



**From Blueprint to Orbit :
How Systems Engineering
is the key enabler to
Realizing India's Private
Space
&
Aerospace Ambitions**

DR. KISHORE BALBADRA

PMP, CQE, CRE, CSQE, CSQP, CMQ/OE

SYSTEMS ENGINEERING

A **system** is an arrangement of parts or elements that together exhibit behaviour or meaning that the individual constituents do not.

An **engineered system** is a system designed or adapted to interact with an anticipated operational environment to achieve one or more intended purposes while complying with applicable constraints.

Systems Engineering is a transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and management methods.

Systems Engineering focuses on ensuring the pieces work together to achieve the objectives of the whole.

WHY SYSTEMS ENGINEERING ?

- **Integrates multi-disciplinary systems**
- **Ensures mission reliability and safety**
- **Navigates complexity from design to orbit**
- **Reduces cost & time-to-launch**
- **Collaborative Development in a Spiral Way**
- **Ensure Systems Thinking**



CORE SYSTEMS ENGINEERING PROCESSES

System Design Processes

System Design Processes applied to each product layer down through system structure

Customer Requirements

Planning of Product Realisation

Design & Development Input

Technical Management Process

Iterative or Recursive

Planning of Product Realization/
Review of Requirements

CM/RM/Control of Documents/D&D Reviews

Measurement, Analysis and Improvement/
Data Analysis

Product Realization Process

Product Realization Processes applied to each product layer up through system structure

Control of Work Transfers; Post Delivery Support, Preservation of Product

V&V/Control of Production

CORE PROCESSES IN SPACE BUSINESS

Satellite Manufacturing

Launch Vehicles and Integration

Collaboration between ISRO-Academia-Industry on Satellite Technologies

Skill Development

Compliances



SPACECRAFT AIT PROCESSES

**Mechanical
Integration**



Checkout



**Electrical
Integration**

Subsystems Realisation

Electronic Fabrication Facility

Mechanical Fabrication Facility

Metrological Lab

Inspection and Test Facilities For Sub-Systems

SYSTEM ENGINEERING : SPACECRAFT AIT PROCESSES

Satellite Sub- Systems

Payload &
Mainframe/
Mainbus
(Mech/Ele/QA)

Mechanical
Structure/
Thermal Control
Systems/
Mechanisms/
Propulsion
Systems

Electrical
Power Systems/
Communication
Systems/
Digital
Systems/
Control Systems

QA &
Reliability

FUTURE OF SYSTEMS ENGINEERING IN SPACE ELECTRONICS

Democratization of space access

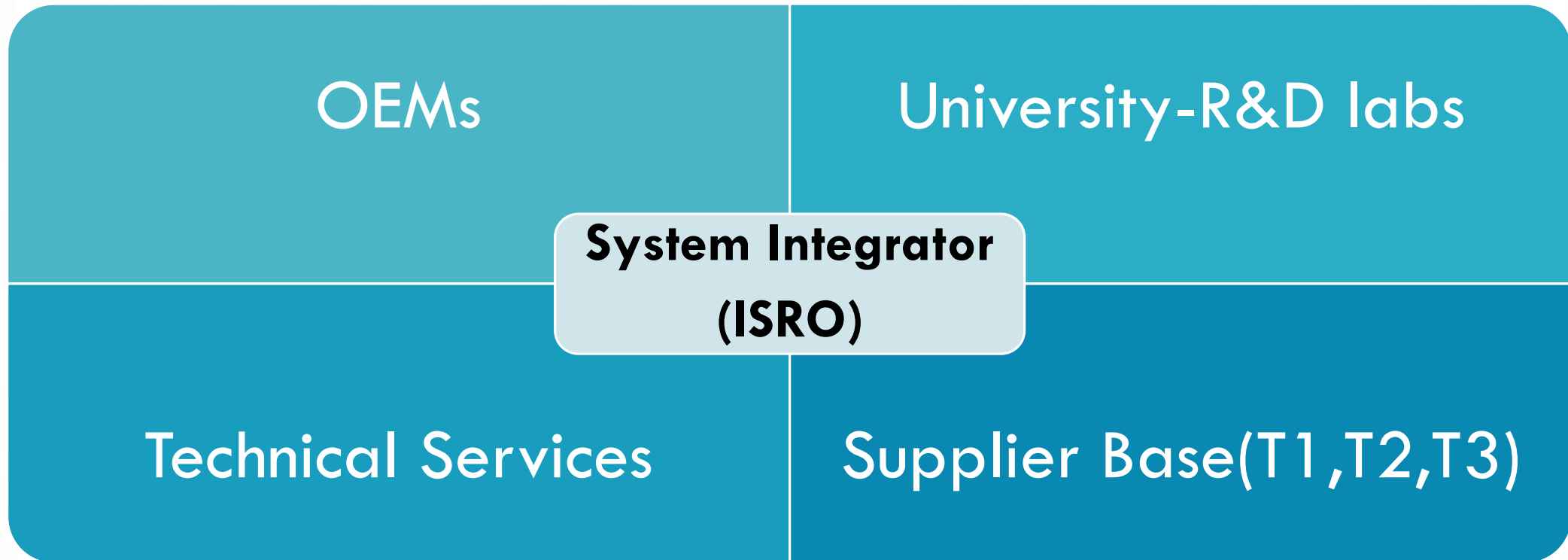
Commercial launch capabilities

Rapid prototyping to deployment

Mission reliability at reduced costs



PARTICIPATION OF CENTRES



The satellite manufacturing segment has largely catered to **contract manufacturing** of launch vehicles by the ISRO.

INNOVATIVE APPROACHES

**Rapid
prototyping
and
Standardizati
on in Rocket
Engines and
its parts**

IIoT

**Cyber
Security and
Data
Protection**

**Global
Navigation
Satellite
Systems
(GNSS)**

**Satellite
Integration,
Transportation
& Testing
Services**

**Payload
Development**



A&D SYSTEMS



A&D ECO SYSTEM IN INDIA

Budget 2025-26
₹ 6.81 Lakh Cr

Private
(21%)

16
DPSUs

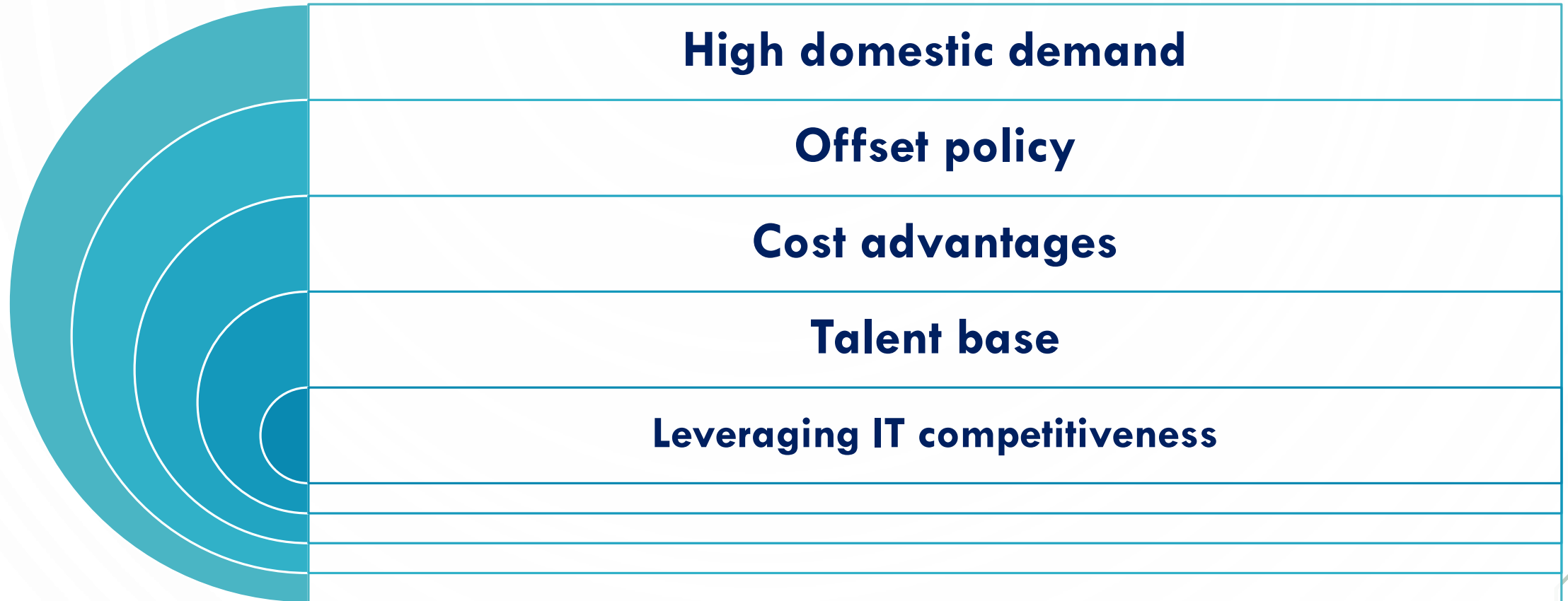
3 Lakh
Cr by
2030

500+
Licensed
COs

74%
FDI

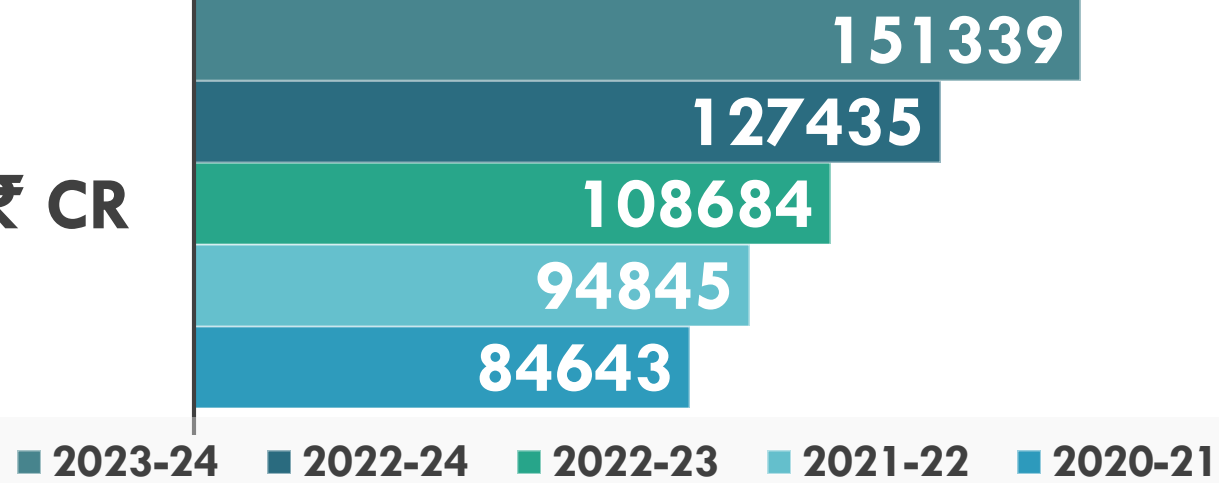
2000
+
MSMEs

TOP FIVE DRIVERS IN A&D BUSINESS



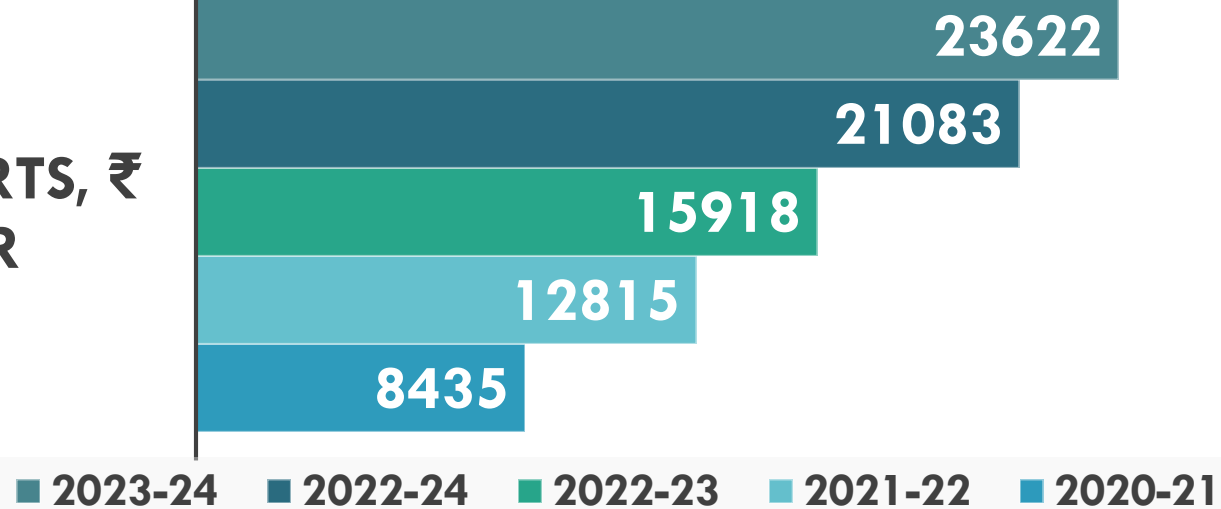
A&D BUSINESS

VOP, ₹ CR



18%
Growth

EXPORTS, ₹
CR



12%
Growth

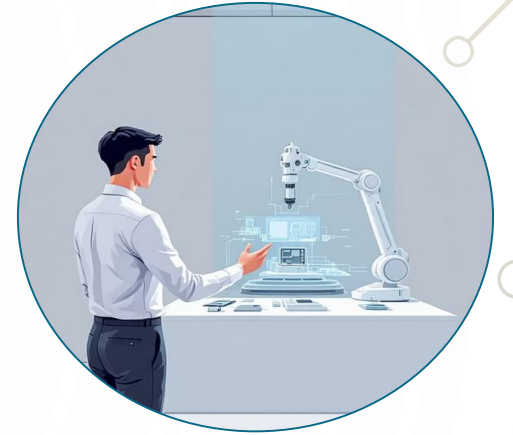
RE-ENGINEERING IN S & AD BUSINESS

- Industry 5.0 – Quality 5.0
- Embracing AI across all Domains(AI & Projects Cell)
- Robotic Process Automation
- Collaboration-Innovation with Co-Creation
- HMI: UI-UX in complex systems
- Model Based System Engineering
- Supply Chain Optimisation in Tri- Services
- MROs - System Integration



OPPORTUNITIES IN SPACE & AEROSPACE

- Automation through AI Models
- Digital Twins, 3D printing & AI powered Inspection
- MR-XR for In-Line Quality Systems
- IoT enabled FRACAS systems for Large Complex Systems
- Digital QMS for MSMEs
- Supply Chain Visibility through block chains
- System of Systems-Quantum Computing
- Edge Computing
- AI Driven Chip Testing



EMERGING TECHNOLOGIES-OPPORTUNITIES

- Unmanned Systems-AI Robotics
- Advanced Avionics
- Smart Materials
- Electro-Optical Sensor Systems
- HMI – LRU Testing Facilities
- Precision Components - Aero structures
- Strategic Electronics System(ASD) Design & Manufacturing
- Sensor Fusion & Electronic Warfare
- Cobots-Collaborative analytics

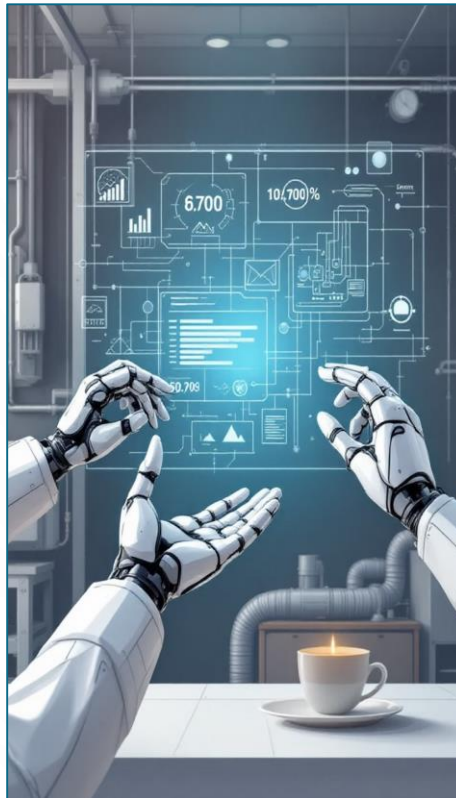


CONCLUSIONS

Human-Centricity, Agility, Sustainability, Ethics, & Resilience

+

AI(ML/RL/DL/XR/CV/IIoT)





Thank you

