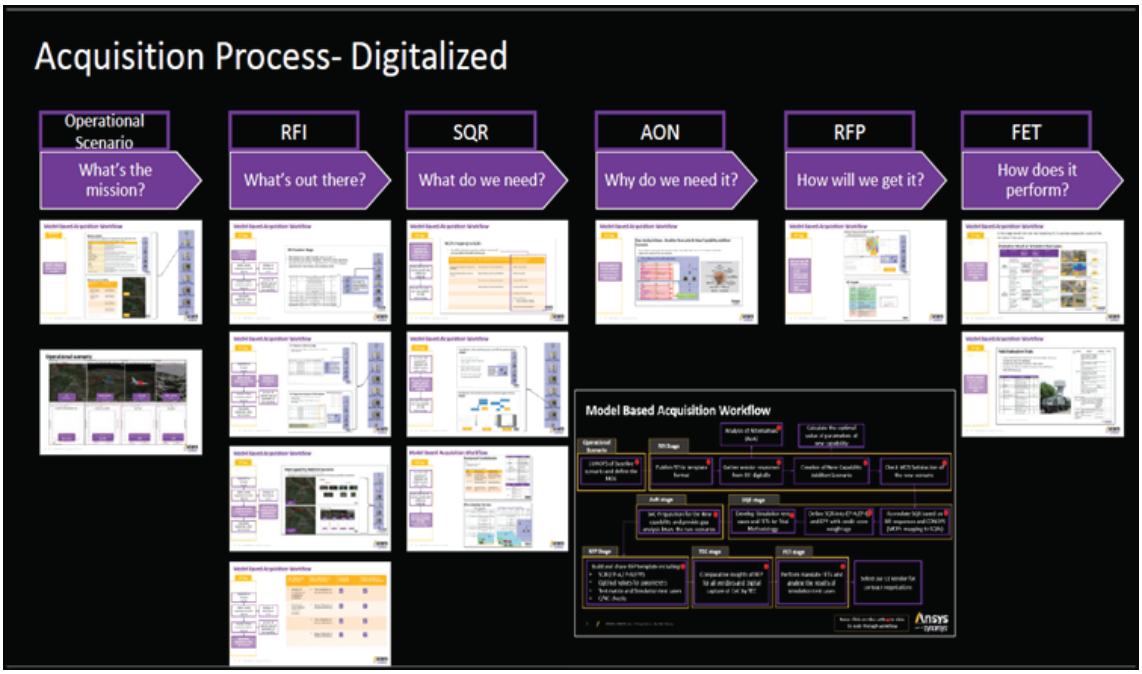
- **Reduces Ambiguity:** Formal models ensure all stakeholders share a common understanding.
- **De-risks Indigenous Programs:** Early flaw detection and virtual testing lower costs and improve predictability.
- **Democratizes Access:** MSMEs and startups can participate via "virtual integration," fostering innovation.
- **Strengthens Atma Nirbhar Bharat:** Builds a robust, self-reliant defence industrial base

While the overload of technical details and a 'fear of the unknown' may look prohibitive for acceptance of the MBAcq, a leap of faith deserves a try, as many other advanced countries have adapted the system with much success. For India, at the threshold of major technological advancements, with a booming economy and on the way to becoming a world leader in defence manufacturing, the time is ripe to move away from the comfort zone and adopt a system beyond a subjective, archaic, document-intensive defence acquisition process.

# Appendix A

*(Refer to Paragraph 5.7 of Chapter 5 of the White Paper)*

## MBAcq in Action




*Digitalised Acquisition Summary (Refer to Figure 2 of the Executive Summary at Page 7)*

## Digitised Workflow envisioned for MBAcq

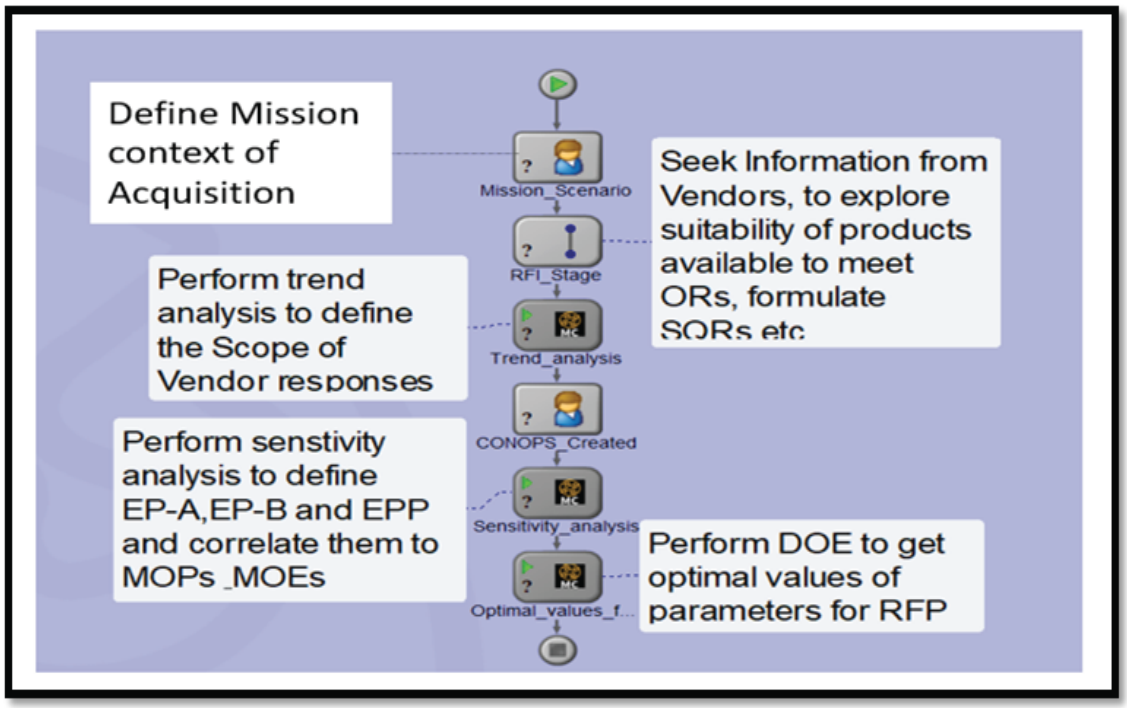



*Figure 10: Digitised Workflow envisioned for MBAcq*

## Mission Scenario

### Mission scenario

- The Mission Scenario guides the RFI for generating the appropriate initial operational requirements for the Medium Range Radar:

| Requirement | Specification |
|---|---|
| Purpose | Air Defense Surveillance |
| Radar Type | 4D Active Phased Array System based on GaN |
| Modules | Solid-state T/R modules |
| IFF System | Integrated IFF system |
| Coverage | 360° coverage under tough environmental conditions |
| Altitude Capability | Deployable at altitude up to 5000 m |
| Surveillance Capability | Primary and secondary surveillance with ability for stare mode operation |
| Additional Radar | X-band radar co-mounted with main antenna for drone detection |
| Display | Common associated/fused display for main and X-band radar |
| Mobility | Vehicle mounted, capable of mobility in all terrains, and air transportable |
| Power System | Independent Radar Energy System with UPS and captive power, capable of high-altitude operations |
| Performance Resilience | Supports "Graceful Degradation" — avoids disproportionate deterioration in detection capability |

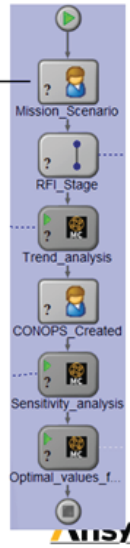



*Figure 11: Mission Scenario*

## Generate Mission Success Criteria for Acquisition and Mapping to Measures of Effectiveness

### Mission Success Criteria

| MOS (MEASURE OF SUCCESS) | MOE (MEASURE OF EFFECTIVENESS) |
|---|---|
| • Detection of Aircraft before it completes its surveillance | • Time of Detection of Aircraft with Pdet>0.8 |
| • Detection of Drones before it crosses our boundary | • Range of Detection of Aircraft with Pdet>0.8 |
| | • Time of Detection of Drones with Pdet>0.8 |
| | • Range of Detection of Drones with Pdet>0.8 |

*Figure 12: Mission Success Criteria for Acquisition and Mapping to Measures of Effectiveness*

## Creating a digital RFI Format linked to the Missions

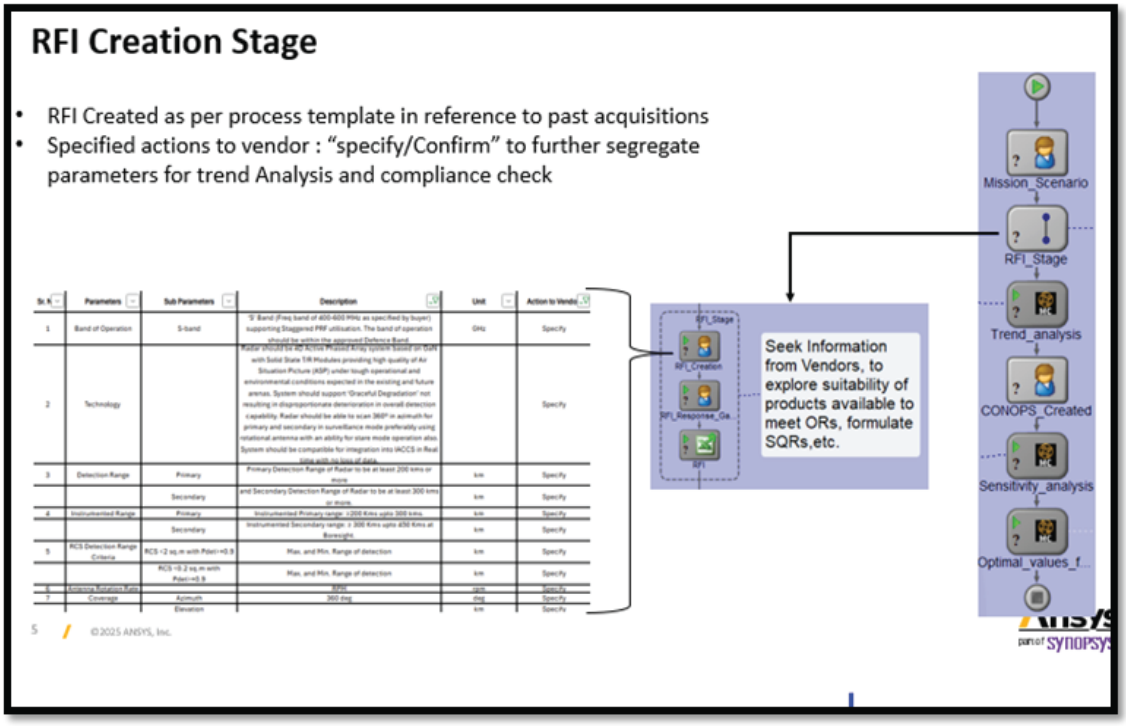



*Figure 13: Creating a digital RFI Format linked to the Missions*

## Using the digital RFI to gather information

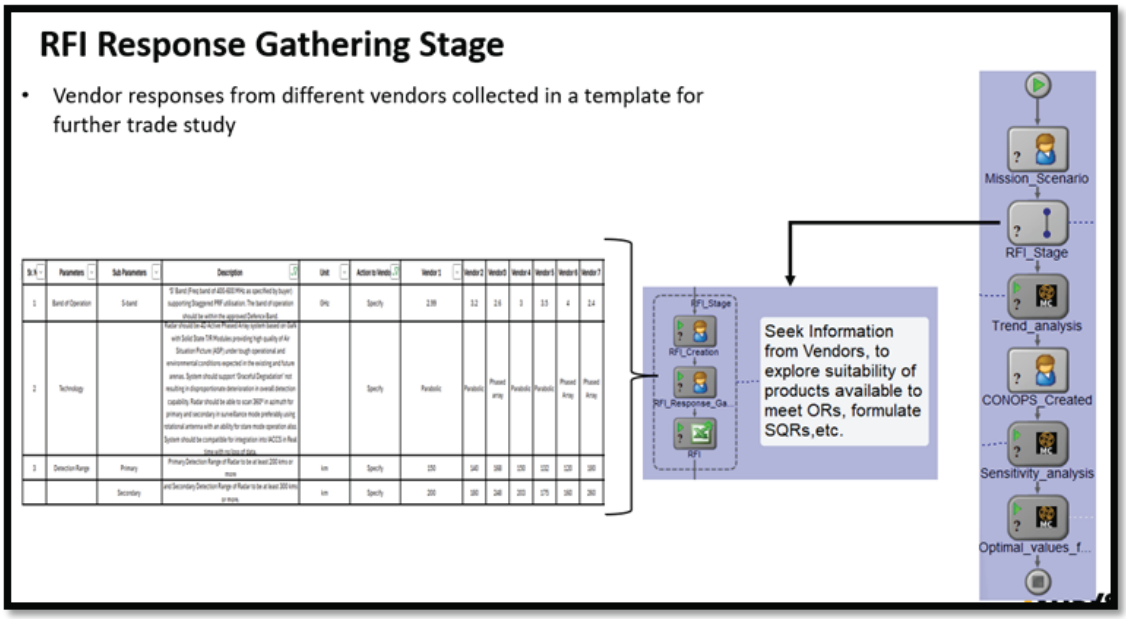



*Figure 14: Using the digital RFI to gather information*

## Identifying Trends in RFI Replies

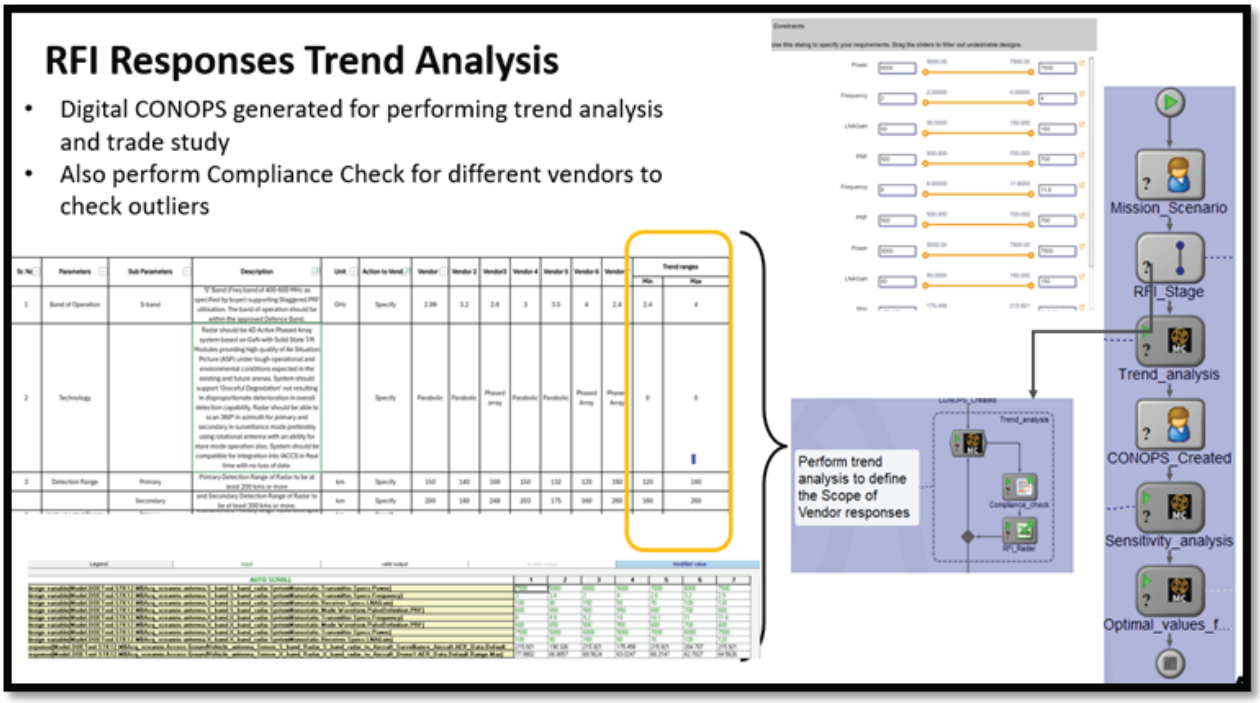



*Figure 15: Identifying Trends in RFI Replies*

## Based on RFI inputs, Refined Mission Scenario

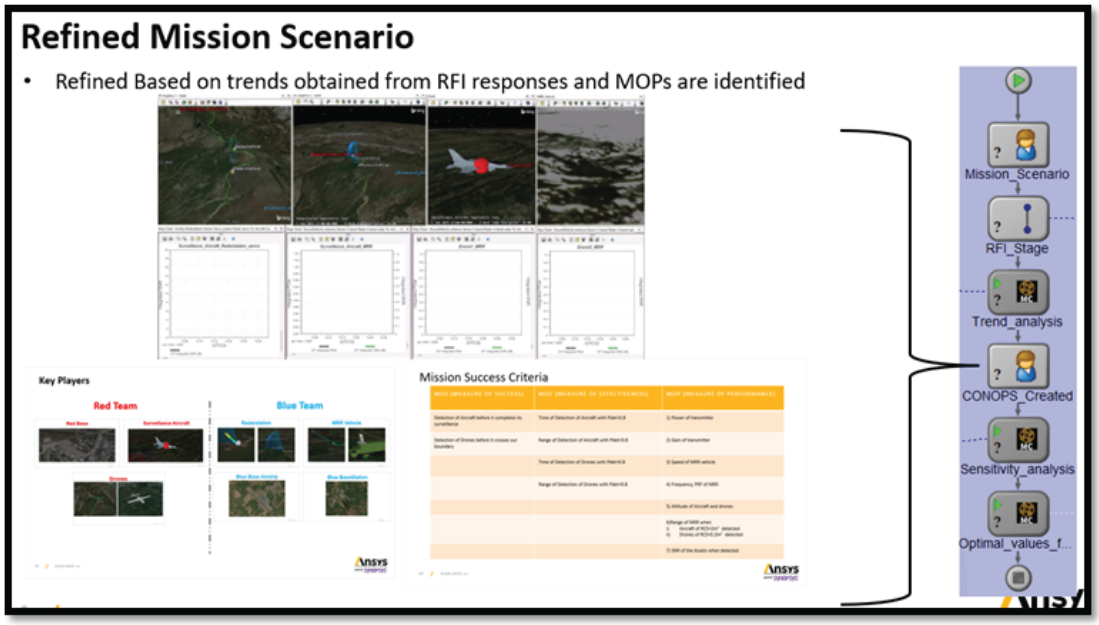



*Figure 16: Based on RFI inputs, refined Mission Scenario*

## Map Mission Success to Measure of Effectiveness to Measure of Performance

| MOS (MEASURE OF SUCCESS) | MOE (MEASURE OF EFFECTIVENESS) | MOP (MEASURE OF PERFORMANCE) |
|---|---|---|
| Detection of Aircraft before it completes its surveillance | Time of Detection of Aircraft with Pdet>0.8 | 1) Power of transmitter |
| Detection of Drones before it crosses our boundary | Range of Detection of Aircraft with Pdet>0.8 | 2) Gain of transmitter |
| | Time of Detection of Drones with Pdet>0.8 | 3) Speed of MRR vehicle |
| | Range of Detection of Drones with Pdet>0.8 | 4) Frequency, PRF of MRR |
| | | 5) Altitude of Aircraft and drones |
| | | 6)Range of MRR when<br>i) Aircraft of RCS>2m² detected<br>ii) Drones of RCS<0.2m² detected |
| | | 7) SNR of the Assets when detected |

*Figure 17: Map Mission Success to Measure of Effectiveness to Measure of Performance*

## Identification of Essential and Enhanced Performance Parameters

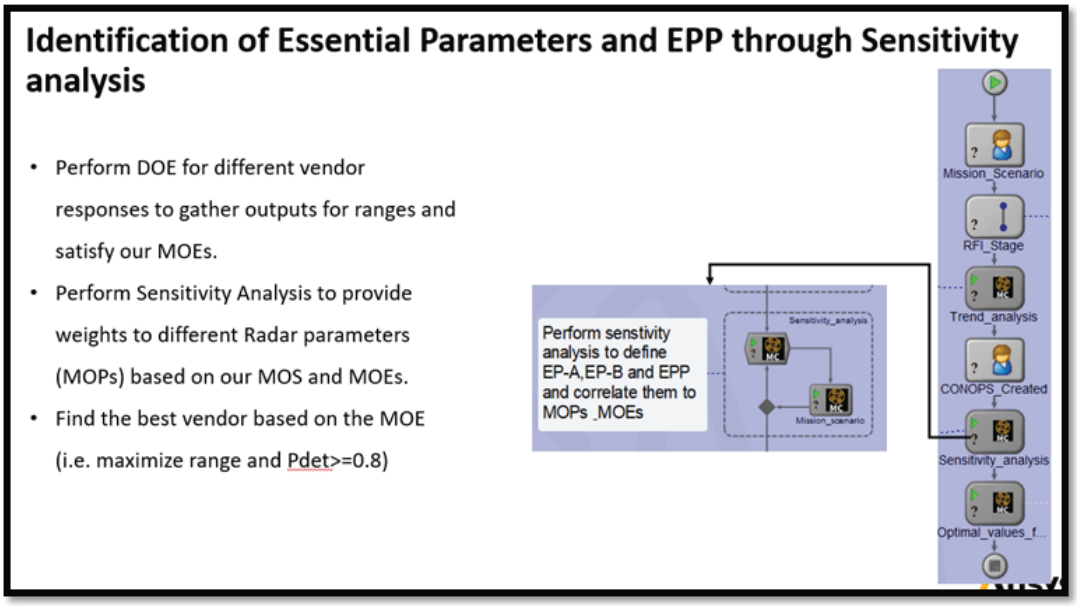



*Figure 18: Identification of Essential and Enhanced Performance Parameters*

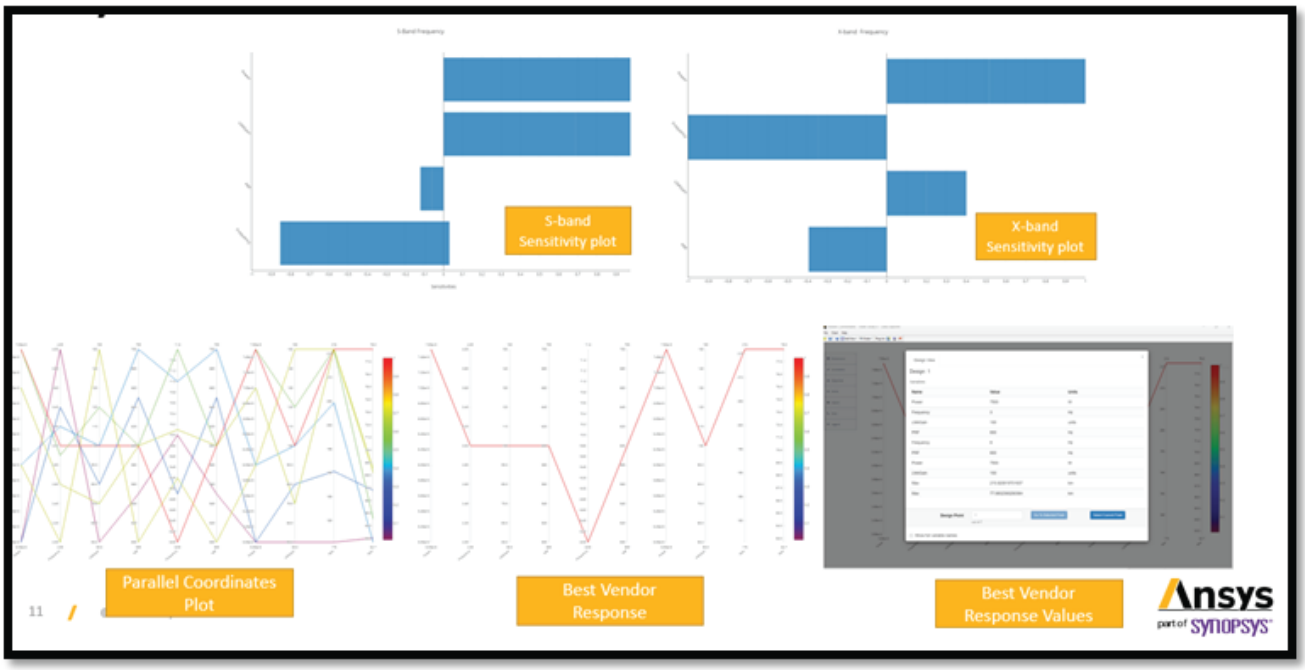



*Figure 19: Identification of Essential and EPP*

## Optimal values identified for specific SQRs in the RFP

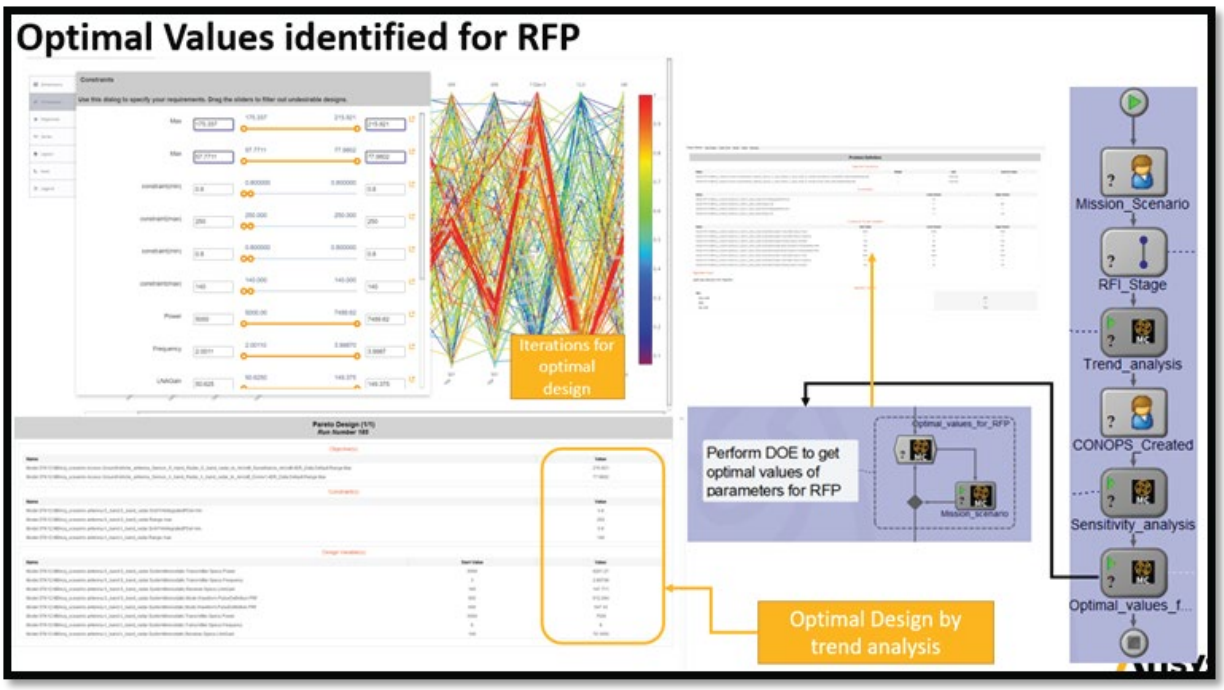



*Figure 20: Optimal values identified for specific SQRs in the RFP*

# Appendix B

*(Refer to Paragraph 5.7 of Chapter 5 of the White Paper)*

## Draft Notes for Suitable Incorporation in New DAP

## (The above Appendix should be Cross-reference to Chapter II & VI in DAP 2020)

The contents of this Appendix shall be applicable to all categories of acquisition under DAP ----- (New DAP), including Buy (Indian), Buy and Make (Indian), Innovation, and other relevant categories.

MBAcq shall be mandatory in respect of complex platforms and systems such as aircraft, warships, ICT systems, and weapon systems, and shall be encouraged in all other cases where digital modelling can substitute or reduce physical trials. MBAcq shall be applied at all stages of procurement.

RFI Stage. The RFI will include the requirement of a digital model of the products available to meet the Operational requirements of the Services and to formulate the SQRs, maintenance philosophy and other contractual provisions. The RFI should be accompanied by a digital format in which prospective vendors will provide their responses. This format would require specific inputs and the use of specified standard units of measurement, which would help standardise the vendor response and the subsequent process of SQR evolution and evaluation. The format should include provisions for additional context and comments, providing vendors with an avenue to offer innovative responses to the RFI.

SQR Formulation Stage.

- The SQR formulation stage would comprise all the stages traditionally incorporated, making use of the digital inputs and connections with the digital operational scenario to ensure traceability of the parameters sought/ received in the RFI response.
- The parameters of SQRs can be digitally established by doing a sensitivity analysis of the effect of various mission parameters on digital mission success. This will help classify the parameters as Essential-A, Essential-B and EPP. The weightages assigned to the EPP can then be applied scientifically by linking them to the digital mission success.

SoC Formulation stage (AON).

- The SoC needs to articulate clearly how the mission is currently undertaken, what the capability gaps are, how this deficiency of capability cannot be overcome by only a change of doctrine without any material addition, how the new capability will mesh with our current capability, its maintenance and so on. A model-based approach will provide a unique ability to give a clear perspective on all these concepts. It can show "what" can be achieved through clear visualisation of the mission, as undertaken with present capability, compared to the mission with "new capability". It can also clearly show how this new capability compares with what is available globally.
- It also important that the capability is tested for various what-if conditions and courses of action that will emanate. Digital Mission Engineering provides an excellent platform to capture the outcomes of various Concepts of Operations (CONOPS).

### Request for Proposal (RFP) Stage.

A provision for including digital artefacts as a part of the response to RFI may be made. The compliance table that needs to be submitted as part of the RFP should be captured in Digital form, including having quantitative data of both Essential Parameters A and B, and the Enhanced Performance Parameters (EPP) captured digitally to calculate credit scores. The Trial Matrix, which will be part of the RFP's Trial Methodology, can be derived from the Digital Concept of Operations. The mandatory test points that need to be validated in FETs, along with additional optional test points, can be suggested for simulation.

The Physical Demo expected in the Field may be clearly articulated in the RFP, along with a scope for providing an animation/simulation of the test procedure that is desired in addition to the documented field test. The following digital assets should be sought as part of a response to an RFP:-

- Digital Documentation of the asset in terms of drawings, manuals, technical specifications, etc.
- Digital representation at a high level of geometry of the asset.
- Characteristics of the asset to determine behaviour in simulation, like- Dimensions, Mass, CG, Moments of inertia.
- Detectability-Radar Cross Section, Thermal Signatures, Projected areas, emissivity/reflectivity. These parameters will assist in Electromagnetic Interference (EMI)/ Electromagnetic Compatibility (EMC) analysis.

### TEC Stage.

The TEC will digitally evaluate the technical responses of the vendors by taking into consideration the following aspects:-

- Compliance Matrix, along with Enhanced Performance Parameters, will be digitally evaluated for all vendors in the context of the digital mission.
- The digital Models used to check the validity of parameters supplied by Vendors.
- Comparative insights of different metrics will be considered.
- Contextualised and refined SQRs without Dilution would be considered.
- Digital capture of Certification of Conformance (CoC) along with test standards and test results, graphs and accredited lab certifications. Key characteristics of these tests were captured digitally.

### Evaluation Criteria.

Proposals shall be evaluated on the basis of:-

- Maturity levels of submitted models (conceptual, validated, certified).
- Fidelity of simulations to replicate operational conditions
- Integration of models into lifecycle sustainment and upgrades.
- Demonstrated readiness of industry to adopt MBAcq practices.

### FETs Stage.

- The physical and digital Trial Methodology as defined in the RFP will form the basis of the Field evaluation trial stage.
- Use of Mission simulation and Digital Engineering to establish and derive parameters based on Mission Success.
- The variance between field tests and simulations will be used to verify and certify simulation results.
- Trial methodology should have an inbuilt provision to ingest Field Evaluation Tests back into the design reference if required.

Deliverables.

- Vendors shall provide validated system models conforming to internationally accepted MBSE standards (e.g., SysML, UML, ISO/IEC).
- A digital twin of the system shall be delivered for lifecycle support, including upgrades and modifications.
- Simulation data covering operational scenarios, safety, maintainability, and performance shall be submitted.
- Verification and validation reports evidencing fidelity and accuracy of models vis-à-vis physical prototypes shall be furnished.

Standards and Interoperability.

- All models shall conform to open, non-proprietary formats to ensure interoperability with the MoD, DRDO, DPSUs, and private industry digital environments.
- Proprietary formats shall not be accepted unless accompanied by open-standard exports ensuring long-term accessibility.

Contractual Provisions.

- MBAcq requirements shall be incorporated into the Standard Contract Document as per Chapter VI (or the relevant chapter after revision) of DAP 2020/2025.
- Vendors shall be contractually obligated to provide updated models during system upgrades, modifications, and mid-life enhancements.
- The extant MoD policies shall govern the IPR of models.