TRANSIT
TRANSITIONING RESEARCH 2026

JUNE 10-12 • PUNE INTERNATIONAL CENTRE • INDIA

Host State

Government of Maharashtra

Organised by

CANEUS

Knowledge Partner

PUNE INTERNATIONAL CENTRE

HANDBOOK

Mid-TRL Technology Transition and Innovation Acceleration

Advancing Aerospace, Defence, Energy, and Advanced Manufacturing Systems

Maharashtra Catalysing India's Mid-TRL Transition Push

TRANSIT 2026 Handbook

International Workshop on
Mid-TRL Technology Transition and Innovation Acceleration

Advancing Aerospace, Energy, and Advanced Manufacturing Systems

In partnership with CANEUS and COEP-TU

10th – 12th June 2026, Pune International Centre,

Panchwati, Pashan, Pune 411008

Index

1.0. Preface

The **TRANSIT 2026 Workshop** represents a landmark initiative designed to accelerate the journey of technologies from research to real-world deployment, with a particular focus on the critical Mid-TRL (Technology Readiness Levels 4–7) stage. This stage, often referred to as the "Valley of Death," is where promising innovations risk stagnation without structured support, industry validation, and collaborative pathways for commercialization.

By convening stakeholders from **industry, academia, government, investors, and international partners**, TRANSIT 2026 creates a unique platform for dialogue, assessment, and action. Through structured sessions, technology gap analyses, and consortium-building activities, participants will work together to identify priority challenges, formulate collaborative projects, and establish actionable roadmaps that strengthen India's innovation ecosystem.

This handbook serves as a **guide and reference** for participants, outlining the workshop's objectives, program structure, thematic focus areas, and expected outcomes. It is intended to provide clarity, direction, and a shared framework for engagement, ensuring that discussions translate into tangible projects, strategic partnerships, and long-term impact.

Ultimately, TRANSIT 2026 is not just a workshop, it is a **catalyst for innovation-led growth**, fostering collaboration across sectors such as Aerospace, Defence, Energy, and Advanced Manufacturing, and contributing to the vision of technological self-reliance and global competitiveness.

2.0. Executive Summary

The **TRANSIT 2026** Workshop is an international, outcome-driven initiative designed to accelerate the transition of promising technologies from research to deployment, with a focus on the critical **Mid-TRL (Technology Readiness Levels 4-7) stage**. This stage often represents a bottleneck where innovations risk stagnation without structured validation, industry collaboration, and commercialization pathways.

By convening **industry leaders, academia, government agencies, startups, investors, and international partners, TRANSIT 2026 provides a collaborative platform** to identify technology gaps, formulate project concepts, and establish strategic consortia. The workshop emphasizes a technology-pull approach, ensuring that innovation is guided by real-world industry needs and market opportunities.

The program is structured into four interconnected components:

- **Strategic Context & Framing** - establishing a shared vision, methodology, and expected outcomes.
- **Sector & Technology Assessments** - identifying gaps and opportunities across Aerospace, Defence, Energy, Advanced Manufacturing, Materials, Sensors, Electronics, and Digital Technologies.
- **Project Formulation & Consortium Development** - translating insights into actionable project concepts and collaborative consortia.
- **Roadmaps, Policy & Implementation Frameworks** - prioritizing projects, defining execution pathways, and contributing to the Pune Declaration 2026.

Over three days, participants will progress from gap validation (Day 1) to solution building and project formulation (Day 2), culminating in commitment, roadmap development, and policy alignment (Day 3).

The success of TRANSIT 2026 will be measured by:

- Identification of priority technology challenges.
- Development of collaborative project concepts.
- Formation of strategic industry–academia–government consortia.
- Creation of actionable roadmaps for technology validation, commercialization, and deployment.

Ultimately, TRANSIT 2026 aims to strengthen India's innovation ecosystem, foster global partnerships, and accelerate the adoption of advanced technologies in Aerospace, Defence, Energy, and Manufacturing, contributing to technological self-reliance and sustainable growth.

2.1. Background and Context

Maharashtra has a strong foundation in advanced manufacturing, automotive, aerospace, and energy systems. However, a key challenge lies in translating research outputs into deployable, industry-ready technologies.

This workshop is designed to bridge that gap by focusing on:
- Industry-driven problem identification
- Technology validation and demonstration
- Collaboration between industry, academia, and research institutions
- Structured pathways for commercialization

It represents an important step toward building a Mid-TRL Innovation Acceleration ecosystem with global linkages.

Alignment with National and State Priorities

The initiative aligns with broader priorities such as:
- Innovation and startup ecosystem development
- Advanced manufacturing and industrial growth
- Skill development and applied research
- National missions such as Atmanirbhar Bharat and Make in India

The focus is on enabling a transition from research-led to deployment-led innovation systems.

2.2. Overview of the Workshop

Objectives

Identify 8–10 high-impact industry challenge statements
- Showcase technology demonstrations and industry case studies
- Develop collaborative Proof-of-Concept (PoC) projects (TRL 4–7)
- Facilitate industry–academia matchmaking
- Establish thematic innovation consortia
- Define commercialization and funding pathways

Workshop Structure

Day 1: Industry Challenges and Strategic Context
- Industry problem statements
- Global technology trends
- Strategic context and sectoral priorities
- Industry–academia matchmaking

Day 2: Technology Deep Dive and Demonstrations
- Technical tracks (AI/Digital Twins, Materials, Sensors, etc.)
- Industry case studies
- Technology demonstrations

Day 3: Collaborative Project Development
- Technology gap analysis
- PoC project formulation
- Consortium formation
- Collaboration and funding discussions

Key Features

- Industry problem-driven approach
- Focus on technology validation (not just presentations)
- Structured stakeholder matchmaking
- Emphasis on deployable outcomes (TRL 4–6)
- Integration of global best practices

Expected Outcomes

- Identification of priority industry challenges
- Development of 3 PoC projects
- Formation of innovation consortia
- Submission of joint funding proposals
- Defined pathways for technology commercialization
- Strategic roadmap for Mid-TRL innovation ecosystem development

Strategic Impact

The workshop is expected to:
- Strengthen industry–academia collaboration frameworks
- Accelerate technology commercialization and adoption
- Enable applied innovation ecosystems
- Attract global partnerships and investments
- Support the development of a structured Mid-TRL innovation pipeline

Participation

The workshop will include participation from:
- Industry leaders (Aerospace, Defence, Energy, Materials & Manufacturing)
- Startups and MSMEs
- Academic and research institutions
- Technology experts and global partners
- Government and policy stakeholders

Way Forward

Post-workshop activities will focus on:
- Initiation of PoC projects
- Formation of innovation consortia
- Development of funding proposals
- Strengthening collaboration platforms
- Advancing a structured roadmap for Mid-TRL innovation acceleration

Contact

Event related: transit2026@coeptech.ac.in

COEP Tech University

Dr. Avinash Joshi

+91 9765497730

avinash.joshi@coeptech.ac.in

CANEUS International

Dr. Milind Pimprikar

+1 514 267 2434

mp@caneus.org

2.3. Purpose of the Handbook

This handbook provides structured guidance to organisers, speakers, session chairs, and moderators to ensure a high-impact, outcome-driven workshop.

Objectives:
- Enable industry-academia-government collaboration
- Identify mid-TRL technology transition opportunities
- Facilitate partnerships and MoUs
- Develop actionable roadmaps

2.4. Governance Structure

Key Roles:

- Workshop Organizers – Overall accountability
- Session Chair – Content direction and time control
- Moderator – Facilitates discussions
- Speaker – Delivers presentations
- Rapporteur – Captures outcomes
- Logistics Lead – Manages operations

Time Management Guidelines

- Keynote: 20–25 minutes
- Technical Talk: 12–15 minutes
- Strict adherence to schedule
- Use visible timers

Speaker Guidelines

- Focus on real-world applications and mid-TRL transitions
- Limit to 10–12 slides
- Include problem, solution, and collaboration ask

Submission Timeline:

- Draft: 10 days prior
- Final: 3 days prior

Session Chair Guidelines

- Align session with objectives
- Introduce speakers briefly
- Maintain time discipline
- Ensure balanced discussions

Moderator Guidelines

- Guide discussions effectively
- Encourage diverse participation
- Use structured questions
- Summarise key insights

Interaction Design

Formats:

- Panel Discussions
- Roundtables
- Breakout Workshops
- Networking Sessions

Break & Networking Strategy

- Coffee Breaks: 15 minutes
- Lunch: 45–60 minutes
- Encourage cross-sector networking

Documentation & Outcomes

- Capture key insights
- Identify technology gaps
- Record collaboration opportunities
- Publish report within 2 weeks

Logistics & Operations

- Ensure AV setup with backups
- Provide badges and welcome kits
- Maintain IT support

Risk Management

- Backup speakers
- Printed presentations
- Flexible scheduling

Communication Protocol

- Pre-event briefings
- Real-time updates during event

Post-Workshop Follow-Up

- Share materials within 48 hours
- Initiate working groups
- Track partnerships

Annexures

- Speaker bios
- Contact directory
- Venue layout
- Emergency contacts

2.5 Workshop Schedule

DAY 1 - JUN 10

June 10, 2026 · Alignment & Gap Validation

TIME	SESSION
08:00 - 09:00	**Registration & Networking Breakfast** Welcome | Delegate check-in | Logistics briefing
09:00 - 10:00	**Welcoming Speech, Opening Plenary, Workshop Framing** Output: Shared vision & expectations
10:00 - 11:45 Parallel Tracks	TRACK A - Aerospace + Defence TRACK B - Energy
11:45 - 12:00	BREAK
12:00 - 13:00	Inauguration Session with Hon'ble Governor
13:00 - 14:00	LUNCH BREAK
14:00 - 15:30 Parallel Tracks	"TRACK C - Advanced Materials + Sensors & Electronics TRACK D - Reliability, Certification & Safety + Manufacturing Efficiency"
15:30 - 15:45	BREAK
15:45 - 17:00	**Cross-Sector Synthesis** Output: Cross-sector technology bottlenecks identified
17:00 - 18:00	**Day 1 Wrap-Up & Validation** Output: Validated gap themes for Day 2
18:00 - 18:30	**Networking** Curated networking · Early consortia conversations
18:00 - 20:30	Followed by Dinner

DAY 2 - JUN 11

June 11, 2026 · Solution Building & Project Formulation

TIME	SESSION / TRACK A
09:00 - 09:45	**Day 2 Opening - Gap Review & Focus Confirmation** Output: Focus areas confirmed for breakout sessions
09:45 - 11:30 Parallel Breakouts	BREAKOUT 1 - Hydrogen Propulsion, Storage & Smaller Moduler Reactors BREAKOUT 2 - Advanced Turbine Materials BREAKOUT 3 - Drone Autonomy & Certification Output: Project concept formulation
11:30 - 11:45	BREAK
11:45 - 13:00	**Concept Refinement Plenary** Draft 1- page project concept notes
13:00 - 14:00	LUNCH BREAK
14:00 - 15:30	Industry & Government Session, Collaboration, Policies and Funding
15:30 - 15:45	BREAK
15:45 - 17:00	**Consortia Formation** Output: 10 - 15 confirmed consortia with named leads
17:00 - 18:00	**Day 2 Wrap-Up**

DAY 3 - JUN 12

June 12, 2026 · Commitment & Roadmap

TIME	SESSION / TRACK A
09:00 - 09:30	**Day 3 Opening - Recap of Projects**
09:30 - 11:00	**Project Pitches - Shortlist Prioritized**
11:00 - 11:15	BREAK
11:15 - 12:30	**Implementation Roadmap** Output: Draft execution roadmap
12:30 - 13:30	LUNCH BREAK
13:30 - 15:00	**Synthesis of Priority Projects and Stakeholder Commitments**
15:00 - 15:30	**Pune Declaration 2026 - Drafting Session**
15:30 - 16:00	**Address by Hon'ble Vice President**
16:30+	**Closing Ceremony & Reception** Formal close · Group photograph · Networking reception

3.0 Workshop Process

TRANSIT 2026 follows a structured, outcome-driven process designed to move identified industry challenges into collaborative project pipelines. Unlike a conventional conference, this workshop is built around **action**; every session is designed to produce a tangible output that feeds directly into the next stage. Participants should come prepared not just to present, but to commit.

The process draws on the proven CANEUS innovation framework and has been re-engineered for TRANSIT 2026's inaugural context, where many participants are engaging with Mid-TRL transition pathways for the first time.

3.1 The Planning Process

The workshop is organized around a three-step planning sequence:

Step 1 - Situational Analysis establishes a shared, evidence-based understanding of where things actually stand. This means honest gap mapping: what technologies exist at what maturity levels, what the industrial operating environment actually demands, and where the disconnects are. This is not a space for aspirational roadmaps; it is a diagnostic exercise grounded in real-world constraints.

Step 2 - Conception translates that diagnosis into structured project ideas. Participants move from gap statements to project concept notes, defining the problem, the proposed approach, the validation environment, and the consortium shape needed to execute. The outputs of Step 2 are the raw material for everything that follows.

Step 3 - Execution refines those concepts into commitments. Teams define teaming structures, assign lead responsibilities, identify funding pathways, and lock in a 30-60-90 day action plan. The culminating output of Step 3 is the TRANSIT 2026 Work Program Portfolio - a vetted set of joint projects phased over a three-to-five-year horizon.

Figure 1 below illustrates the flow between these steps. Note that the arrow does not loop back - the process is deliberately forward-moving. Participants who do not complete Step 1 rigorously will find Step 2 difficult; those who do not complete Step 2 will have nothing concrete to commit to in Step 3.

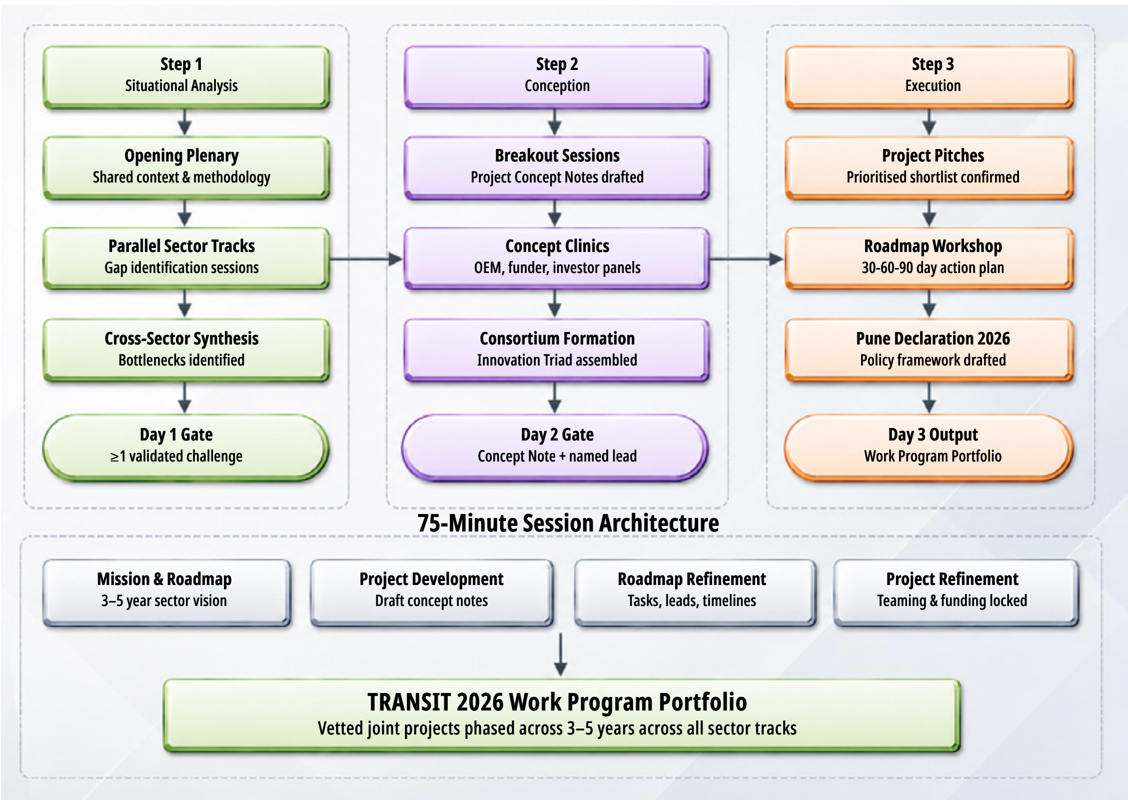

Figure 1: TRANSIT 2026 Three-Step Planning Process

3.2. How the Three Days Map to the Process

The three workshop days are structured so that each corresponds to a stage in the planning process and each closes with a gate that must be cleared before the next day begins.

Day 1 (June 10) - Situational Analysis

The opening plenary establishes shared context: India's Mid-TRL landscape, the sectors in focus, and the methodology participants will use for the next three days. The morning parallel tracks (Aerospace, Defence, Energy) and afternoon tracks (Advanced Materials, Sensors & Electronics, Manufacturing Efficiency, Reliability & Certification) are structured gap-identification sessions, not presentations. Each track is expected to produce a validated set of industry challenge statements by the end of the day.

Day 1 Gate: Every participant must align under at least one validated, industry-backed challenge statement before Day 2 begins.

Day 2 (June 11) - Conception

Breakout groups form around the challenge clusters identified on Day 1. The morning sessions are dedicated to drafting 1-page Project Concept Notes. The afternoon Clinics with government funding agencies, OEM representatives, and investors stress-test these concepts in real time, forcing early refinement against funding criteria and industrial requirements. By the end of the day, core consortium structures must be in place, with Named Track Leads designated.

Day 2 Gate: Completion of a Project Concept Note and designation of a Named Lead for each emerging consortium.

Day 3 (June 12) - Execution

Consortia present their prioritized concepts to the full delegation. The Execution Roadmap Workshop converts the strongest concepts into 30-, 60-, and 90-Day Action Plans. The afternoon Policy Engagement session aligns projects with government priorities and funding schemes, feeding directly into the Pune Declaration 2026, a macro-level policy framework drafted collectively by participants.

3.3. Session Architecture

The core working sessions at TRANSIT 2026, both track sessions on Day 1 and breakout/consortium sessions on Day 2, follow a 75-minute structured format adapted from the CANEUS consortium model. Each session has one chair, a panel of 4–8 participants, and a designated rapporteur. The four session types and their objectives are:

Mission, Goals & Roadmap

Participants formalize the 3- to 5-year sector vision for their track. The chair provides a brief context-setting overview; the panel then works toward consensus on the key challenge areas and strategic priorities.

Output: a shared sector roadmap with identified gap themes.

Project Development & Framework

Two or three participants present active TRL 4/5 prototypes or live industry problems. The group drafts a 1- to 2-year project framework aligned with the roadmap from the previous session. Business development issues, NDA requirements, IP arrangements, and regulatory constraints are addressed here, not deferred.

Output: a draft Project Concept Note.

1. Preface
2. Executive Summary
3. Workshop Process
4. Session Objectives
5. TRANSIT 2026 Projects
6. Expected Outcomes
7. Concept Notes
8. COEP-CANEUS Pilot Project Fund (CC-PPF)

Roadmap Refinement

The roadmap is translated into operational terms. Tasks are assigned, responsibilities are named, and hard timelines are attached to milestones.

Output: an actionable task-responsibility matrix with named owners.

Project Refinement

Teaming structures are finalized, funding schemes are confirmed, oversight protocols are established, and success metrics are defined.

Output: a refined Project Concept Note ready for the Day 3 pitch.

3.4. The Project Concept Note

The Project Concept Note is the primary working document of TRANSIT 2026. It is a single-page structured summary - analogous to the CANEUS Quad Chart format that captures the essential elements of a proposed collaborative project. Every emerging consortium is expected to produce one by the close of Day 2.

A complete Project Concept Note addresses the following:

Problem Statement - the validated industrial gap this project addresses, stated in terms of specific operating environment requirements, not abstract research objectives

Proposed Approach - the technical pathway from current TRL to target TRL, with key milestones

Target Validation Environment - the specific industrial context in which the technology must perform (e.g., turbine operating temperatures, electrolyzer current densities, UAV certification standards)

Consortium Structure - the Innovation Triad: Technology Developer, Industrial End-User, and Validation Enabler

Funding Pathway - identified government schemes, industry co-funding, or international collaboration mechanisms

Success Metrics - measurable technical and commercial criteria that define project completion

The Project Concept Note is a public-domain document and should not contain proprietary information. It is the basis for the Day 3 pitches, for inclusion in the TRANSIT 2026 Work Program Portfolio, and for subsequent detailed project planning undertaken post-workshop.

3.5. The Work Program Portfolio

The ultimate output of TRANSIT 2026 is a Work Program Portfolio, a structured, vetted collection of joint projects phased across a three-to-five-year horizon across the Aerospace, Defence, Energy Materials, and Advanced Manufacturing sectors.

The Portfolio is not a wish list. Only projects that clear the Day 2 gate with a completed Project Concept Note, a confirmed consortium lead, and at least two committed partners enter the Portfolio. Projects are classified into three types:

- **Technology Development Projects** - product, process, or system developments that provide a total solution to a validated industrial need, progressing from TRL 4/5 to TRL 6/7 over the project period.
- **Strategic Initiatives** - activities that address systemic barriers to Mid-TRL transition: standards development, certification pathway mapping, market studies, or policy position papers.
- **Innovation Consortia** - thematic programs that center on a technology domain or application area and prosecute multiple projects under a shared roadmap and governance structure.

The Portfolio will be published in the TRANSIT 2026 Workshop Report within two weeks of the event and will serve as the reference document for all post-workshop follow-up, including MoU finalization, funding proposal submissions, and consortium formation.

3.6. What Participants Should Bring

To make full use of the three-day process, participants are encouraged to arrive with:

- **A clear statement** of the technology or industrial problem they represent, anchored to a specific TRL level and operating environment
- **An honest assessment** of where their technology or capability currently falls short of industrial deployment requirements
- **Openness to consortium formation** - the process only works when technology developers, end-users, and validation partners are in the same room and willing to commit
- **Any existing project concepts**, NDA frameworks, or funding applications that can be accelerated through the workshop

The workshop process is designed to compress months of bilateral negotiation into three focused days. The more honestly participants engage with the gap-mapping in Step 1, the more durable the projects that emerge from Step 3 will be.

4.0. Session Objectives

4.1. Workshop Framing & Strategic Alignment Objective

The objective of this session is to establish a common understanding of TRANSIT 2026's goals, methodology, and expected outcomes. Participants will be introduced to the Mid-TRL technology transition framework, workshop structure, sector priorities, and the collaborative approach required to accelerate technology development and deployment.

4.2. Technology Gap Assessment Objective

The objective of this session is to identify and validate critical technology gaps, capability deficiencies, and industry challenges across Aerospace, Defence, Energy, and Advanced Manufacturing sectors. Participants will assess current technological capabilities, future requirements, import dependencies, and opportunities for indigenous innovation and technology advancement.

4.3. Project Development Objective

The objective of this session is to convert identified challenges into structured project concepts. Participants will define problem statements, proposed solutions, technical scope, target TRL progression, expected outcomes, and potential impact. The focus will be on developing practical and deployable technology solutions aligned with industry needs.

4.4. Consortium Building Objective

The objective of this session is to facilitate collaboration among industry, academia, government agencies, startups, investors, and international partners. Participants will identify strategic partners, define roles and responsibilities, and establish collaborative consortia capable of executing technology development and validation projects.

4.5. Implementation & Roadmap Objective

The objective of this session is to refine project concepts and develop actionable implementation plans. Participants will identify funding pathways, infrastructure requirements, validation mechanisms, commercialization opportunities, key milestones, and performance metrics. The session will contribute to the development of project roadmaps and strategic recommendations that will serve as the basis for the Pune Declaration 2026.

5.0. TRANSIT 2026 Projects

5.1. Scope

The primary objective of TRANSIT 2026 is to accelerate the transition of promising technologies from research and development to deployment by bridging the Mid-TRL "Valley of Death" that often exists between laboratory validation and commercial implementation. The workshop focuses on enabling the advancement of technologies within the Aerospace, Defence, Energy, Advanced Manufacturing, and dual-use sectors.

TRANSIT 2026 serves as a collaborative platform that brings together industry leaders, academia, research institutions, government agencies, investors, startups, and international partners to identify technology gaps, validate industry requirements, and develop solutions that address real-world challenges. The workshop promotes a technology-pull approach, where innovation is driven by industry needs, operational requirements, and market opportunities rather than solely by technology availability.

Projects discussed during the workshop will be identified through structured gap analysis, sector-specific assessments, and stakeholder consultations. Participants will work together to define problem statements, evaluate technology readiness, identify collaboration opportunities, and formulate project concepts aligned with strategic national and industrial priorities.

The workshop provides a framework for establishing industry–academia–government consortia capable of advancing technologies through validation, prototyping, demonstration, certification, and commercialization. Through this collaborative approach, participants will develop implementation roadmaps, funding strategies, and partnership models that support successful technology transition.

TRANSIT 2026 encourages both focused project collaborations and larger consortium-based initiatives that leverage complementary expertise, infrastructure, and resources across organizations. By fostering coordinated innovation and reducing development risks, the workshop aims to build a pipeline of high-impact projects that advance technological self-reliance, industrial competitiveness, and sustainable economic growth.

The success of TRANSIT 2026 will be measured by the identification of priority technology challenges, the development of collaborative project concepts, the formation of strategic consortia, and the establishment of actionable pathways for technology deployment and commercialization.

5.2 Project Classifications

Projects and outcomes emerging from TRANSIT 2026 may be classified into one of the following categories:

• Technology Development Projects

Projects focused on developing, validating, and transitioning technologies, products, processes, or services from Mid-TRL stages towards deployment and commercialization.

• Strategic Initiatives

Activities such as technology assessments, policy recommendations, standards development, market studies, funding frameworks, and ecosystem-building programs.

• Innovation Consortia

Collaborative partnerships involving industry, academia, government, startups, and international organizations to develop technology roadmaps, execute projects, and accelerate innovation.

5.2.1 Technology Development Project

A Technology Development Project focuses on the development, validation, demonstration, or commercialization of a technology, product, process, or service. These projects are intended to address identified industry challenges and support the transition of technologies from Mid-TRL stages towards deployment and market adoption.

5.2.2 Strategic Initiative Project

A Strategic Initiative Project is established to strengthen the innovation ecosystem and address challenges that may hinder technology adoption and commercialization. Examples include technology assessments, standards development, policy recommendations, market studies, funding frameworks, workforce development programs, and testbed initiatives.

5.2.3 Innovation Consortium Project

An Innovation Consortium Project is a collaborative program involving industry, academia, government agencies, startups, investors, and international partners working towards a common technology or sector objective. These projects focus on developing technology roadmaps, sharing expertise and infrastructure, advancing pre-competitive research, and accelerating technology transition and deployment.

Examples of Innovation Consortia may include:

- Aerospace & Defence Consortium
- Energy Systems Consortium
- Advanced Manufacturing Consortium
- Materials, Sensors & Electronics Consortium
- Digital Technologies & AI Consortium

5.3. TRANSIT 2026 Resources

TRANSIT 2026 supports participants by providing a structured framework for identifying technology gaps, developing project concepts, forming strategic partnerships, and creating implementation roadmaps. The workshop facilitates collaboration among industry, academia, government agencies, investors, startups, and international partners to accelerate the transition of technology from research to deployment.

Among the resources and support mechanisms provided through TRANSIT 2026 are:

- **Technology Gap Assessment Framework** – A structured process for identifying industry challenges, capability gaps, technology requirements, and innovation opportunities across priority sectors.
- **Project Concept Templates** – Standardized templates to help participants define problem statements, proposed solutions, target TRL progression, expected outcomes, potential partners, and funding requirements.
- **Consortium Formation Support** – Facilitation of collaborations among industry, academia, government agencies, investors, and international organizations to establish project teams and innovation consortia.
- **Roadmap Development Framework** – Tools and guidance for developing implementation roadmaps, defining milestones, identifying resource requirements, and establishing technology transition pathways.
- **Funding & Commercialization Guidance** – Information on government schemes, industry partnerships, investment opportunities, international collaborations, and commercialization pathways to support project execution and deployment.

These resources are intended to help participants transform identified challenges into actionable projects, strategic partnerships, and implementation plans that contribute to technology validation, commercialization, and deployment.

5.4. Project Execution

The successful transition of technologies from research to deployment requires a structured approach to project execution, stakeholder collaboration, and continuous monitoring. TRANSIT 2026 provides a platform for participants to develop implementation-ready projects supported by industry, academia, government agencies, investors, and international partners.

Project teams and innovation consortia formed during the workshop will be encouraged to establish clear objectives, responsibilities, timelines, milestones, and performance indicators to ensure effective execution. Participants will also identify funding pathways, validation mechanisms, infrastructure requirements, and commercialization opportunities necessary for successful technology transition.

Through collaborative planning, roadmap development, and stakeholder engagement, TRANSIT 2026 aims to support the progression of identified projects from concept to implementation, thereby accelerating innovation, reducing development risks, and strengthening the technology transition ecosystem.

6.0. Expected Outcomes from TRANSIT 2026

The activities and discussions conducted during TRANSIT 2026 are expected to culminate in a series of technology roadmaps, collaborative project concepts, strategic partnerships, and implementation frameworks that support the transition of technologies from research to deployment.

Participants in the workshop process will collectively identify priority technology challenges, formulate project opportunities, establish innovation consortia, and develop actionable recommendations to accelerate technology validation, commercialization, and deployment.

The primary outcomes of TRANSIT 2026 will include technology transition roadmaps, prioritized project opportunities, consortium action plans, and a workshop report capturing the key recommendations and decisions emerging from the event.

6.1. Technology Transition Roadmaps

Each sector and thematic track should develop a Technology Transition Roadmap containing:

- Priority technology challenges
- Vision and strategic objectives
- Technology development priorities
- Implementation pathways and milestones
- Collaboration and partnership opportunities

6.2. Project Opportunity Portfolio

A portfolio of collaborative projects should emerge from the identified challenges and roadmap priorities. These projects will be prioritized based on industry relevance, technology readiness, potential impact, and stakeholder commitment.

6.3. Consortium Action Plan

Each consortium or working group should establish a set of action items outlining the next steps for project development and implementation. These may include partnership discussions, project proposal development, funding engagement, pilot activities, and future meetings or workshops.

6.4. TRANSIT 2026 Workshop Report

A comprehensive workshop report will be prepared that summarizes the key discussions, the technology gaps identified, the project concepts developed, the partnership opportunities, the roadmap recommendations, and the implementation actions proposed during the workshop. The report will serve as a reference document for future collaboration and technology transition activities and will contribute to the development of the Pune Declaration 2026.

7.0. Concept Note

7.1. Concept paper 1 : Advanced Materials Consortium for Aerospace, Defence, and Energy Systems

Drafted by: Department of Metallurgy & Materials Engineering, COEP Tech University, Pune, Maharashtra

Prepared for: Government of Maharashtra, Ministry of Defence (DRDO), Ministry of New & Renewable Energy (MNRE), Large Aerospace & Defence Primes, and Western India Engineering MSMEs & SMEs

Operational Mandate: TRL 7+ Field Validation & Qualification Ecosystem

Abstract

India is rapidly expanding its footprint in aerospace, defence, and clean energy, yet remains heavily reliant on imported advanced materials. To achieve true strategic autonomy, domestic development of high-performance materials must bridge the "valley of death" between laboratory research and industrial deployment. This Concept Paper serves as the foundational discussion document for the proposed Industry-Academia-Government Consortium on advanced materials, hosted by COEP Tech University in Pune.

Targeting a Technology Readiness Level (TRL) of 7 and above, this initiative focuses on three core domains: high-temperature superalloys for aerospace, advanced ballistic composites for defence, and next-generation energy storage materials. By leveraging a co-funded model supported by the Government of Maharashtra and industry partners, the consortium aims to deliver field-qualified, manufacturing-ready material prototypes within a 3-to-5-year timeframe [1].

1. Rationale for Recommendation

1.1 Strategic and Regional Imperative

Maharashtra is a recognized industrial powerhouse with established aerospace and defence manufacturing hubs in Pune, Nashik, and Nagpur. Aligning with national mandates like Atmanirbhar Bharat and the DAP 2020 Positive Indigenisation Lists, there is a guaranteed policy-driven demand for indigenous materials. Developing domestic supply chains for these sectors is strategically non-negotiable.

1.2 The Consortium Value Proposition

No single entity can efficiently navigate the entire journey from material formulation to a field-qualified product. Traditional metallurgical qualification cycles present a massive bottleneck for industrial deployment: physical material validation typically demands 10 to 15 years of repetitive physical testing [1]. While digital software frameworks can be iterated overnight, the physical synthesis, thermal processing, creep evaluation, and environmental testing of structural alloys require extensive, long-term experimental lifecycles. This consortium replicates proven global models by instituting four design principles:

- Shared pre-competitive R&D accessible to consortium members.
- Application-specific prototyping driven by industry primes and MSMEs.
- Co-owned Intellectual Property (IP) with tiered licensing, ensuring strategic government access.
- Pooled testing and qualification to drastically reduce individual certification costs.

1.3 The COEP Tech Advanced Materials Consortium breaks this bottleneck through two unique structural differentiators:

- **Integrated Computational Materials Engineering (ICME) Commons:** By combining thermodynamic modeling (DFT, MD, CALPHAD, GMC/FEA) with machine learning, the consortium simulates material performance before physical synthesis [1]. This reduces the material iteration loop from years to months.

- **Shared Qualification and Certification Sandbox:** Advanced characterization equipment (e.g., high-temperature creep testing, environmental fatigue rigs, ballistic evaluation infrastructure) is financially out of reach for SMEs. The consortium offers a "Pay-per-Use Shared Risk" framework, allowing SMEs to test, iterate, and qualify prototypes to international aerospace/defence standards at a fraction of commercial costs, cutting certification bottlenecks.

2. Current State-of-the-Art & TRL Objectives

While India possesses strong academic foundations in materials science (TRL 3–5), there is a pronounced gap in translating these into industry-qualified, deployable products (TRL 7–9). This consortium is explicitly designed to bridge this gap, focusing strictly on advancing technologies to TRL 7 (system prototype demonstration in an operational environment) and beyond within a 36-60 month window[3].

Material Domain	Global State-of-the-Art	National Mission Linkage	Current India TRL	Target TRL (36-60 Months)
High-Temp Aerospace Superalloys	Superalloys for hot-section turbine blades.	DAP 2000 Indigenization Lists, TPCR-2025 [2-4]	4–5	7–8 (Field-tested components)
Defence Ballistic Composites	Ultra-lightweight UHMWPE/ Graphene hybrid armor.	iDEX/Make in India [4, 5]	5–6	8 (MIL-STD qualified modules)
Next-Gen Energy Materials	Solid-state battery electrolytes and high-efficiency turbine coatings.	National Green Hydrogen Mission, PLI, ACC [6-8]	4–5	7 (Scaled operational prototypes)

3. Baseline Use and Leading Applications

3.1 Aerospace

- Engine Hot-Section Materials: Development of advanced thermal barrier coatings and superalloys for domestic turbine engine programs, replacing imported high-temperature materials [9].
- Lightweight Composites: High-strength, fatigue-resistant composite structures for UAVs and next-generation commercial aircraft structures.

3.2 Defence

- Advanced Armor & Protection: Manufacturing scalable, lightweight ballistic composites for personnel and vehicular protection, meeting strict DRDO and global military standards [10].
- Stealth & Signature Management: Radar-absorbent materials (RAM) integrated directly into structural components.

3.3 Energy

- Renewable Infrastructure: Corrosion-resistant, high-endurance materials for wind turbine blades and offshore energy platforms, reducing maintenance overheads [7, 8].

- Energy Storage: Scale-up of advanced cathode materials and solid-state electrolytes to support Maharashtra's growing EV manufacturing ecosystem [7, 8].

4. Drivers for Change

4.1 Market and Policy Pull

The PLI (Production Linked Incentive) schemes and state-level aerospace/defence policies provide powerful incentives for MSME and large industry participation. Furthermore, Western export controls on dual-use technologies highlight the critical need for sovereign domestic capabilities in advanced materials.

4.2 Technology Push

Advancements in additive manufacturing, materials informatics (AI-driven material discovery), and scalable green synthesis methods have made the domestic production of complex materials economically viable, provided the initial prototyping risks are mitigated through a shared consortium model.

5. Prototype Programme and Implementation Plan

The consortium will focus on specific, highly targeted pilot projects to convert industry problem statements into executable prototypes. Projects will typically undergo concept refinement, prototype development, validation, and qualification planning.

Project	Domain	Deliverable (TRL 7+)	Estimated Budget (INR Cr)
AM-01	**Aerospace**	**Flight-test ready superalloy turbine blade prototype.**	**15–20**
AM-02	**Defence**	**MIL-STD qualified lightweight composite armour panel.**	**10–15**
AM-03	**Energy**	**Scaled production of solid-state battery electrolyte batch.**	**12–18**

Infrastructure and Facilities at COEP Tech

The pilot projects will leverage COEP's institutional contributions, including faculty expertise, laboratories, testing facilities, and technical infrastructure, which will serve as vital in-kind support.

6. Investment Possibilities, Risk Assessment, and Governance

6.1 Funding Model

The fund is a pre-commercial acceleration mechanism designed to reduce early execution risk. Funding will be structurally distributed to support late-stage TRL development over a 5-year program

Funding Source	Mechanism	% of Total Contribution
Govt. of Maharashtra / Central Grants	Core infrastructure & matching grants	40–50%
Large Industry Partners	Cash + in-kind (testing, integration)	30–40%
MSME / Startup Pool	Equity / PLI-linked co-investment	10–15%
Academic (COEP Tech)	Researcher time, laboratory infrastructure	5–10%

Note: A small administrative reserve will be established to support project coordination, reporting, and review meetings.

6.2 Governance & IP Principles

- Steering Committee: The fund and projects will be governed by a review committee representing COEP Tech, the Govt of Maharashtra, and major industry contributors.
- IP Management: Background IP will remain with the originator. Foreground IP and commercialization terms will be defined at the project level, ensuring fair data-sharing, teaming agreements, and viable commercialization pathways [1]. Government partners will receive appropriate licensing provisions for state or national strategic use [2].

6.3 Stakeholder Value Proposition (The Incentive Framework)

- To ensure active collaboration, the consortium moves away from traditional "academic philanthropy" and provides tangible, high-value incentives tailored to each stakeholder group:

For MSMEs & SMEs: Eliminating the CAPEX Barrier

Subsidized Infrastructure Access: Micro and small enterprises receive up to 70% subsidies on testing, high-temperature synthesis, and characterization via a "Materials Voucher" scheme [4].

- De-Risked Prototyping: Financial contributions from MSMEs are kept low (10-15%), backed by government matching grants, enabling small industries to bid safely for high-value defence (iDEX) or aerospace contracts [3].

For Large Industrial Primes: De-risking R&D and Vendor Development

- Qualified Tier-2 Vendor Base: Primes (e.g., Bharat Forge, Tata Advanced Systems) gain access to a network of pre-vetted, consortium-trained MSMEs operating under certified quality guidelines.
- Pre-Competitive IP Access: Large co-investors secure the first right of refusal for licensing co-developed structural material IPs, accelerating their internal product timelines [1].

For Government & Strategic Agencies: Sovereignty and Supply Resilience

- Sovereign Supply Chains: Complete mitigation of foreign export controls or structural material supply blocks during geopolitical disruptions.
- Maximizing Public Funds: Every rupee of government grant is matched by industry cash and institutional infrastructure, ensuring high capital efficiency.

6.4 Risk Mitigation

To prevent projects from losing momentum, the fund ensures that partners have immediate financial and structural backing for testing and early demonstration. Continuous industry alignment will ensure that prototypes meet operational criteria, enabling a swift transition to commercial manufacturing and deployment once TRL 7+ is validated.

6.5 Intellectual Property & Commercialization Architecture:

- Background Intellectual Property remains entirely with the respective originator.
- Foreground IP generated from consortium pilot projects will be jointly held by the executing industry partner and COEP Tech. Tiered commercial licensing terms will be contractually established prior to project launch.
- Government entities funding the respective pilots retain non-exclusive, royalty-free usage rights for sovereign, non-commercial, or state-strategic security purposes.

7. References

[1] National Research Council (NRC) Canada & NASA Ames Research Center. (2022). Integrated Computational Materials Engineering (ICME) for Accelerated Vehicle and Structural Material Insertion. Joint Technical Report NASA/TM-2022-219453.

[2] Ministry of Defence, Government of India. (2020). Defence Acquisition Procedure (DAP) 2020: Chapter III - Innovation and Positive Indigenisation Lists. New Delhi, India.

[3] Department of Defence Production (DDP), Ministry of Defence. (2024). Innovations for Defence Excellence (iDEX) Operational Framework and Rules for Technology Development Fund (TDF). New Delhi, India.

[4] Department of Industries, Government of Maharashtra. (2018). Aerospace & Defence Manufacturing Policy - 2018. Gazette Notification, Mumbai, India.

[5] Ministry of New & Renewable Energy (MNRE), Government of India. (2023). National Green Hydrogen Mission: Strategic Interventions for Green Hydrogen Transition (SIGHT) Program Guidelines. New Delhi, India.

[6] Ministry of Steel, Government of India. (2021). Production Linked Incentive (PLI) Scheme for Specialty Steel in India: Operational Guidelines. Gazette Notification, New Delhi, India.

[7] NITI Aayog & RMI India. (2022). Turning the Page on Battery Storage: A Roadmap for Advanced Chemistry Cell (ACC) Manufacturing under PLI. Government of India, New Delhi, India.

[8] Reed, R. C. (2006). The Superalloys: Fundamentals and Applications. Cambridge University Press, Cambridge, UK.

[9] ASM International Handbook Committee. (2020). ASM Handbook, Volume 21: Composites (Advanced Ultra-Lightweight Polyethylene & Carbon-Graphene Hybrids). ASM International, Materials Park, OH.

7.2. Concept Paper: Advanced Multi-Domain Sensor Systems & Intelligent Devices

Abstract

India imports over 75% of its advanced sensor requirements. The global sensor market (USD 236 Bn in 2024, growing to USD 450 Bn by 2032) underpins aerospace, defence, and energy sectors where domestic capability is strategically non-negotiable. This Concept Paper serves as the foundational discussion document for the proposed Industry-Academia-Government-MSME Consortium on Sensor and Device Development. It identifies five priority sensing domains — MEMS-based Structural Health Monitoring (SHM), Harsh Environment Chemical Sensors, Distributed Fibre Optic Sensing, Multi-spectral / IR Sensor Arrays, and IoT-enabled Energy Monitoring — and proposes a structured 5-year co-development programme. Five prototype projects with clear TRL uplift targets, indicative budgets, and a tri-partite governance model are detailed. The programme is designed to be co-funded by Government grants (DRDO TDF, DST, MNRE), industry co-investment, and MSME/startup pools under existing PLI incentives. The consortium aims to produce 10–20 jointly-owned patents, qualify at least three sensor families to MIL-STD / RTCA DO-160 standards, and establish domestic manufacturing at cost parity with imports within five years.

1. Rationale for Recommendation

Strategic Imperative

Three converging national mandates make domestic sensor development urgent. First, Defence: DAP 2020 Positive Indigenisation Lists and iDEX challenges create policy-guaranteed demand for indigenous sensors in unmanned systems, missile guidance, radar, and CBRN detection. Second, Aerospace: India's growing MRO sector and HAL's LCA Tejas Mk2 / AMCA programmes cannot depend on perpetually imported SHM and avionics sensors. Third, Energy: India's 500 GW renewable target by 2030 requires dense, intelligent sensor infrastructure for wind turbine blade health, solar panel diagnostics, and smart grid power quality — domains where domestic supply is negligible.

Consortium Value Proposition

No single entity traverses the full journey from material innovation to field-qualified sensor product. The proposed consortium replicates the TRANSIT 2026 organised by COEP and CANEUS (Canada-Europe-USA), IMEC (Belgium), and Fraunhofer (Germany) models adapted to India's industrial structure, with four design principles: (i) Shared pre-competitive R&D funded by government, accessible to all members; (ii) Application-specific prototyping by industry primes and MSMEs; (iii) Co-owned IP with tiered licensing, including royalty-free government licences for national use; and (iv) Pooled qualification and testing, reducing per-organisation certification cost by 60–70%.

2. Current State-of-the-Art

The table below benchmarks India's current domestic TRL against global state-of-the-art across the five priority sensor domains identified for the consortium programme.

Sensing Domain	Global SoA Summary	India TRL	Critical Gap
MEMS Inertial / SHM	Aerospace-qualified MEMS IMUs (Honeywell, Safran); 32-ch wireless SHM arrays in composite airframes	3–5	Aerospace-qualified MEMS IMU — none domestic
Harsh Env. Gas / Chemical	SiC/GaN sensors operational to 600°C; CNT arrays at ppb sensitivity; SERS at single-molecule level	3–4	SiC/GaN MEMS process capability very limited
Fibre Optic SHM	Multi-axis FBG sensors embedded in composite lay-ups; distributed Brillouin sensing over km ranges	5–6	Distributed sensing, large-structure deployment
Multi-spectral / IR	Uncooled LWIR FPAs; MEMS-tunable Fabry-Perot filters for UAV payloads; cooled HgCdTe for standoff	4–6	Uncooled FPA integration; MEMS-tunable filters
IoT Energy Sensors	Piezoelectric energy harvesting (1–50 mW from vibration); sub-GHz secure mesh; AI at edge	4–5	Energy harvesting; secure mesh networking at scale

A consistent pattern emerges: India has strong academic and government-lab foundations (TRL 3–6) but a pronounced valley-of-death to industry-qualified, field-deployable products (TRL 7–9). Bridging this valley is the consortium's primary purpose.

3. Baseline Use and Leading Applications

Aerospace

- Composite Airframe SHM: Embedded MEMS + FBG networks for real-time delamination, fatigue crack, and impact damage detection — LCA Tejas, HAL 228 NG, future AMCA.
- Engine Health Monitoring: SiC-based pressure / temperature sensors (400°C+) for Kaveri and Shakti engine hot-section predictive maintenance.
- Cabin Air Quality: CNT sensor arrays monitoring CO_2, VOCs, and particulates for crew health and cabin air certification compliance.

Defence

- Standoff Chemical Threat Detection: Portable SERS + mid-IR spectral processor achieving sub-10 ppm CWA simulant detection for DRDO CBRN mandate.
- UAV Multi-spectral Payloads: Miniaturised 8-band imaging modules + navigation-grade MEMS IMUs for TAPAS / Rustom-class UAVs.
- Border Perimeter Security: Distributed seismic-acoustic sensor networks classifying footfall and vehicle movement with low false-alarm rates.

Energy

- Wind Turbine Blade Health: Self-powered piezoelectric sensor nodes (strain + vibration + temperature) providing continuous condition monitoring without power cabling.
- Smart Transformer Monitoring: Metal-oxide nanowire DGA sensors detecting H_2, CH_4, C_2H_2 in transformer oil — early fault indicators for grid operators.
- Solar Farm Diagnostics: Distributed IR micro-sensors for hot-spot detection and soiling index measurement across utility-scale installations.

4. Drivers for Change

Technology Push

- Convergence of MEMS fabrication, edge AI/ML, and low-power wireless (BLE 5.3, LoRaWAN, NB-IoT) enables dense sensor deployment inside composite laminates, at high altitudes, and in radiation environments — previously inaccessible locations.
- Wide-bandgap semiconductor maturity (SiC epitaxy, GaN-on-Si) makes high-temperature domestic sensor production economically feasible with 4–6 inch wafer infrastructure investment.
- Piezoelectric energy harvesting has crossed the practicality threshold: 1–50 mW from ambient structural vibration is sufficient to power wireless MEMS sensor nodes indefinitely.

Policy and Market Pull

Atmanirbhar Bharat Abhiyan, DAP 2020 PILs, and iDEX challenges create policy-guaranteed procurement for qualifying indigenous sensors in defence and aerospace.

- PLI scheme for electronics manufacturing offers up to 6% production incentive on sensor/IoT device turnover — a powerful MSME and ODM participation incentive.
- China now produces >40% of global MEMS sensor units; India faces price competition in industrial segments, making aerospace/defence technology differentiation a commercial survival imperative.
- Western export controls on dual-use sensing technologies (precision guidance, CBRN) underscore the urgency of sovereign domestic capability.

5. Prototype Programme and Implementation Plan

Five prototype projects are proposed, each independently fundable, sharing common infrastructure. The 5-year programme is phased as: Phase 1 — Foundation (M1–12): Governance setup, shared lab commissioning, project initiation. Phase 2 — Development (M13–36): Engineering prototypes to TRL 6–7, joint patent filings, qualification testing initiation. Phase 3 — Qualification & Commercialisation (M37–60): MoD/CEMILAC/DGCA acceptance, MSME volume manufacturing ramp, licensing to non-members.

Project	Domain	36-Month Deliverable	TRL Uplift	Budget (INR Cr)
P-01	Aerospace SHM	32-ch wireless MEMS SHM network, flight-test ready	4 → 7	12–18
P-02	Defence Chem.	Portable CWA detector - SERS + IR spectroscopy	3→6	15–22
P-03	Wind Energy	Self-powered FBG blade health sensor system	4 → 7	8–14
P-04	Defence ISR	UAV-borne 8-band multi-spectral imaging pod	4 → 7	20–30
P-05	Smart Grid	IoT power quality sensor network - 1,000-node pilot	5 → 8	6–10

Shared Infrastructure (Year 1 - INR 14–20 Cr, co-located at nodal institution)

- Sensor Reliability & Environmental Test Lab - MIL-STD 810 chambers, vibration tables, thermal cycling (INR 3.5–5 Cr).
- MEMS Probe & Characterisation Suite - electrical, optical, thermal probe to 400°C (INR 2.5–4 Cr).
- Optical / Photonics Bench - FBG interrogation, multi-spectral calibration, LIDAR (INR 2–3.5 Cr).
- Secure RF / EMI-EMC Facility - anechoic chamber, 1–18 GHz, MIL-STD 461 (INR 4–6 Cr).
- Edge AI / FPGA Development Lab - GPU cluster, embedded AI tools (INR 1.5–2.5 Cr).

Governance & IP

Steering Committee: one seat each for Government Sponsor, Large Industry, MSME Sector, ODM Sector, Academic Lead. Background IP remains with originator. Foreground IP jointly owned proportional to contribution, managed by a Consortium IP Trust. Government agencies receive royalty-free licences for national defence / strategic use. Commercial licences available to non-members at market rate.

6. Investment Possibilities and Risk Assessment

Funding Structure - Total Programme: INR 100–150 Crore over 5 Years

Funding Source	Mechanism	% of Total
Govt. Grant (DRDO TDF, DST NIDHI, MNRE)	Grant via nodal agency	40–50%
Large Industry & ODMs	Cash + in-kind (facilities, engineering time)	30–40%
MSME / Startup Pool (PLI, SIDBI, VC)	Equity / convertible instruments	10–15%
Academic (MHRD IERA, SERB)	Researcher salaries, shared infra	5–10%

Key Risks and Mitigations

Risk	Probability	Mitigation
MEMS fab access delay (SCL capacity)	Medium	Dual-source with private foundry; TSMC India liaison
IP disputes between consortium members	Low-Medium	Detailed pre-project IP agreements; independent escrow
Defence qualification timeline slippage	Medium	CEMILAC pre-engagement in Phase 1; TRL milestone gates
MSME partner capability gaps	Medium	Academic/large-industry mentor pairing; skill programme
Semiconductor supply chain disruption	Low-High	Strategic buffer stocks; certified 2nd-tier global suppliers

Expected Returns

- **Technology Sovereignty: 5 sensor families at domestic TRL 7+, eliminating strategic import dependency.**
- **Employment: 200–300 direct high-skill jobs in MSME sensor fabrication; 500+ indirect in supply chain.**
- **Export Potential: MIL-STD / DO-160 qualified sensor modules exportable to friendly nations - estimated INR 500 Cr annual export by Year 7.**
- **IP Portfolio: 10–20 consortium patents providing licensing revenue & competitive differentiation in global markets.**

References

1. CANEUS 2004 Concept Paper Compendium, NASA / Boeing / Lockheed Martin / NRC Canada, 2004.
2. MEMS & Sensors Industry Group, World MEMS & Sensors Market Report 2024–2032, S&P Global.
3. DRDO, Technology Perspective and Capability Roadmap (TPCR) 2023–2033, MoD, Govt. of India.
4. Ministry of New & Renewable Energy, National Wind-Solar Hybrid Policy, Govt. of India, 2023.
5. Li J. et al., 'Nano Sensors and Devices for Space and Terrestrial Applications,' CANEUS A09, NASA Ames / Goddard, 2004.
6. Kneipp K. & Kneipp H., 'Novel Nanosensors based on SERS,' CANEUS A12, Harvard Medical School, 2004.
7. Blue Road Research, 'MNT-Based Sensors for Aircraft SHM,' CANEUS A11, Gresham OR, 2004.
8. BIS, Indian Standard Roadmap for Sensor Technologies IS/IEC 62047 Series, 2023–2028.
9. NASSCOM, 'India IoT and Sensor Market Landscape 2024,' 2024.
10. NITI Aayog, 'Deep Tech Strategy for India: Sensors, Robotics and Advanced Manufacturing,' 2023.

7.3. CONCEPT PAPER

Reliability Engineering for Energy, Defence, and Aerospace Systems

Abstract

Reliability engineering is the science of ensuring that systems perform their intended function under stated conditions for a specified period of time. In energy, defence, and aerospace, reliability is not just a performance metric but a strategic necessity. Failures in these sectors can lead to catastrophic consequences grid instability, mission failure, or aircraft accidents.

India's current reliability ecosystem is fragmented, with limited indigenous capability in accelerated life testing, probabilistic reliability modelling, and digital twin validation. This paper proposes an Industry-Academia-Government-MSME Consortium on Reliability Engineering, modelled on Fraunhofer (Germany), NASA Reliability Programs, and TRANSIT 2026 organised by COEP and CANEUS frameworks.

The consortium will focus on three priority domains:

- Energy Systems Reliability (smart grids, renewable assets, nuclear safety)
- Defence Reliability & CBM+ (Condition-Based Maintenance for UAVs, missiles, and armoured vehicles)
- Aerospace Reliability & Digital Twins (airframe fatigue, propulsion systems, avionics).

The programme will deliver five prototype reliability projects, uplift TRLs, and establish India's first Reliability Qualification and Digital Twin Validation Centre. Expected outcomes include 10-15 patents, MIL-STD/DO-160 qualified reliability protocols, and domestic reliability toolchains within five years.

1. Rationale for Recommendation

Strategic Imperative

Reliability is defined as the probability that a system will perform its intended function without failure for a given time under specified conditions [1]. In mission-critical domains, reliability is directly linked to safety, cost-effectiveness, and national security.

- Energy: India's renewable energy expansion (500 GW target by 2030) requires reliability protocols for wind turbine blades, solar panels, and smart transformers. Current failure rates in wind blades exceed 15% within 10 years, demanding predictive reliability frameworks [2].
- Defence: DAP 2020 mandates indigenous CBM+ systems for UAVs, missiles, and tanks. Without reliability qualification, imported systems dominate mission readiness [3].
- Aerospace: HAL's LCA Tejas Mk2 and AMCA programmes require validated fatigue and reliability models for composite airframes and propulsion systems. Current reliance on imported reliability protocols is unsustainable [4].

Consortium Value Proposition

Reliability engineering requires multi-disciplinary collaboration: materials science, mechanical engineering, AI/ML, and systems engineering. No single entity can traverse the journey from failure-mode discovery to field-qualified reliability protocols. The consortium will:

- Share pre-competitive R&D funded by government.
- Develop application-specific reliability demonstrators with industry/MSMEs.
- Co-own IP with tiered licensing.
- Pool qualification/testing infrastructure, reducing certification costs by 60-70% [5].

2. Current State-of-the-Art

Reliability engineering globally has matured into a discipline with probabilistic models, accelerated testing, and digital twins. India, however, remains at TRL 3-6 in most domains.

Domain	Global SoA	India TRL	Critical Gap
Energy Reliability	Digital twin-based predictive maintenance for wind/solar; IEC 61400 reliability standards	3-5	Lack of validated digital twins for renewable assets
Defence CBM+	US DoD CBM+ protocols; NATO reliability databases	4-6	No indigenous CBM+ framework for UAVs/missiles
Aerospace Reliability	FAA-certified fatigue models; AI-driven reliability twins	3-5	Absence of MIL-STD qualified reliability protocols

India has strong academic foundations but faces a valley-of-death between TRL 3-6 and TRL 7-9. Bridging this gap is the consortium's primary purpose [6].

3. Baseline Applications

- Energy: Wind turbine blade fatigue monitoring, transformer reliability diagnostics, nuclear safety reliability protocols.
- Defence: UAV CBM+, missile reliability qualification, armoured vehicle predictive maintenance.
- Aerospace: Airframe fatigue digital twins, propulsion reliability models, avionics reliability certification.

Reliability in these domains is measured using Mean Time Between Failures (MTBF), Failure Rate (λ), and Reliability Function R(t) = e^(-λt) [7].

4. Drivers for Change

Technology Push

- Advances in AI/ML enable predictive reliability models that learn from sensor data [8].
- Digital twins allow virtual replication of systems for accelerated reliability testing.
- Accelerated life testing (ALT) techniques such as Highly Accelerated Life Testing (HALT) and Highly Accelerated Stress Screening (HASS) reduce qualification timelines [9].

Policy Pull

- Atmanirbhar Bharat, DAP 2020, and renewable energy mandates create guaranteed demand for indigenous reliability frameworks [10].
- BIS has initiated Indian Standards for Reliability Engineering, but implementation is nascent [11].

Market Pressure

- Western export controls on reliability toolchains necessitate sovereign domestic capability [12].
- China's dominance in reliability-qualified components creates commercial pressure for India to differentiate in aerospace/defence.

5. Prototype Programme and Implementation Plan

Project	Domain	Deliverable (36 months)	TRL Uplift	Budget (INR Cr)
R-01	Energy	Digital twin for wind turbine blade reliability	4 → 7	10-15
R-02	Defence	UAV CBM+ reliability demonstrator	3 → 6	12-18
R-03	Aerospace	Composite airframe fatigue reliability model	4 → 7	15-20
R-04	Defence	Missile reliability qualification protocol	3 → 6	18-25
R-05	Energy	Smart transformer reliability monitoring system	5 → 8	8-12

Shared Infrastructure (Year 1, INR 15-20 Cr):

- Reliability & Environmental Test Lab (MIL-STD 810 chambers, vibration tables).
- Digital Twin Validation Centre (AI/ML clusters, simulation suites).
- Accelerated Life Testing Facility (thermal cycling, fatigue rigs).

1. Preface
2. Executive Summary
3. Workshop Process
4. Session Objectives
5. TRANSIT 2026 Projects
6. Expected Outcomes
7. Concept Notes
8. COEP-CANEUS Pilot Project Fund (CC-PPF)

6. Investment and Risk Assessment

Funding Structure (INR 120-160 Cr over 5 years):

- Govt. Grants (DRDO, DST, MNRE): 40-50%
- Industry/ODMs: 30-40%
- MSMEs/Startups: 10-15%
- Academia: 5-10%

Risks & Mitigations:

- **Testing delays → Pre-engagement with Centre for Military Airworthiness and Certification (CEMILAC) [13].**
- **IP disputes → Pre-project IP agreements [14].**
- **MSME capability gaps → Mentor pairing with academia/industry [15].**

7. Expected Returns

- Technology Sovereignty: Indigenous reliability protocols for energy, defence, aerospace.
- Employment: 200-300 direct jobs in reliability labs, 500+ indirect in supply chains.
- Exports: Reliability-qualified modules exportable to various nations (INR 400-500 Cr annually by Year 7).
- IP Portfolio: 10-15 patents in reliability engineering [16].

References

1. IEC 60050 Reliability Terminology, IEC, 2024.
2. IEC 61400 Reliability Standards, International Electrotechnical Commission, 2024.
3. MoD, Defence Acquisition Procedure (DAP) 2020, Govt. of India.
4. HAL, LCA Tejas Mk2 Programme Roadmap, 2025.
5. Fraunhofer Reliability Engineering Model, Germany, 2023.
6. NASA Reliability Engineering Handbook, 2022.
7. IEEE Reliability Metrics Guide, 2023.
8. IEEE Transactions on Reliability, Vol. 73, 2024.
9. MIL-STD 810G, US DoD, 2021.
10. NITI Aayog, Deep Tech Strategy for India: Reliability & Digital Twins, 2023.
11. BIS, Indian Standards for Reliability Engineering, 2023–2028.
12. US DoD CBM+ Guidebook, 2021.
13. CEMILAC Reliability Qualification Protocols, 2024.
14. SIDBI MSME Capability Development Report, 2024.
15. Fraunhofer MSME Mentorship Programme, 2023.
16. World Reliability Market Report, S&P Global, 2024–2032.

7.4. Concept paper 4 : Drone Consortium for Aerospace, Defence, and Energy Systems

Drafted by: Department of Electrical Engineering , COEP Tech University, Pune, Maharashtra

Prepared for: Government of Maharashtra, Ministry of Defence (DRDO), Ministry of New & Renewable Energy (MNRE), Large Aerospace & Defence Primes, and Western India Engineering MSMEs & SMEs

Operational Mandate: TRL 7+ Field Validation & Qualification Ecosystem

Abstract

The rapid and widespread adoption of unmanned aerial vehicles (UAVs) across civilian, commercial, and defence domains has introduced a parallel and growing class of security threats. Unauthorized drones operating in restricted airspace pose real risks to airports, military installations, public gatherings, and critical infrastructure. This Concept Paper presents the foundational research, engineering work, and forward roadmap for a student-led, faculty-guided project at the Department of Electrical Engineering, COEP Technological University, aimed at developing a fully autonomous counter-unmanned aerial system (C-UAS) platform.

Across two completed project stages, the team has built and validated three core subsystems: (1) a quadrotor platform modelled and simulated from first principles using the Newton-Euler formulation, with full 6-DOF dynamics and open-loop MATLAB simulation; (2) a radar-based drone classification system using micro-Doppler spectral analysis and SVM classifiers, achieving 94-100% accuracy in differentiating drones from birds; and (3) a dual-mode RF detection system using HackRF SDRs with directional LPDA antennas, tested in the field against a DJI Mavic drone. A YOLOv4 and YOLOv8-based vision pipeline has also been developed and integrated with a SLAM framework for spatial awareness and target tracking.

The final project phase, now underway, targets the development of a fully autonomous interceptor drone platform capable of detecting, tracking, and physically neutralizing unauthorized UAVs using hard-kill methods. Component selection, phased integration, and autonomous flight control architecture have been finalized. The system is designed to be deployable on edge hardware such as the Raspberry Pi 5, with trajectory planning, PID control, and autonomous interception logic forming the core of the final deliverable.

Targeting a Technology Readiness Level (TRL) of 7 and above, this initiative focuses on three core domains: high-temperature superalloys for aerospace, advanced ballistic composites for defence, and next-generation energy storage materials. By leveraging a co-funded model supported by the Government of Maharashtra and industry partners, the consortium aims to deliver field-qualified, manufacturing-ready material prototypes within a 3-to-5-year timeframe [1].

1. Rationale for Recommendation

1.1 The Security Problem with Drones

Commercial drones, originally designed for photography, surveying, and logistics, are now frequently misused for surveillance, smuggling, and in some cases as delivery platforms for attacks on high-value targets. The low cost and wide availability of quadrotor hardware mean the threat is no longer limited to sophisticated actors. Events at airports, military airfields, and public infrastructure have demonstrated that even small hobby-grade UAVs can cause massive operational and security disruptions.

India's rapidly expanding drone ecosystem, combined with a shortage of deployable domestic counter-drone solutions, creates a critical gap. Most available C-UAS products are either imported, prohibitively expensive, or limited to soft-kill techniques (jamming, spoofing) which are inadequate against autonomous or encrypted drones. Hard-kill solutions, which physically intercept or disable the target UAV, are necessary for high-consequence environments.

1.2 The Academic and Technical Gap

Existing academic work on C-UAS systems tends to address individual components in isolation: detection algorithms, control systems, or mechanical design, but rarely as an integrated, end-to-end autonomous system. This project is structured to address that gap by building a closed-loop system spanning RF detection, computer vision, flight control, and physical interception from a single, cohesive engineering effort. The quadrotor designed in Stage I serves as the target UAV for testing detection and classification algorithms. The autonomous interceptor drone developed in Stage II and Stage III will be capable of independently identifying and neutralizing this target, providing a self-contained research and demonstration ecosystem.

1.3 Institutional and National Alignment

This project aligns closely with national priorities under Atmanirbhar Bharat and the defence indigenisation agenda. Indigenous development of autonomous C-UAS technology represents a high-value capability for DRDO, border security agencies, and private defence primes. The project also contributes directly to COEP Tech's positioning as a hub for applied defence and autonomous systems research."prototypes to international aerospace/defence standards at a fraction of commercial costs, cutting certification bottlenecks.

2. Current State of Work and TRL Status

The project has been executed across three academic semesters, with each stage building systematically on the previous one. The following table summarises the current state across the three technical domains developed so far.

Technical Domain	Work Completed	Current TRL	Target TRL (Final Stage)
Quadrotor Dynamics & Simulation	Full Newton-Euler 6-DOF model, MATLAB open-loop simulation, 3D animation, CAD design (Fusion 360), FEA structural validation (Ansys)	TRL 3–4	TRL 6 (Physical prototype with closed-loop control)
Radar-Based Drone Classification	Micro-Doppler simulation of drone/bird targets, STFT spectrograms, SVM classifier with RBF kernel, 94–100% accuracy validated	TRL 3–4	**TRL 5–6 (Real radar hardware integration)**
RF Detection (SDR)	**(SDR)** **Dual HackRF SDR system, LPDA directional antenna, CFAR peak detection, field-tested against DJI Mavic drone at 41 ADSR Pune**	TRL 5	TRL 6–7 (Integrated with tracking pipeline)

Computer Vision (YOLO)	**YOLOv4 trained on custom drone dataset (transfer learning, MATLAB); YOLOv8 Nano running on live camera stream with 0.8 confidence threshold**	**TRL 4–5**	**TRL 6 (Edge-deployed on Raspberry Pi 5)**
Autonomous Interception System	**Architecture designed; component selection complete; E88 drone reverse-engineered; communication protocol mapped**	**TRL 3**	**TRL 6–7 (Autonomous intercept trial)**

3. Technical Work Done — Stage I (5th Semester)

3.1 Mathematical Modelling and Open-Loop Simulation

The quadrotor was modelled as a rigid body with six degrees of freedom using the Newton-Euler formulation. Two coordinate frames, an inertial Earth-fixed frame and a body-fixed frame, were defined. The complete set of nonlinear differential equations was derived, accounting for rotor thrust, drag torques, gyroscopic coupling, and rotational kinematics. The model parameters were chosen to represent a lightweight test platform: 0.5 kg mass, 0.25 m arm length, and thrust coefficient kF = 3×10^{-6} $N\cdot s^2$.”),

The system was simulated in MATLAB over an 8-second window at a fixed 0.01-second time step. A small rotor-speed perturbation was applied to observe uncontrolled behaviour. As expected for an under-actuated system, the simulation confirmed inherent open-loop instability roll, pitch, and yaw angles diverge continuously in the absence of feedback, validating the dynamic model and motivating the need for closed-loop control in the next stage.

3.2 Radar-Based Drone vs. Bird Classification

A complete micro-Doppler simulation and classification pipeline was implemented in MATLAB. Drone rotor motion was modelled using four blades rotating at 56 rps, while bird wingbeat was simulated as an 8 Hz sinusoidal velocity envelope. Short-Time Fourier Transform (STFT) spectrograms were computed, and three features were extracted per frame: mean Doppler energy, Doppler bandwidth, and spectral entropy.

An RBF-kernel SVM classifier was trained on these features. Under clean simulation conditions (SNR = 40 dB), the classifier achieved 100% accuracy. Under noisy and perturbed conditions mimicking real radar environments, accuracy was 94–96%. Drone spectrograms showed symmetric, high-frequency sidebands up to ±35 m/s, while bird signatures were confined to ±10 m/s with sinusoidal modulation providing clear spectral separability.

3.3 YOLO-Based Visual Drone Detection

A YOLOv4 object detector was trained using transfer learning on a custom-labelled UAV dataset in MATLAB, using pre-trained COCO weights initialised on the CSPDarknet53 backbone. The dataset was curated with images captured under varied lighting, backgrounds, and orientations. Training was carried out for 3 epochs using an NVIDIA RTX 1080 GPU, with validation loss dropping from ~16,000 to ~2.9, confirming effective transfer learning.

Testing revealed a data variance issue: the model performed well for distant drones but produced multiple overlapping detections on close-up targets, indicating the training data was skewed toward long-range imagery. This limitation was documented and factored into the Stage II dataset expansion strategy.

3.4 Mechanical Design and Component Selection

A 250 mm unibody X-configuration ABS frame was designed in Fusion 360 following Design for Additive Manufacturing (DfAM) principles. Hollow box-beam arms were used to maximise bending stiffness while minimising weight, with filleted junctions to reduce stress concentration. The frame was optimised for support-free printing with filament aligned to primary bending loads.

Component selection was driven by a 3:1 thrust-to-weight ratio target, yielding a total thrust requirement of approximately 2442 g. The EMAX ECO II 2306-1900KV motor was selected paired with a 5.1\" × 5.0\" tri-blade propeller, powered by a 3S 2200 mAh 40C LiPo battery with 30A ESCs. FEA in Ansys confirmed maximum von Mises stress of 10.65 MPa against an ABS yield strength of ~40 MPa, and a frame natural frequency of 431 Hz, well above the motor operating range of 166–266 Hz.

4. Technical Work Done Stage II (7th Semester)

4.1 SDR-Based RF Drone Detection — Prototype and Field Testing

A dual-SDR detection system was built using two HackRF One receivers. The first SDR, connected to an omnidirectional antenna, performed continuous wideband spectrum scanning across UAV communication bands (433 MHz, 868 MHz, 2.4 GHz, 5.8 GHz). FFT-based spectral analysis was used to compute power spectral density, followed by noise floor estimation and CFAR peak detection to isolate candidate drone signals.

Once a candidate was validated (via SNR, bandwidth occupancy, and frequency band checks), the second HackRF, connected to a Log Periodic Dipole Array (LPDA) directional antenna mounted on a motorised rotator, performed a 360-degree bearing scan. Received signal power was logged at each angular position to build a power map, and the peak angle was identified as the estimated drone bearing. Kalman filtering was applied to smooth the bearing estimate, and free-space path loss was used for distance estimation.

Field testing was conducted at 41 ADSR, Pune, with a DJI Mavic as the target UAV. The system successfully detected and logged the drone's RF emissions, estimated its bearing, and displayed the position on a radar GUI. The experiment validated the complete detection pipeline from spectrum capture to visual output.

4.2 YOLOv8 and SLAM-Based Vision Pipeline

A YOLOv8-nano model was integrated into a live camera tracking pipeline using Python and OpenCV. The detection was treated as a single regression problem, returning bounding box coordinates for identified targets. A strict confidence threshold of 0.8 was enforced to suppress false positives. The model.track() function was used to maintain temporal consistency — assigning unique IDs to targets across frames, enabling the system to retain lock through brief occlusions.

The error vector between the target centroid and the image centre was computed at each frame to drive a virtual PID flight controller. Since a physical IMU was not available on the test platform, Visual Odometry was used to estimate the drone's ego-motion from the camera feed. Initial testing of the YOLOv8 nano model on a standard workstation achieved an mAP50 of 79.2% on general datasets, with projected improvement to over 90% after fine-tuning on drone-specific datasets.

On the Raspberry Pi 5 target hardware, inference at 480-pixel resolution with INT8 quantisation achieved 6–20 FPS, with per-frame latency of 16–34 ms, sufficient for real-time virtual joystick corrections. Active cooling was identified as a requirement to prevent thermal throttling during sustained inference.

4.3 Hard-Kill Technique Survey and Architecture Design

A systematic comparative analysis of hard-kill counter-drone techniques was completed. High-energy lasers offer autonomous engagement independent of communication links but require high power and precise tracking. Net-capture systems are effective regardless of drone autonomy but are range-limited. Anti-aircraft weapons and kinetic projectiles carry high collateral risk and regulatory overhead. Interceptor drones were identified as the most suitable approach: they are capable of physically engaging the target airframe with medium collateral impact and are deployable within an autonomous guidance framework.

A phased interception architecture was designed with four functional layers: Sensing (EO/IR camera, IMU), Perception and Localisation (OpenCV preprocessing, YOLO detection, ORB-SLAM mapping), Decision and Planning (target tracking, interception logic, trajectory planner), and Control and Actuation (PI controller, PWM generation, ESC/motor driver). The architecture supports fully autonomous closed-loop operation from target acquisition to physical intercept.

4.4 Drone Reverse Engineering and Communication Protocol Mapping

The E88 WiFi FPV drone was acquired and its hardware initialisation sequence was reverse-engineered from schematics. The drone boots via STM32F030F4P6 microcontroller, pairs with a 2.4 GHz RF controller (XN297LBW), and streams video over a separate WiFi channel. The decoupled nature of the video and control channels allows video to be intercepted and processed externally without disrupting the control link, which is the basis of the Stage III integration strategy.

5. Proposed Final Stage Autonomous Interceptor System

5.1 Phased Integration Strategy

To manage risk and cost, the final stage follows a four-phase progression towards full autonomy. Rather than attempting to build and fly a complete autonomous interceptor immediately, each phase adds a discrete layer of capability on top of a stable, tested baseline.

Phase	Description	Hardware	Autonomy Level
Phase 1	**Ground-based YOLO detection. Raspberry Pi streams and processes video from a flying drone. Model detects target drone in real time.**	**E88 drone, Raspberry Pi 4B, RPi Camera V2**	**None – manual flight, ground inference**
Phase 2	**Raspberry Pi mounted onboard. YOLO runs in the air from the interceptor's own camera feed.**	**Same setup + airborne Rasp-berry Pi on interceptor**	**Sensor autonomy – detection in-flight**

Phase 3	**YOLO output drives PID controller. Interceptor autonomously adjusts flight to keep target centred.**	**Full interceptor platform**	**Full autonomy – no human input during pursuit**
Phase 4	**SLAM and depth estimation integrated. Field intercept trials with target E88 acting as rogue drone.**	**Complete system**	**End-to-end autonomous interception**

Infrastructure and Facilities at COEP Tech:

The pilot projects will leverage COEP's institutional contributions, including faculty expertise, laboratories, testing facilities, and technical infrastructure, which will serve as vital in-kind support.

5.2 Control and Guidance System

The trajectory planner will generate real-time intercept paths based on target position estimates from the YOLO and SLAM pipeline. A PI controller will regulate attitude and thrust commands, converting them into PWM signals for the ESC motor drivers. A Global Nearest Neighbour (GNN) tracker or Kalman Filter will be used for temporal target association, enabling occlusion handling across detection gaps. When the IMU is unavailable, monocular Visual Odometry will provide ego-motion estimates.

5.3 Edge Deployment

The final system targets deployment on the Raspberry Pi 5 (primary) and NVIDIA Jetson Nano (secondary for GPU-accelerated inference). On the Raspberry Pi, the YOLOv4-tiny model will be used with INT8 quantisation to maintain acceptable frame rates. On the Jetson, MATLAB GPU Coder will generate optimised CUDA C++ code for the YOLOv4 model. Both paths are currently under evaluation.

5.4 Transfer Learning and Dataset Expansion

The training dataset will be expanded using VisDrone and custom-labelled Roboflow datasets to improve UAV-to-UAV detection performance. Data augmentation will include rotation, scaling, and motion blur to simulate high-speed pursuit conditions. The fine-tuned model is expected to achieve mAP50 above 90% on drone-specific targets.

6. Prototype Programme and Implementation Timeline

EE-01	Domain	Deliverable	Timeline
EE-01	UAV Dynamics	Closed-loop PID/LQR controller for quadrotor, validated in MATLAB/Simulink	March 2026
EE-02	RF Detection	Integrated SDR detection with autonomous bearing-to-flight handoff	April 2026
EE-03	Computer Vision	YOLOv8-based drone tracker running onboard Raspberry Pi 5	April 2026
EE-04	Interception	Autonomous field intercept trial – interceptor drone pursues and engages E88 target	May 2026
EE-05	Documentation	Final project report and presentation	May 2026

7. System Architecture Overview

The complete autonomous C-UAS system integrates three detection modalities, a trajectory planning engine, and a physical interception actuator. The architecture is organised as follows:

Layer	Component	Technology
Detection — RF	Wideband spectrum monitoring, directional bearing estimation	Dual HackRF SDR, LPDA antenna, CFAR, GNU Radio
Detection — Vision	Real-time UAV identification and bounding box localisation	YOLOv8-Nano, OpenCV, RPi Camera Module V2
Detection — Radar	Micro-Doppler signature classification for drone vs. bird	STFT spectrograms, SVM classifier, MATLAB
Localisation	Ego-motion estimation, 3D spatial mapping	ORB-SLAM3, Visual Odometry, Monocular Depth Estimation
Decision	Target tracking, interception logic, trajectory computation	Kalman/GNN Tracker, Intercept Geometry Algorithms, Python
Control	Attitude/thrust regulation, motor PWM generation	PI Controller, ESC Motor Driver, STM32 Flight Controller
Airframe	Interceptor quadrotor platform	E88 Development Drone Custom ABS/Carbon Fibre Frame

8. Risk Assessment and Mitigation

Risk	Likelihood	Impact	Mitigation
Raspberry Pi compute insufficient for real-time YOLO	Medium	High	Fallback to Jetson Nano with GPU acceleration; INT8 quantisation and YOLOv8-Tiny as primary model
RF signal masked by environ-mental interference	Medium	Medium	CFAR adaptive thresholding; complementary YOLO detection provides redundancy
Autonomous intercept causes collision/damage	Low	High	Phased testing in open field; failsafe Return-to-Home (RTH) and signal-loss protocols; net-based soft intercept considered for early trials
Training data insufficient for drone-on-drone detection	Medium	High	VisDrone dataset plus custom Roboflow label-ling; aggressive data augmentation pipeline
Communication reverse-engineering incomplete	Low	Medium	Wi-Fi sniffing approach as primary method; direct hardware bypass as fallback

9. Investment and Resource Requirements

The proposed autonomous drone detection and interception system requires a combination of commercially available UAV hardware, embedded computing platforms, RF sensing equipment, and rapid prototyping resources. The primary hardware includes two E88/F8 WiFi FPV drones that serve as the target UAV and initial interceptor development platform, Raspberry Pi 4B/5 boards for onboard computer vision and trajectory planning, RPi Camera Modules for visual sensing, and a dual HackRF One software-defined radio (SDR) setup with LPDA directional antennas for RF-based drone detection and bearing estimation. Additional components include a motorised antenna rotator, propulsion hardware consisting of EMAX ECO II brushless motors and ESCs, LiPo batteries, and custom 3D-printed airframe structures fabricated using ABS filament. The estimated total hardware expenditure is approximately ₹68,000–₹75,000, with a significant portion of the required equipment already procured during earlier project stages. Software development and system validation will leverage both licensed institutional tools and open-source frameworks. MATLAB, Simulink, and associated toolboxes will be used for dynamic modelling, controller design, and machine learning development, while Python-based tools including Ultralytics YOLOv8, OpenCV, and GNU Radio will support computer vision and RF signal processing tasks. Mechanical design and structural verification will be performed using Fusion 360 and Ansys Mechanical,respectively. Additional open-source resources such as ORB-SLAM3 and Roboflow will be utilised for localisation, dataset preparation, and model training. The combination of existing hardware assets, institutional software licenses, and open-source technologies significantly reduces project cost while ensuring the availability of a complete development ecosystem for achieving the targeted Technology Readiness Levels (TRLs).

10. Stakeholder Value Proposition

For DRDO and Defence Agencies

This project delivers a working, end-to-end prototype of an autonomous hard-kill C-UAS system, built entirely from domestic effort. The detection stack combining RF sensing, radar classification, and computer vision mirrors the multi-modal approach recommended in military drone defence doctrine. The platform can serve as a low-cost testbed for evaluating engagement algorithms and sensor fusion strategies.

For Airport Operators and Smart City Planners

The vision-RF fused detection system offers a deployable perimeter monitoring framework at a fraction of commercial system costs. The SDR-based RF scanner can be tuned to monitor specific drone brands or protocols, and the YOLO pipeline can be updated with new training data to adapt to evolving drone form factors without hardware changes.

For the Broader Drone and Defence MSME Ecosystem

The open architecture of this system built on commodity hardware (Raspberry Pi, HackRF), open-source software (YOLOv8, ORB-SLAM, GNU Radio), and standard communication protocols means the codebase and methodology are accessible for further development by MSMEs and startups without requiring specialised proprietary tools.

For the Institution

This project establishes COEP Tech's Electrical Engineering department as a credible contributor to autonomous systems and defence electronics research. The multi-semester, multi-domain scope spanning control theory, RF engineering, computer vision, and mechanical design demonstrates the department's capacity to execute complex, integrated engineering projects aligned with national strategic priorities.

11. References

[1] T. Luukkonen, "Modelling and Control of Quadcopter", Independent Research Project in Applied Mathematics, Aalto University, Aug. 2011.

[2] S. Park, H. T. Kim, S. Lee, H. Joo, and H. Kim, "Survey on Anti-Drone Systems: Components, Designs, and Challenges", IEEE Access, vol. 9, pp. 42666–42695, 2021.

[3] Y. V. Ahirrao, R. P. Yadav, and S. Kumar, "RF-Based UAV Detection and Identification Enhanced by Machine Learning Approach", IEEE Access, Nov. 2024.

[4] F.-L. Chiper et al., "Drone Detection and Defence Systems: Survey and a Software-Defined Radio-Based Solution", Sensors, vol. 22, no. 4, p. 1453, 2022.

[5] R. M. Narayanan, B. Tsang, and R. Bharadwaj, "Classification and Discrimination of Birds and Small Drones Using Radar Micro-Doppler Spectrogram Images", Signals, vol. 4, no. 2, pp. 337–358, 2023.

[6] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection", Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2016.

[7] A. Bochkovskiy, C.-Y. Wang, and H.-Y. M. Liao, "YOLOv4: Optimal Speed and Accuracy of Object Detection", arXiv:2004.10934, 2020.

[8] R. Mur-Artal, J. M. M. Montiel, and J. D. Tardós, "ORB-SLAM: A Versatile and Accurate Monocular SLAM System", IEEE Transactions on Robotics, vol. 31, no. 5, pp. 1147–1163, 2015.

[9] M. Pliska, M. Vrba, T. Báča, and M. Saska, "Towards Safe Mid-Air Drone Interception: Strategies for Tracking and Capture", IEEE Robotics and Automation Letters, vol. 9, no. 10, pp. 8810–8817, Oct. 2024.

[10] M. S. Allahham, T. Khattab, and A. Mohamed, "Deep Learning for RF-Based Drone Detection and Identification: A Multi-Channel 1-D CNN Approach", International Conference on Internet of Things (ICIoT), 2020.

[11] V. Chamola et al., "A Comprehensive Review of Unmanned Aerial Vehicle Attacks and Neutralization Techniques", Ad Hoc Networks, vol. 111, 2021.

[12] S. M. Parandha and Z. Li, "Design and Analysis of 3D Printed Quadrotor Frame", International Advanced Research Journal in Science, Engineering and Technology (IARJSET), vol. 5, no. 4, 2018.

8. COEP-CANEUS Pilot Project Fund (CC-PPF)

Nomenclature. This initiative is recognized as the COEP-CANEUS Pilot Project Fund, also referred to as the Workshop Project Acceleration Fund.

Fundamental Concept. The CC-PPF is a project-specific, pre-market financial instrument crafted to provide seed or matching assistance for high-priority ventures originating from the COEP-CANEUS forum. It is not intended as a venture capital pool; rather, it mitigates preliminary implementation hazards to attract supplementary industrial and governmental support.

1.0 Rationale and Strategic Necessity

The COEP-CANEUS sessions define industrial hurdles in sectors like advanced materials, intelligent sensing, and Mid-TRL transition. Often, promising innovations stall post-workshop because stakeholders lack formalized structures, legal frameworks, or immediate fiscal backing.

Gap Mitigation. The fund addresses these deficiencies by:

- Sustaining progress via immediate post-selection team assistance.
- Translating industry-defined problems into actionable proof-of-concept ventures.
- Establishing a rigorous methodology for securing matching capital.
- Minimizing preliminary technical, financial, and partnership hazards prior to large-scale funding pursuits.

2.0 Scope of Fund Support

Initial efforts will target the primary 3–5 projects in materials and sensing, offering partial resources for:

- Technical due diligence, project scoping, and implementation planning.
- Design of prototypes, materials synthesis, and testbed formulation.
- Physical, laboratory, and field validation protocols.
- Integration planning and alignment with industry requirements.
- Formulating IP strategies and data-sharing consortium agreements.
- Drafting follow-on proposals for larger government or industrial grants.

3.0 Architecture and Financial Model

The fund functions as a managed, project-specific contribution tool. Every pilot utilizes a blended financing structure:

- Direct Fund Assistance: Seed or matching grants covering 20-40% of approved costs.
- Industrial/User Contribution: Cash, facilities, or participation in field trials.
- Institutional In-Kind: Faculty mentorship, student research, and laboratory infrastructure.
- Government Grants: Pursued for mature projects ready for national programs.
- Operating Reserve: Fixed percentage for transparent project coordination and reporting.

4.0 Methodology for Project Selection

Post-event selection follows a transparent framework prioritizing industry-originated, technically sound concepts capable of demonstrating Mid-TRL milestones within 6-18 months.

Primary Criteria:

- Validated industry or end-user problem definition.
- Alignment with COEP academic expertise and research assets.
- Strategic CANEUS role in consortium alignment and stakeholder management.
- Formal commitment from industrial or validation partners.
- Feasible transition pathway to secondary funding or commercial deployment.

5.0 Governance and Management Principles

An investment review committee assesses each project's suitability as a collaborative pre-market pilot.

Stakeholder Role	Management Function	Constituent Participants
Steering Committee	Validate criteria, authorize funding, and oversee milestone progression.	COEP, CANEUS, primary contributors, and domain advisors.
Project Team	Develop technical briefs, budgets, IP strategies, and delivery schedules.	COEP faculty/scholars, industry partners, and CANEUS leads.
CANEUS Coordination	Align consortia members, support teaming, and map transition roadmaps.	CANEUS project office and strategic sector specialists.
COEP Institutional	Host prototyping, lead research, provide lab access, and manage talent.	Specific COEP departments and specialized technical centers.

6.0 Value Proposition for Contributors

Participants gain value through strategic proximity and innovation access rather than direct fiscal returns. Strategic advantages include:

- Early Intelligence: Direct visibility into emerging technologies and industry gaps.
- Operational Engagement: Involvement in technology reviews and field trials.
- Priority Access: First-right opportunities for downstream licensing or partnership.
- Global Connectivity: Integration into international aerospace and energy innovation networks.

7.0 Intellectual Property and Teaming Protocols

Commercialization terms are project-specific; no uniform IP model is enforced.

- Pre-requisite: A concise teaming agreement is mandatory prior to resource allocation.
- Defined Scope: Protocols must address background IP, data sovereignty, and commercial pathways consistent with COEP/CANEUS standards.

8.0 Preliminary Project Pipeline (First 60 Days)

Vetted projects must establish detailed implementation roadmaps within a 30-to-60-day window.

Sector Track (Tentative)	Indicative Outcome	COEP Tech Mandate	CANEUS Mandate
Advanced Materials	Validated coatings, coupons, and scaling strategies.	Characterization and testing.	Consortium and IP alignment.
Smart Sensors	Harsh-environment demos and SHM testbeds.	System integration and analysis.	Standards and user linkage.
Reliability / Twins	Predictive models and failure databases.	Physics-based modeling.	Funding and roadmap oversight.

9.0 Proposed Launch Sequence

1. Finalize fund scope and definitive nomenclature.
2. Confirm preliminary contributors and participation models.
3. Release 1-page stakeholder brief defining governance and value.
4. Establish selection criteria and application templates.
5. Inaugurate the COEP-CANEUS review committee.
6. Select initial pilots and finalize IP agreements.
7. Leverage pilot results to pitch for national funding programs.

Appendix-I

Detailed Program Outline & Workshop Management Guidelines

1.0 Workshop Objectives

- Identify and accelerate Mid-TRL technologies towards commercialization
- Facilitate Defence, Aerospace, Energy, and Automotive collaboration
- Build structured industry–academia–government partnerships
- Capture MoU-ready opportunities and pilot projects
- Strengthen India's indigenous R&D and manufacturing ecosystem

2.0 Thematic Tracks

2.1 Aerospace & Defence

- Aircraft systems and subsystems
- Avionics and embedded systems
- Structural materials and composites
- UAV and autonomous systems
- Defence electronics and sensors

2.2 Energy Systems

- Advanced power systems
- Renewable integration technologies
- Energy storage systems
- Defence-energy dual-use technologies

2.3 Advanced Manufacturing

- Additive manufacturing
- Precision machining
- Digital manufacturing and Industry 4.0
- Quality assurance systems

3.0 Workshop Structure

Day 1 – Vision, Policy & Technology Landscape

- Inaugural session

- Government keynote addresses
- Industry vision presentations
- Technology gap identification panels

Day 2 – Deep Technical Tracks

- Parallel sector breakout sessions
- Mid-TRL technology showcases
- Case studies from industry
- Problem definition workshops

Day 3 – Transition & Execution Pathways

- Industry - R&D matchmaking
- MoU drafting sessions
- Funding & commercialization frameworks
- Closing plenary and roadmap consolidation

4.0 Speaker & Session Templates

4.1 Speaker Profile Template

- Name:
- Organization:
- Designation:
- Domain Expertise:
- Key Projects:
- Relevance to Workshop:

4.2 Speaker Presentation Template

- Presentation Title:
- Name:
- Organisation:
- Introduction to Company:
- Problem Statement:
- Current Problem:
- Current State:
- Desired State to be :

- Gap Analysis:
- Company's Needs:
- Proposed Areas of Collaboration:
- IP Ownerships:
- Resources Required:
- TimeLine of the Project:

4.3 Session Structure Template

- Session Title:
- Objective:
- Moderator:
- Speakers:
- Key Discussion Points:
- Expected Output:

5.0 Rapporteur Reporting Sheet

Session Summary

- Session Title:
- Date & Time:
- Key Observations:
- Technology Gaps Identified:
- Collaboration Opportunities:
- Proposed Actions:

Output Classification

- Immediate Actions (0–6 months)
- Mid-Term Actions (6–18 months)
- Long-Term Actions (18+ months)

Individual Presentation Summary

- Presentation Title
- Author
- Company Information
- Notes Taken By:
  - Statement of Problem Description:

- o Accomplish to date:
- o Technology Synergies:
- o Applications:
- o Stakeholder involvement:
- o Other discussion points:

6.0 MoU / Collaboration Capture Form

- Organization A:
- Organization B:
- Nature of Collaboration:
- Technology Area:
- TRL Level:
- Expected Deliverables:
- Funding Requirement:
- Timeline:
- IP Considerations:
- Contact Persons:

7.0 Funding & Execution Framework

- Government Grants & Schemes
- Industry Co-Funding Models
- Defence Procurement Pathways
- International Collaboration Funding
- Public–Private Partnership (PPP) Models
- Pilot Project Fund

8.0 Technology Transition Framework

- TRL 1–3: Research Phase
- TRL 4–6: Validation & Prototyping
- TRL 7–9: Deployment & Commercialization

Key Transition Enablers:

- Testbeds
- Certification support

- Industrial pilots
- Defence validation channels

9.0 Logistics & Operations

- Registration desk setup
- Badge classification system
- Room allocation by track
- Audio-visual requirements
- Documentation & recording system

10.0 Expected Outcomes

- 30–50 structured technology transition proposals
- 10–20 draft MoUs
- National roadmap for Mid-TRL acceleration
- Cross-sector innovation clusters
- Investment-ready project pipeline

Appendix-II

Technology Evaluation Criteria Matrix

Each technology proposal may be assessed using the following scoring framework:

Parameter	Description	Weight (%)	Score (1–5)
TRL Level	Current maturity level	20	
Innovation Value	Novelty and uniqueness	15	
Industrial Relevance	Applicability to industry	20	
Defence/Aerospace/Energy Impact	Strategic importance	15	
Commercial Potential	Market viability	15	
Scalability	Ease of scaling production	10	
Funding Readiness	Ability to attract funding	5	

Total Score = Weighted Sum / 5

Decision Bands:

- 80–100: High priority for transition
- 60–79: Medium priority
- Below 60: Requires further development

Appendix-III

Risk & Compliance Checklist

This checklist ensures all collaborations comply with regulatory, legal, and strategic requirements.

1. Legal & IP

- NDA signed between parties
- IP ownership clearly defined
- Background IP documented
- Export control compliance verified

2. Security & Defence Compliance

- No restricted technology violations
- Compliance with national security guidelines
- Data classification (if applicable)

3. Funding Compliance

- Funding source identified
- Audit trail established
- Conflict of interest declared

4. Project Execution Risk

- Technical feasibility assessed
- Supply chain availability confirmed
- Timeline realism validated

5. Collaboration Readiness

- Defined roles and responsibilities
- Communication plan established
- Milestone tracking mechanism

Appendix-IV
Questionnaire.

1. **What all comes under strategic Partnership?**
2. **Technical Expertise team's earlier experience.**
3. **Case studies of the projects done earlier**
4. **How funding is coming?**
5. **Are you ready to do NDA?**
6. **How are you going to decide which problems to be selected?**
7. **Timeline of the project.**

1. What all comes under Strategic Partnership?

A strategic partnership is not just collaboration, it's **co-development + co-investment + co-ownership of outcomes**. It typically includes:

- **Technology Co-Development**
    - Joint R&D programs (TRL 3-6 focus)
    - Access to labs, simulation platforms, test beds
- **Industrial Participation**
    - OEMs, Tier-1/2 suppliers, MSMEs integration
    - Supply chain localization and indigenization
- **Academic & Talent Pipeline**
    - Universities, research institutes, skilling programs
- **Government Alignment**
    - Policy support, regulatory facilitation, national missions
- **IP & Commercialization Framework**
    - Defining Background IP Ownerships
    - Arising Joint IP ownership models
    - Licensing and commercialization pathways
- **Market Access**
    - Entry into India/global markets via partners

So, in summary, we are building "An ecosystem-led model, bridging research, industry, and government to accelerate mid-TRL innovation into deployable solutions."

2. Technical Expertise & Team Experience

We need to communicate to the stakeholders that we will have our Projects framed across three layers as defined below:

a) Core Team

- Aerospace, defence, nuclear, automotive domain experts from CANEUS and COEP TU
- Systems engineering, design, manufacturing specialists
- Digital engineering (AI/ML, digital twins, simulation)

b) Advisory Board

- Former OEM leaders, DRDO scientists, policy experts including senior experts from CANEUS and COEP TU
- International collaborators when needed (Canada, EU, etc.)

c) Execution Partners TO CANEUS-COEP TU

- Industry (OEMs, Tier-1s)
- Research labs (materials, propulsion, electronics)
- MSMEs in India providing special materials, processes & computational/design capabilities

We highlight:

- Our (CANEUS/COEP TU) years of cumulative experience
- Programs worked on (engines, structures, materials, sensors etc.)
- Cross-sector capability (aerospace + energy + defence)

3. Case Studies of Previous Projects

CANEUS and COEP will provide information projects carried previously in the format below.

- **Project Title**
- **Problem Statement**
- **Solution Developed**
- **Technology Readiness Level (TRL in when started and TRL out when completed)**
- **Industry Impact**
- **Partners Involved** (If naming isn't possible, we should only name sectorial industry)

Examples we can provide:

- Advanced manufacturing setup (e.g., aerospace components)- from COEP TU
- Simulation/digital twin initiatives- From COEP TU
- Industry–academia collaborative programs- From COEP TU

- Large scale multi-industry (OEM) Collaboration on special themes-CANEUS
- Defence or energy-related technology pilots- COEP TU

If we find that we have Gaps, then we can frame those areas as:
"Early-stage pilots and ongoing collaborations with defined plans for scaling up."

4. How is the Funding Coming?

We may have a blended funding model:

- **Government Funding**
  - Central/state schemes (MeitY, DRDO, DST, Maharashtra Govt etc.)
- **Industry Contributions**
  - Sponsored R&D
  - Membership or participation fees
- **International Grants**
  - Bilateral programs (e.g., Canada–India collaborations)
- **Private Capital**
  - Strategic investors, venture funding
- **Revenue Streams**
  - Training programs
  - IP licensing
  - Testing & certification services

So, we will be positioning ourselves clearly: "No single dependency i.e. our risk will be diversified across public, private, and program-based funding."

5. Are we Ready to Do NDA?

Answer to Clients should be direct:

- Yes, fully prepared to execute **Non-Disclosure Agreements (NDAs)** and **IP protection frameworks**
- Standard practices will include:
  - Confidentiality agreements (bilateral/multilateral)
  - Data security protocols
  - Controlled access environments
- For other type of agreements/protocols, we will be flexible for any:
  - OEM-specific compliance requirements
  - Government security protocols (defence/nuclear)

We can emphasize that “IP protection and confidentiality are foundational to our operating model.” We will always protect the Client’s IP as well as ours.

6. How Will You Decide Which Problems to Select?

Generally, our protocol will be the following structured selection framework as follows:

Criteria:

- **National (India’s) Priority Alignment**
  (Defence, aerospace, energy & mobility)
- **Industry Demand**
  (Validated by OEMs/Tier-1s)
- **Technology Gap**
  (Clear TRL gap: typically, 3-6 or 7)
- **Commercial Potential**
  (Scalability and market relevance)
- **Feasibility**
  (Available expertise, infrastructure & laboratories)
- **Time-to-Impact**
  (12-36 months horizon)

Process:

1. Problem statements sourced from industry/government
2. Technical screening committee evaluation
3. Feasibility & impact scoring
4. Final selection with partner alignment

The CANEUS-COEP TU team is positioning as: “A demand-driven, impact-focused selection, not academic exploration.”

7. Timeline of the Project

We believe that we will be working towards the following **phased roadmap**:

Phase 1: Setup (0-6 months)

- Partnerships formalized
- Infrastructure & team setup
- Problem statements identified

Phase 2: Pilot Projects (6-18 months)

- Initial R&D project launched
- Prototypes/digital models developed
- Industry validation begins

Phase 3: Scale-Up (18-36 months)

- Technology maturation (TRL progression)
- Industry deployment
- IP generation & commercialization

Phase 4: Expansion (3-5 years)

- Global partnerships
- Multi-sector scaling
- Revenue stabilization

So, basically, we will provide "From concept to commercialization within a 24–36-month innovation cycle."

In summary:

We can summarize our entire response with a strong positioning statement:

"This initiative is designed as a mission-driven, industry-aligned platform that converts high-potential ideas into deployable technologies. These are carried out through structured partnerships, secured funding, and disciplined execution."

Rapporteur Summary Sheet Format

Track A/B/C/D

NOTE TAKER INSTRUCTIONS: *For each speaker/presentation please summarize your notes using the following table. Include note summaries for only those categories that the presenter actually discussed. If the category was not discussed just leave the cell blank. It is easier to simply type the notes in raw form during the session then after the session has ended go back through your notes expanding on what you missed and summarizing the information using the table. Include your raw notes below each table*

Presentation Title [Name of company]
[Name of Presenter or Author]
Notes Taken By: [NAME]
Technology Description [Statement of Problem]:
Accomplishments to Date:
Technology synergies: **Discuss the complementary technologies or developments identified by the presenter that are addressed by or could benefit from the other TRANSIT Workshop Sector Consortia**
Applications:
Stakeholder Involvement: **What stakeholders (end-users, customer, government, funding orgs, universities, labs, etc.) were identified during the presentation?**
Regulatory Compliance Issues: **What regulatory issues were discussed during the session**
Other Discussion Points:
Q&A:

Raw Notes:

Quad Chart Format

Task Title

FY26 - Title of TRANSIT 2026 Working Group/Team Supported

Last Update : MM/DD/YY

Relevance to Workshop: List a few sentences on why this work is relevant to the goals of NEXT and what issue/objective is being addressed. Describe how this work benefits the near and long term needs of Participant/ Contributor. Discuss the applicable design reference missions/architectures in terms of environments and applications. State why it is important that this work be done now.

Approach: Provide a few sentences which simply and clearly describe the basic premise behind the technology or concept to be studied. Mention the means and methods of task execution and validation (analytical, testing, etc). Address the level of internal and external collaborations and leverage involved. Cite the performance metric parameters that will determine success.

Replace this box with representative imagery
- Annotate with text if the image is not obvious
- Try to use jpg images and limit image size to <1Mb to preserve quad chart emailability

Minimum Font Size = 10

Background :

Note the innovation and merits of this work relative to past efforts by others.

Task Milestones/Products:

Month/Year - TBD Meeting

Month/Year - TBD Review/Event

Month/Year - Final report

Must supply final report with completion month/date listed. Should also estimate several key events like design/requirement reviews, tests, meetings, workshops, conferences and websites. A graphical schedule is not required.

Resources:

Fiscal Year	26-27	27-28	28-29	29-30
GOV Funding (₹K)	XXX	XXX	XXX	XXX
Company/ Private(₹K)	XXX	XXX	XXX	XXX
Labor	X.X	X.X	X.X	X.X
Others	X.X	X.X	X.X	X.X

Participants: List Organizations, Universities and Industry.

List address of relevant website when known

POC: List name, 10 digit phone # and email of technical rep

COEP-CANEUS Intellectual Property Policy

International Collaborative Projects and Workshop-Originated Consortia

1. Purpose & Objectives

The primary mandate of this policy is to accelerate the commercialization of R&D outcomes emerging from COEP-CANEUS collaborative initiatives. Core objectives include:

- **Commercial Incentives:** Cultivating an ecosystem that prioritizes active commercial development, high-skill job creation, and industrial expansion.
- **Equitable Rewards:** Establishing a transparent framework for distributing commercialization benefits among inventors and participating organizations.
- **Collaborative Leverage:** Motivating partners to utilize shared technical facilities and expertise for mutual economic impact.

2. Core Principles of IP Management

- **Ownership of Contributions:** Participating entities maintain title to the intellectual contributions they introduce to or develop within a project.
- **Streamlined Joint IP:** To mitigate legal friction, ownership of collaborative IP is assigned to a single party where feasible, with compensation defined in the **Project Teaming Agreement.**
- **Access Based on Project Type:**
  - **Pre-competitive Projects:** High-risk collaborative research where all institutional partners retain rights for internal use.
  - **Proprietary Projects:** Targeted developments where access to enabling details is restricted strictly to Project Team members.
- **The Brokerage Role:** COEP-CANEUS serves as a neutral broker to facilitate technology transfer and maximize value in strategic markets.

3. Key Definitions

- **Intellectual Property (IP):** All protectable assets including patents, trademarks, trade secrets, and technical know-how generated during project execution.
- **Background IP:** Pre-existing technology owned by a partner prior to the project. Ownership remains exclusively with the originating entity.
- **Jointly Developed IP:** Technological innovations conceived or realized collectively by two or more partners during the collaborative effort.
- **Project Teaming Agreement:** The definitive governing document defining the IP strategy, valuation, and compensation for a specific initiative.

4. Licensing and Commercialization

- **Internal Use Rights:** Corporate partners retain the right to internal application of project IP, though third-party sales require established title ownership.
- **Royalty Caps:** Cumulative royalties are typically limited to a pre-agreed percentage of the final product's sell price.
- **Disclosure Requirements:** Partners must promptly report patentable innovations. If a title holder declines protection, other partners may negotiate for those rights.

5. Enforcement and Transfers

- **Infringement Notice:** Parties must provide written notification prior to initiating infringement claims against third parties regarding shared IP.
- **Transfer Restrictions:** Assignment of interest in joint IP to third parties is prohibited without prior written consent from all team partners.

Project Teaming Agreement (PTA) Framework

Project Title: [Insert Project Name]

Effective Date: [MMM DD, YYYY]

Project Manager: [Insert Lead Organization/Contact]

1.0. Scope and Objectives

This initiative is established under the operational framework of the **COEP-CANEUS Partnership**. The central mandate is to transition identified concepts into [Proof-of-Concept / Prototype / Validation / Qualification] milestones as detailed in the **Detailed Project Plan**.

2.0. Project Team and Governance

The Project Team comprises critical stakeholders forming the Innovation Triad:

- **End User:** [Organization Name]
- **System Integrator:** [Organization Name]
- **Technology Provider:** [Organization Name]
- **Service/Research Provider:** [Organization Name]
- **COEP Institutional Role:** Execution of research, prototyping, and technical reporting.
- **CANEUS Coordination Role:** Consortium structuring and strategic stakeholder alignment.

3.0. Intellectual Property (IP) Plan

Governed by the **COEP-CANEUS IP Policy**, the following provisions apply to this specific initiative:

3.1. Background IP:

- Title remains exclusively with the originating Partner as defined in **Exhibit A**. Negotiation for required licenses will be conducted in good faith to enable commercialization.

3.2. Foreground (Project) IP:

- Sole inventions remain with the creator. Jointly developed IP title will be assigned to [Lead Partner Name] to facilitate market entry, with contributing Partners compensated per the **Compensation Schedule (Exhibit B)**. Partners retain royalty-free usage rights for internal R&D.

3.3. Licensing and Royalties:

- Aggregate royalties are capped at [X%] of the product sell price. System Integrators are granted sufficient IP control to maintain market competitiveness.

4.0. Funding and Resource Allocation

Project financing utilizes a blended assistance structure:

- **Pilot Project Fund (CC-PPF)**: [20–40%] pre-market matching assistance.
- **Industry Contribution**: Cash or in-kind assets including test articles.
- **Institutional Contribution**: COEP technical infrastructure, laboratory access, & faculty expertise.

5.0. Confidentiality and Data Sharing

All technical exchanges and proprietary data are governed by the confidentiality provisions established in the COEP-CANEUS Partnership Agreement. Identified innovations must be disclosed within one week of discovery.

6.0. Implementation Roadmap

This project aims to clear demonstrable Mid-TRL gates within [6–18 months], following a three-phase progression:

Phase 1: Technical due diligence, implementation planning, and detailed scoping (30–60 days).

Phase 2: Core technical development and laboratory/field validation protocols.

Phase 3: Final technical reporting and follow-on proposals for large-scale funding programs

Signatures of Authorizing Agents

Partner Organization	Name & Title	Signature	Date
COEP Tech University			
CANEUS International			
[Partner 1]			
[Partner 2]			

Non-Disclosure Agreement

between

[Contract Partner / Workshop Participant Name]

[Address]

[Post Code, City]

[Country]

and

[Contract Partner / Workshop Participant Name]

[Address]

[Post Code, City]

[Country]

– all of the above hereinafter being referred to individually as the "Party" or collectively as the "Parties." –

0. Scope and Definitions

Prior to, during the process of negotiations, and within the framework of business relations between the Parties, it may be the case that Confidential Information will be disclosed by a Party to the other Party, or by an Affiliate of a Party to the other Party.

"Confidential Information" includes, but is not limited to:

- various data, findings, experiences, technologies, or other information,
- software and associated documents, computer printouts, other data carriers, computer recordings or other documents, in particular drawings, descriptions, specifications, protocols, cards, microfilms, or
- samples, specimens, models or type-specific devices, such as tools and measuring equipment.

"Affiliates" are all companies:

- in which the respective Party individually or jointly, directly or indirectly holds a majority interest,
- which individually or jointly, directly or indirectly hold a majority interest in the respective Party ("Holding Company"), or
- in which a Holding Company of the respective Party holds a majority interest, either individually or jointly, directly or indirectly.

1. Confidentiality

The recipient in relation to which Confidential Information is made available (hereinafter referred to as the "Recipient") by the discloser (hereinafter referred to as the "Discloser") hereby undertakes to keep such Confidential Information confidential, not to make it available to any third party and to keep it secure. The Recipient may use Confidential Information only for the purpose designated or permitted by the Discloser.

2. No Duty to Disclose

This Non-Disclosure Agreement does not create any obligation to disclose Confidential Information.

3. Title, Duplication, Return and Destruction

Confidential Information shall remain the property of the Discloser. It may not be reproduced without the prior written consent of the Discloser, which may be revoked at any time. This prohibition shall not apply to copies which inevitably occur within the scope of data transmission processes (e.g. e-mail, fax) due to technical circumstances. Physical copies shall become the property of the Discloser of Confidential Information at the time of production. The Parties hereby agree on the transfer of ownership and further agree that the Recipient shall take the copies into its custody on behalf of the Discloser.

Upon the request of the Discloser, the Recipient shall immediately return or destroy Confidential Information and any copies thereof. Upon request, the Discloser shall be provided with a written declaration stating that the Confidential Information has been destroyed. The obligation to return or destroy shall not apply to copies of Confidential Information which the Recipient must archive due to mandatory commercial and/or tax regulations, nor shall it apply to any routinely made back-up copies of electronic data. In such case, the Recipient hereby undertakes to keep such copies separately and to treat them for an indefinite period in accordance with the confidentiality obligations of this Non-Disclosure Agreement.

4. Use of Confidential Information / Need-to-know Principle / No recording of Telephone and Videoconferences

The Recipient may make available Confidential Information and copies of such only to employees or employee-like persons (e.g. temporary workers) only insofar as such persons need to know the Confidential Information for the purposes intended or permitted by the Discloser and only to the extent needed to carry out these purposes; the above mentioned persons shall be made subject to duties of confidentiality by the Recipient corresponding to those contained in this Non-Disclosure Agreement prior to any transfer, unless such persons are already legally or contractually obliged to maintain confidentiality (e.g. on the basis of an employment contract). In the event of any breach of confidentiality by one of the aforementioned persons, the Recipient shall be directly liable to the Discloser.

Important Note: Without the express prior consent of the Discloser, the recording of telephone or video conferences in whole or in part (even if only temporarily) is strictly prohibited. The same applies for taking screenshots.

5. Consultants and Affiliates

Disclosure of Confidential Information to consultants (e.g. attorneys, tax consultants, auditors) or Affiliates shall be permitted if and to the extent that such persons need to know the Confidential Information for the purposes intended or permitted by the Discloser and if and to the extent that they are subject to duties of confidentiality corresponding to those in this Non-Disclosure Agreement. The Recipient shall be directly liable to the Discloser for any breach of these obligations by such Affiliate or such consultant.

Furthermore, the Recipient shall be entitled to pass on Confidential information to a third party within the scope of contract data processing, if and to the extent that the third party is subject to duties of confidentiality corresponding to those in this Non-Disclosure Agreement. The Recipient shall be directly liable to the Discloser for any breach of these obligations by such third party.

6. Export Control

The Parties shall comply with all export control laws and regulations of India, EU, USA or any other export control regulations, as applicable. The Discloser shall obtain all necessary permits before transferring Confidential Information to the Recipient and shall inform the Recipient unrequested of any respective export control classification number (e.g. US law ECCN) for the Confidential Information and any restrictions on its transfer.

7. Exceptions to Confidentiality Obligation

Notwithstanding any other provisions of this Non-Disclosure Agreement, the above obligations shall not apply,

- to the extent that the Confidential Information is or becomes publicly available without any breach of this Non-Disclosure Agreement on the part of the Recipient,
- to the extent that the Recipient is entitled to know the Confidential Information without any obligation of confidentiality at the time of receipt or thereafter,
- to the extent that the Confidential Information was developed independently by employees of the Recipient without knowledge of the Confidential Information provided by the Discloser,
- to the extent that the Recipient is obliged to disclose the Confidential Information of the Discloser within the framework of judicial, official or similar procedures and the Recipient informs the Discloser without undue delay of such a request in written form, enclosing appropriate evidence (e.g. copies).

The Recipient shall bear the burden of proof with respect to the existence of such exceptions.

8. Rights and Licences

The Discloser hereby reserves all rights (including copyright, rights of use and exploitation as well as the right to apply for industrial property rights such as patents, utility models, designs, topography protection rights, etc.) with regard to Confidential Information. This Non-Disclosure Agreement and the mutual communication of Confidential Information, whether proprietary rights exist or not, shall not grant any rights of ownership, rights to license, reproduce or use or any other rights beyond the use permitted to the extent described in this Non-Disclosure Agreement.

9. Effective Date, Term and Post-Contractual Confidentiality Period

This Non-Disclosure Agreement shall come into force upon signing by all Parties and shall have a fixed term of five years from the time of coming into force ("Fixed Term"). After expiry of this Fixed Term, the term of this Non-Disclosure Agreement shall extend for an indefinite period. This Non-Disclosure Agreement may be terminated ordinarily in writing for the first time with effect from the end of the Fixed Term, and thereafter with effect from the end of each calendar year, by either Party with six months' notice. The right to terminate in writing for good cause shall remain unaffected thereby.

All obligations arising from the receipt of Confidential Information until a termination takes effect shall remain unaffected by such a termination of this Non-Disclosure Agreement and shall continue to apply even after the ending of this Non-Disclosure Agreement.

10. Written Form

Any amendments or supplements to this Non-Disclosure Agreement including the waiver of this requirement must be in writing.

11. Choice of Law and Arbitration

This Non-Disclosure Agreement shall be governed by the substantive law of India. All disputes arising out of or in connection with the present Confidentiality Agreement shall be resolved in a final and binding manner in accordance with the Arbitration and Conciliation Act, 1996, this provision expressly excluding the ability to have such a dispute resolved in the ordinary courts. The place of arbitration shall be Pune, India. The language of the arbitration proceedings shall be English.

12. Severance Clause

Should any provision of this Non-Disclosure Agreement be or become invalid, the validity of the remaining provisions of the Non-Disclosure Agreement shall remain unaffected. In place of the invalid provision, the Parties shall agree on an appropriate provision which is legally permissible and which most closely reflects the commercial purpose of the original provision.

Signatures

Place, dated: ___________________________

[Contract Partner / Participant Name]

Name in Block Letters: ___________________________

Signature: ___________________________

Pune, dated: ___________________________

[Contract Partner / Participant Name]

Name in Block Letters: ___________________________

Signature: ___________________________

NOTES

NOTES

NOTES

TRANSIT
TRANSITIONING RESEARCH 2026

JUNE 10-12 • PUNE INTERNATIONAL CENTRE • INDIA

International Workshop on
Mid-TRL Technology Transition and Innovation Acceleration

Host State

Government of Maharashtra

Organised by

COEP TECH UNIVERSITY PUNE

CANEUS MNT

Knowledge Partner

PUNE INTERNATIONAL CENTRE