Green Initiatives in Indian Civil Aviation / Aerospace

CSIR

NAL

Shyam Chetty

Actg. Director, NAL

Contours of Presentation

- CSIR-NAL – an overview
  - Contributions to National Programmes
  - New Technologies & Systems at NAL
  - Expertise and Capabilities at NAL
  - Infrastructure & Facilities at NAL
- Civil Aircraft Design & Development
  - Technologies for NCA
  - Green Initiatives

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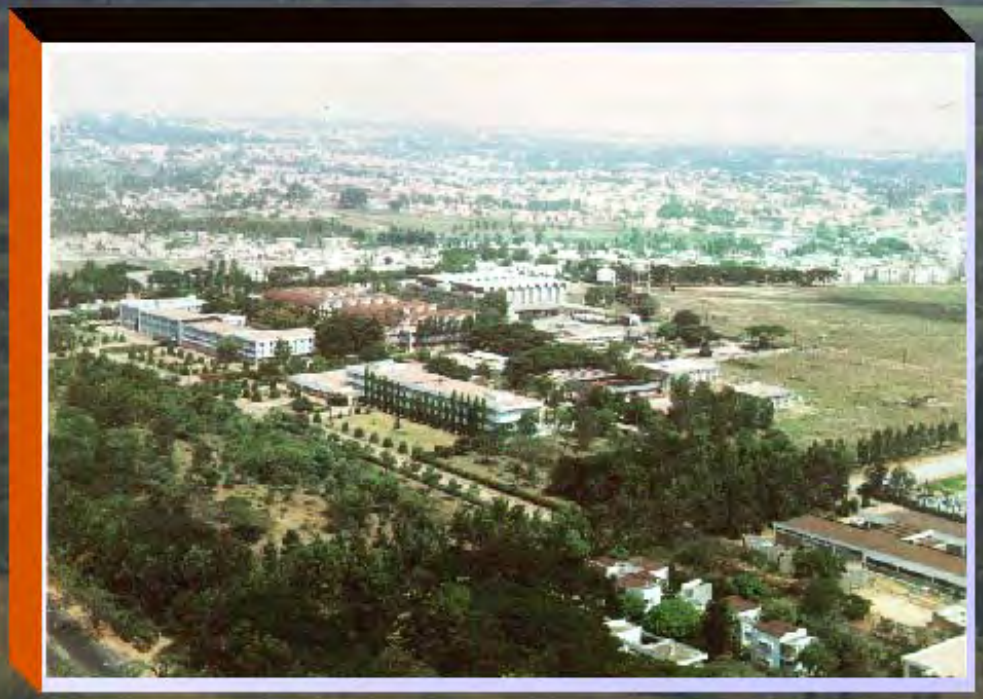
The Two Campuses



Kodihalli

Belur

CSIR - NAL

CSIR NAL

- NAL is a constituent of CSIR
- Established in 1959-60
  2008-09 Golden Jubilee Year
- India's premier R&D establishment in aeronautics and allied disciplines
- 1032 employees,
  352 Scientists
  80 or more Ph.D.'s
- Annual budget of about
  Rs. 2800 Millions. *(75% CSIR, 20% external sources)*
- *Certified ISO 9001-2008 QMS Standard*

MISSION & MANDATE

- **Development of national strengths in aerospace science & technology**
- **Advanced technology solutions to national aerospace programmes**
- **Design and development of a small and medium sized aircraft**

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Major R&D Disciplines

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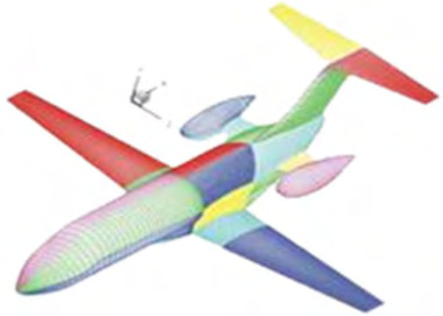
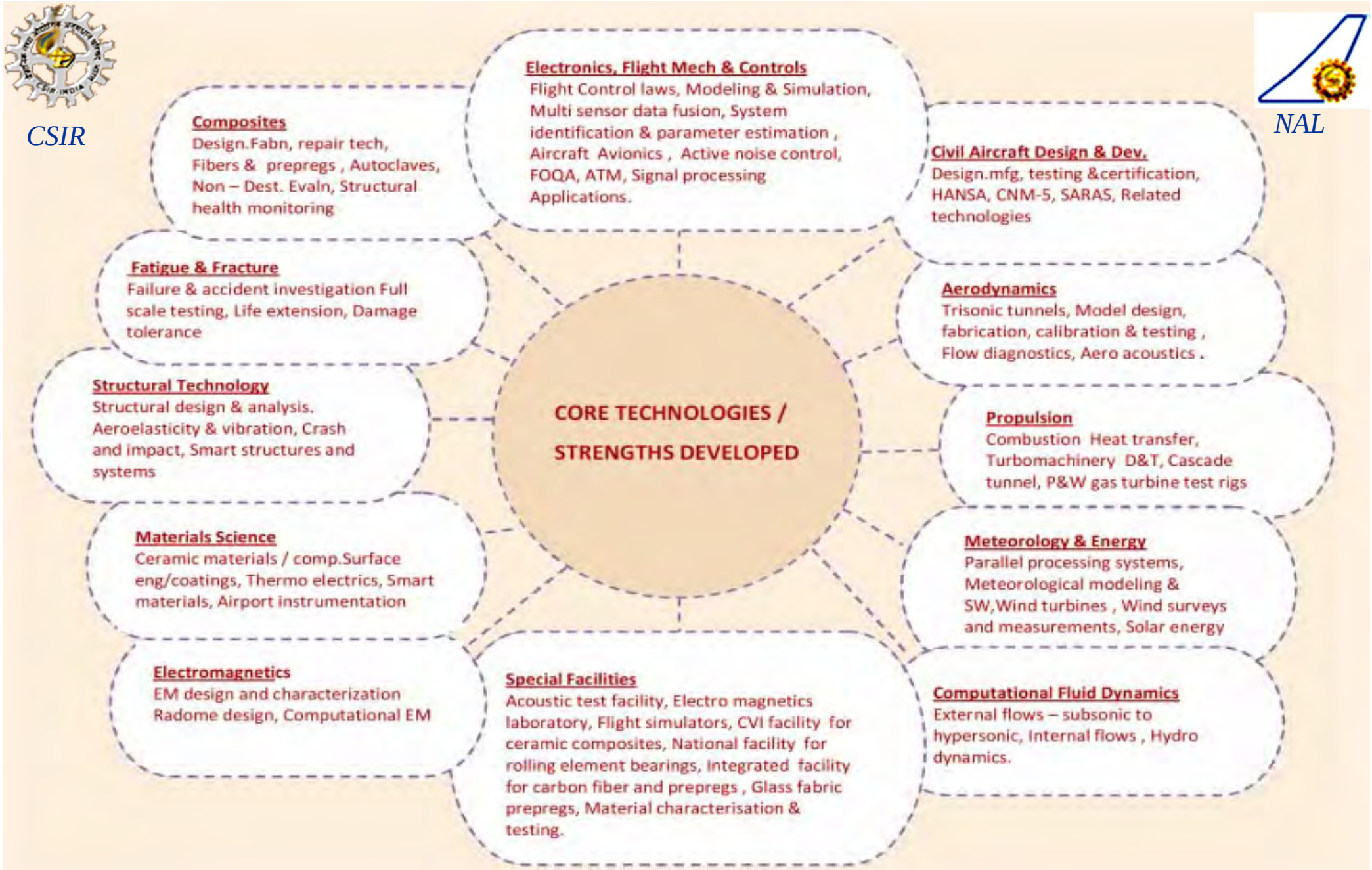
Core competence of NAL spans practically the whole aerospace sector



- ✓ Computational fluid dynamics
- ✓ Experimental aerodynamics
- ✓ National Trisonic Aerodynamic Facilities
- ✓ Flight mechanics and control
- ✓ Propulsion
- ✓ Composites
- ✓ Structural design, analysis and testing
- ✓ Structural dynamics and integrity
- ✓ Surface modification
- ✓ Aerospace materials
- ✓ Aerospace electronics and systems
- ✓ Micro Aerial Vehicle design & development

- ✓ Civil aviation
- ✓ Parallel processing computers
- ✓ Meteorological modeling
- ✓ Wind energy
- ✓ Manufacturing technology
- ✓ Information systems

- ▶ Ability to provide complete holistic technology solutions
- ▶ Interaction with all aerospace related organisations
- ▶ Recognised in India and abroad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Electronics, Flight Mech & Controls
Flight Control laws, Modeling & Simulation, Multi sensor data fusion, System identification & parameter estimation , Aircraft Avionics , Active noise control, FOQA, ATM, Signal processing Applications.
Composites
Design.Fabn, repair tech, Fibers & prepregs , Autoclaves, Non – Dest. Evaln, Structural health monitoring
Civil Aircraft Design & Dev.
Design.mfg, testing &certification, HANSA, CNM-5, SARAS, Related technologies
Fatigue & Fracture
Failure & accident investigation Full scale testing, Life extension, Damage tolerance
Aerodynamics
Trisonic tunnels, Model design, fabrication, calibration & testing , Flow diagnostics, Aero acoustics .
Structural Technology
Structural design & analysis. Aeroelasticity & vibration, Crash and impact, Smart structures and systems
CORE TECHNOLOGIES / STRENGTHS DEVELOPED
Propulsion
Combustion Heat transfer, Turbomachinery D&T, Cascade tunnel, P&W gas turbine test rigs
Materials Science
Ceramic materials / comp.Surface eng/coatings, Thermo electrics, Smart materials, Airport instrumentation
Meteorology & Energy
Parallel processing systems, Meteorological modeling & SW,Wind turbines , Wind surveys and measurements, Solar energy
Electromagnetics
EM design and characterization Radome design, Computational EM
Special Facilities
Acoustic test facility, Electro magnetics laboratory, Flight simulators, CVI facility for ceramic composites, National facility for rolling element bearings, Integrated facility for carbon fiber and prepregs , Glass fabric prepregs, Material characterisation & testing.
Computational Fluid Dynamics
External flows – subsonic to hypersonic, Internal flows , Hydro dynamics.

Significant Contributions to National Programmes

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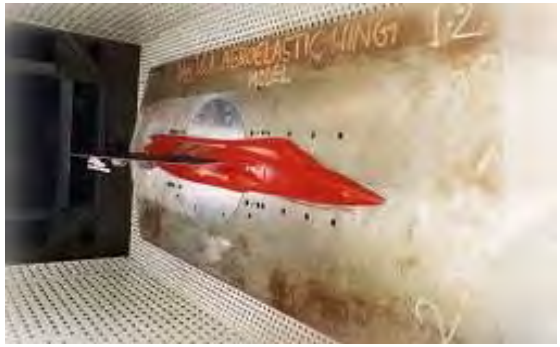
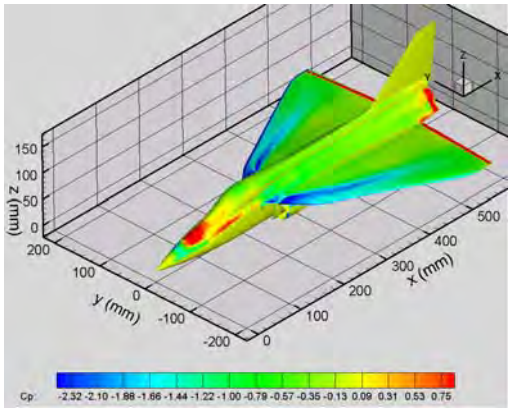
Contributions to National Programmes : Defence Programmes

Tejas – India's LCA

Funding : Rs 2500 Mi

- Leadership of National Team for CFC Wing
- Leadership of National Team for Flight Control Law Development
- Advanced Composite Structures • Carbon Fibers
- Wind Tunnel Testing – Aero. Data Generation & Flt. Validation
- Material / Box level Testing and Characterization for Certification
- CFD Analysis • Surface coating • Noise measurement & control
- Flow Diagnostics Studies • Aeroelastic Model Studies
- Dynamic Response Studies

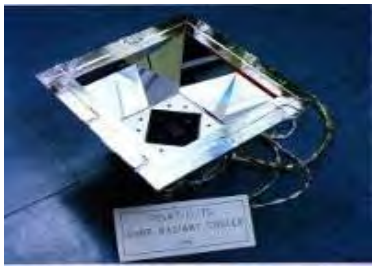




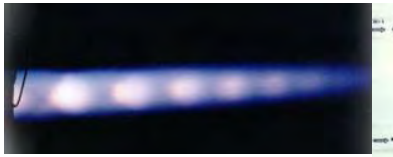
Support to National Programmes : Space Programme

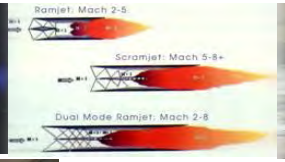
Funding : Rs 1000 Mi

- Acoustic test facility
- Wind Tunnel Testing
- Sunshield Mirrors for IR Sensor Cooling on Satellites
- Composite Radome for DWR
- Thermo - Structural – Aeroelastic Analysis for RLVTD
- High Speed Combustor Design and Testing
- Transonic Buffet Studies on Launch Vehicle Models
- SATCOM Applications
- Special Grade Carbon Fibers



INSAT-2 VHRR
RADIANT COOLER





Civil Aircraft Design & Development at NAL

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Civil Aircrafts from CSIR – NAL

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NCA

Under Planning / Approval

CNM-5

5 – Seat, multirole, all-metal aircraft to be certified under FAR23

SARAS

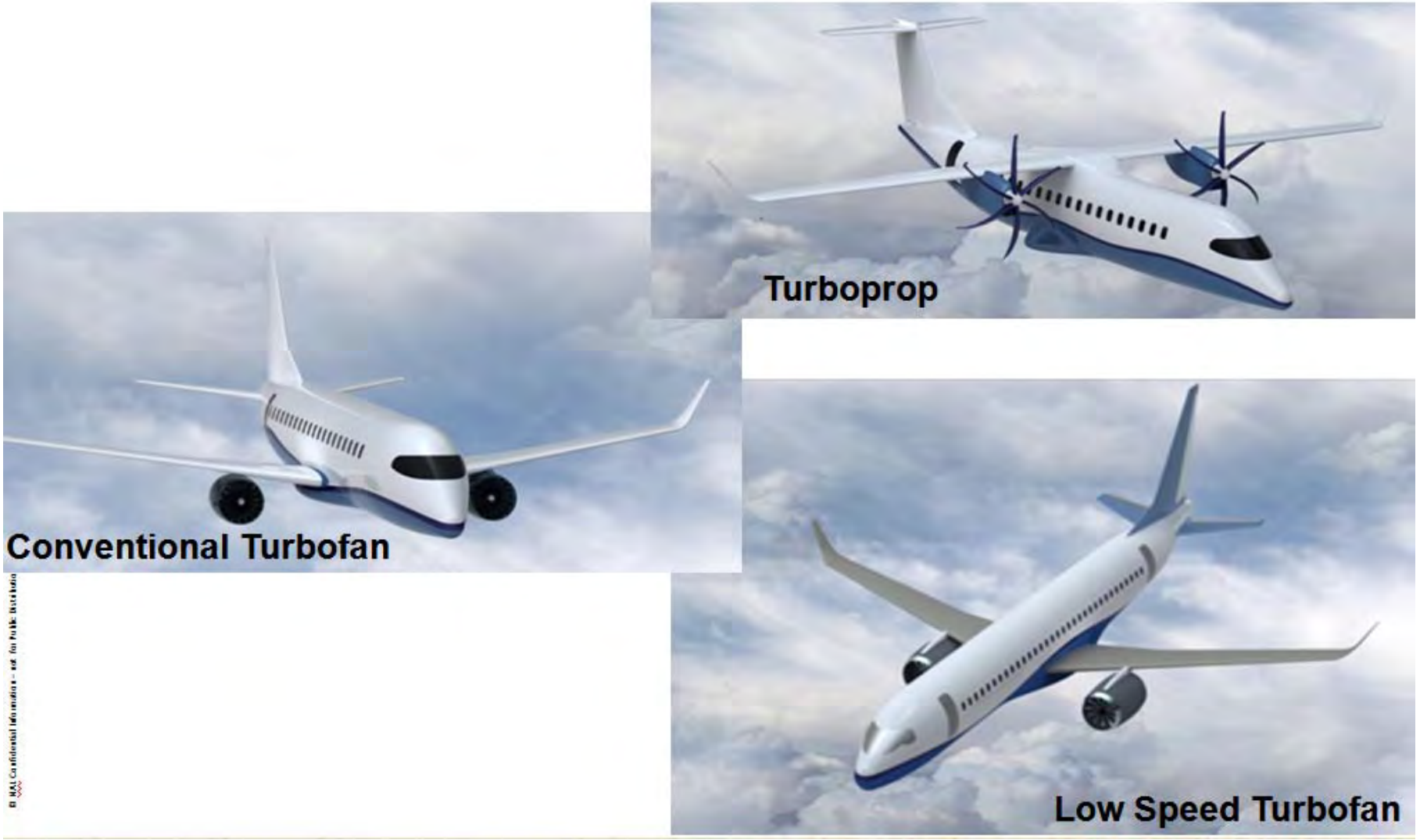
14 Seat aircraft (7 ton class) to be certified under FAR23

HANSA

2-Seat, All composite aircraft certified under JAR-VLA for ab-initio training

1985 1990 1995 2000 2005 2010 2015 2020

National Civil Aircraft Development



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National Civil Aircraft Development

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OBJECTIVES

- To develop a low cost, efficient and technologically advanced regional ac
- To incubate civil aviation industry in both public and private sectors

TARGETS

- Low Costs of Acquisition, Operation & Maintenance
- Advanced Technologies
- Wide cabin provides Narrow Body comfort
- Two fuselage lengths for 70 to 100 pax
- Operations from ill-equipped airfields
- All weather operations – Enhanced & Synthetic Vision Systems
- Low Emissions
- Low Noise (FAR-36 stage IV)

One Year Feasibility Study Completed under HPC - NCAD

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TECHNOLOGIES TO REDUCE EMISSIONS

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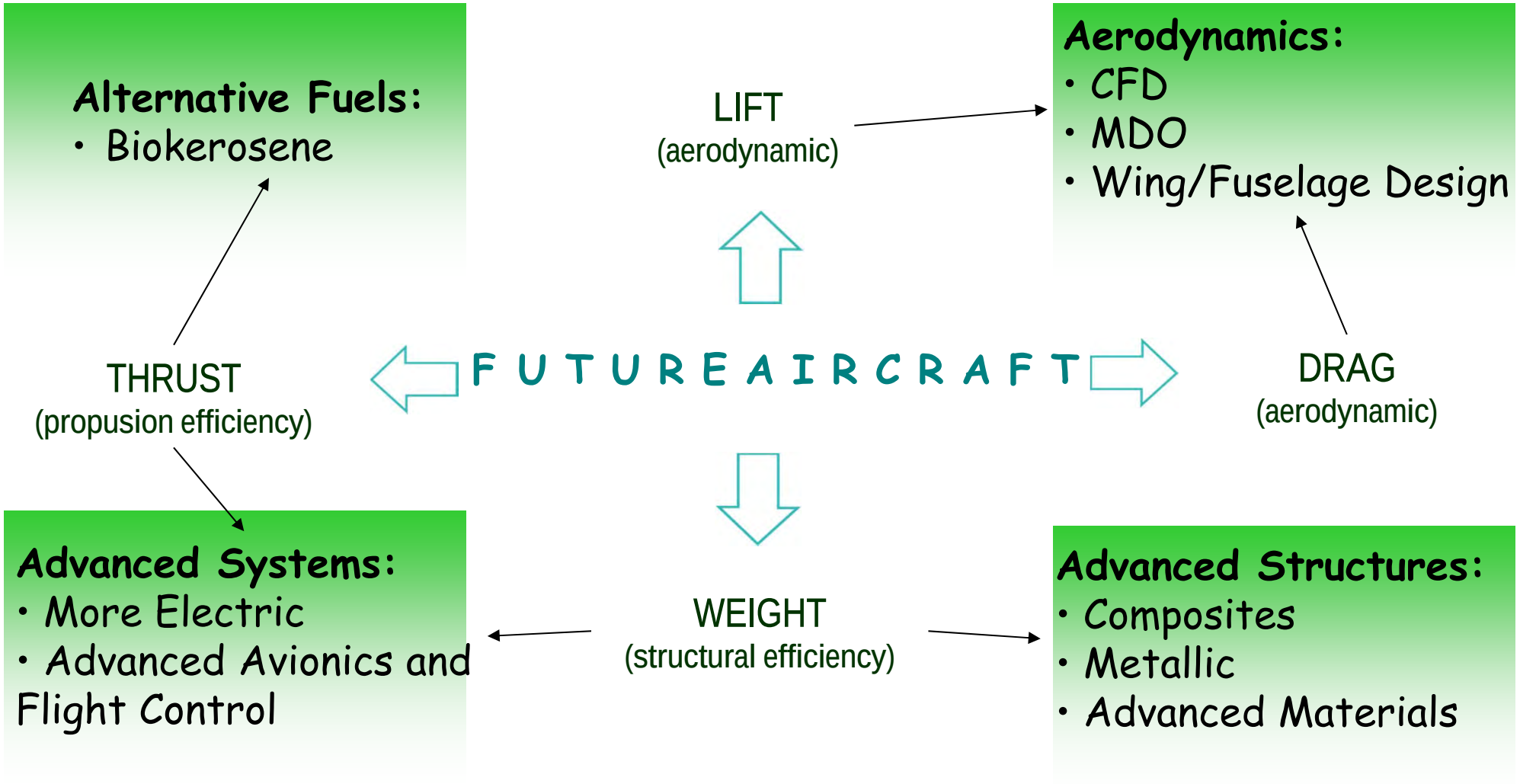

TECHNOLOGIES FOR NCA

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- Low Drag Configuration
- Next generation power plant
- Fly by wire flight control system
- Open distributed modular AVIONICS
- GPS-WAAS-LAAS
- ADS-B
- Advanced Display Systems
- Active Vibration and Noise control
- Composite airframe
- Structural Health Monitoring

NCA

- Maintenance Concepts that reduce maintenance by 50%
  - IVHM
  - SHM
  - Faster Trouble shooting
- Self clean coatings
- Deicing coatings
- Abrasion resistant coatings
- Lean Ground Infrastructure
- More Electric aircraft systems

Criteria for adoption : High TRL, time and cost to maturity

Reference wing

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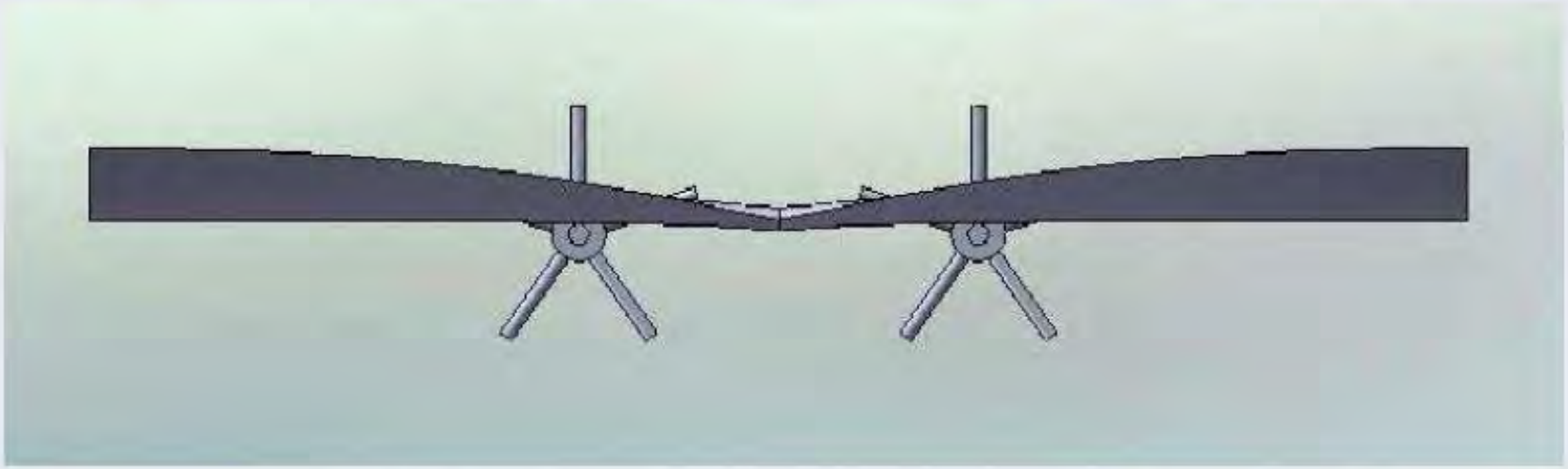
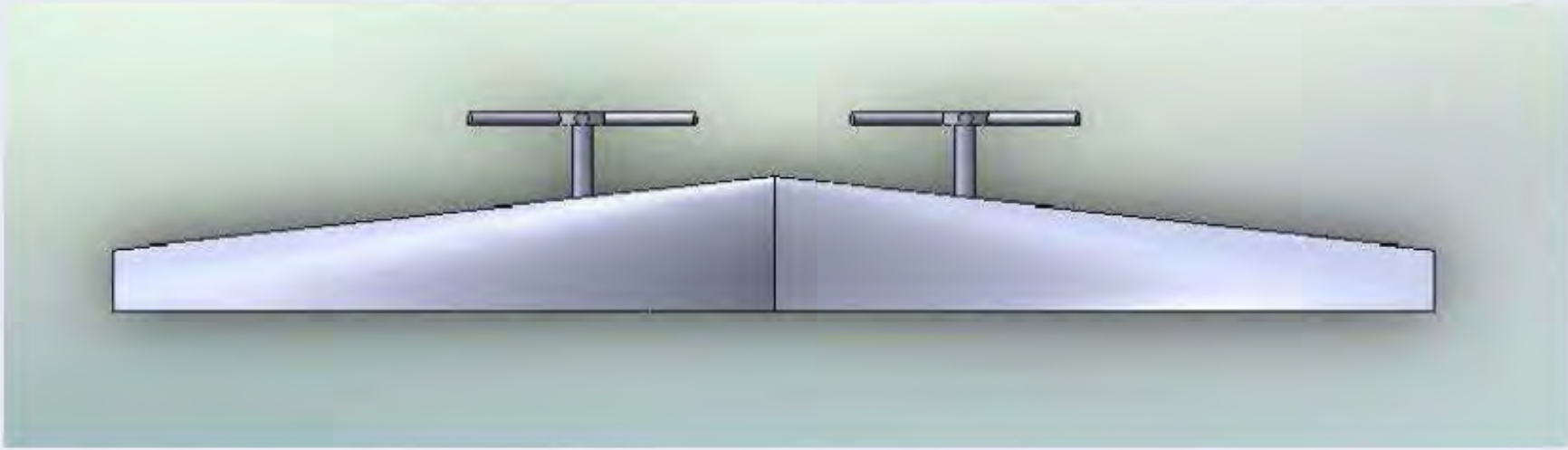
$C_L = 0.38$, wash out twist (twist magnified by 20 times!!!), AR = 12



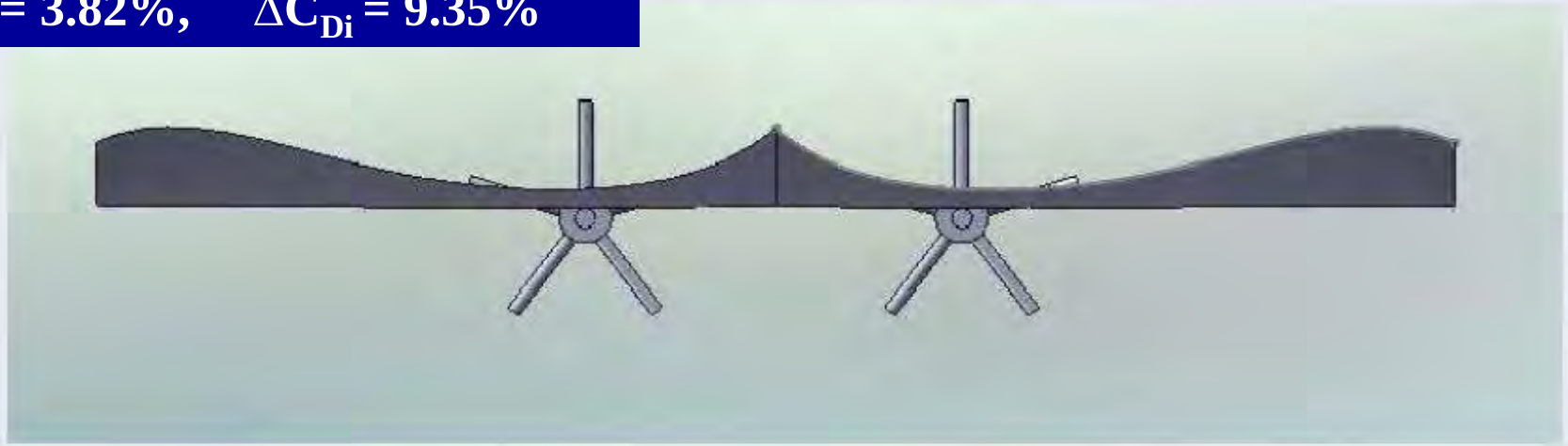


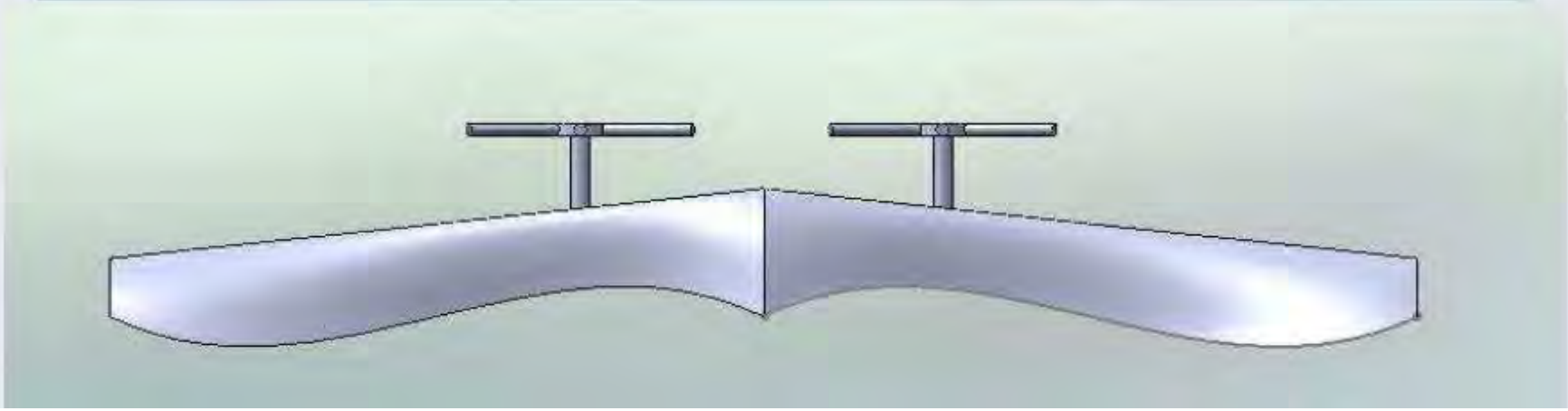
Optimized wing

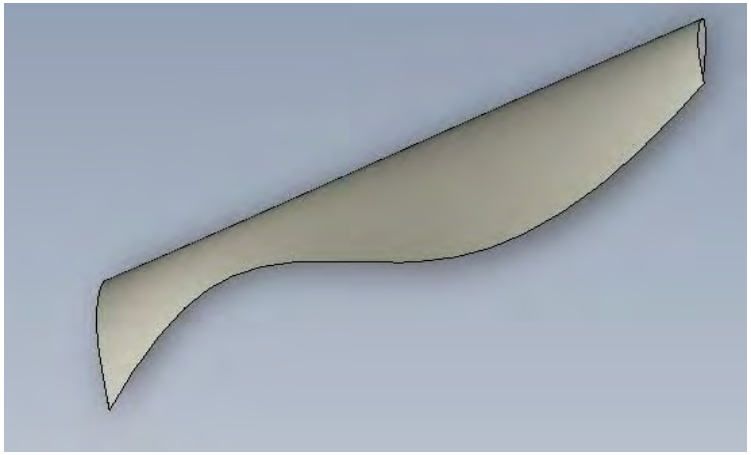
NAL

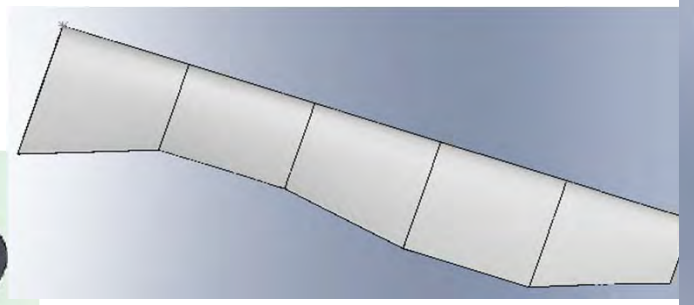
$nc = 320,\ nf = 48,\ nwc = 4,\ nwt = 4,\ -14^o \leq \alpha_t \leq 14^o,\ C_L = 0.38,$
twist magnified by 20 times!!!, AR $= 12,\ c_m = 1.0717s,\ c_t = 0.5359s,$
$\Delta C_d = 3.82\%,\ \Delta C_{di} = 9.35\%$, Up-Inboard

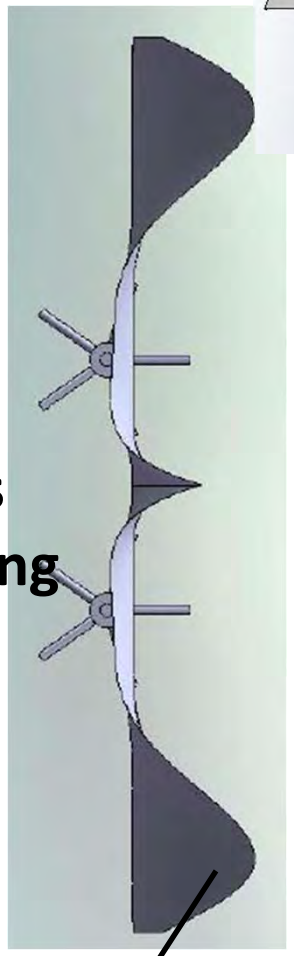
ΔC_D= 3.82%, ΔC_{Di} = 9.35%

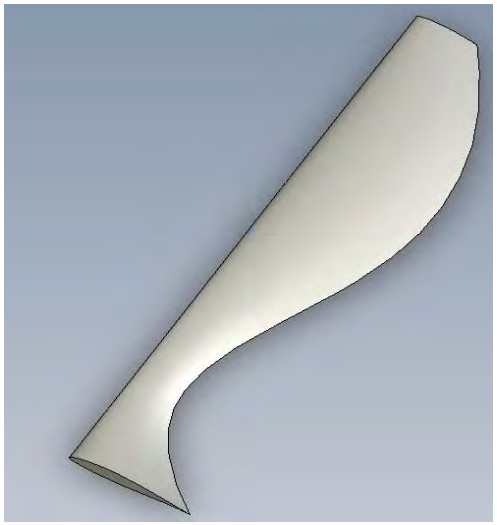




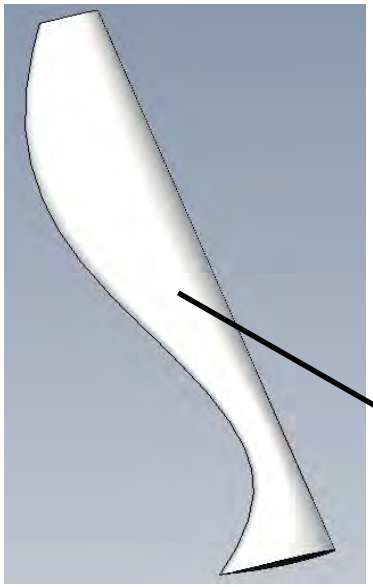








Different views of an optimal wing



suction surface

Twist distribution magnified by 20 times!!!

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Nano Coatings for Aerospace Applications

- Self-cleaning effect
- Anti-icing property
- Abrasion resistance property
- Laminar/Turbulent Drag Reduction(?)

Super-Hydrophobic Coatings -'LOTUS EFFECT'

- ❑ Self-cleaning property
- ❑ Anti-icing property
- ❑ Anti-sticking property

Normal Polyurethane Topcoat

WCA = 165°

Superhydrophobic Coating

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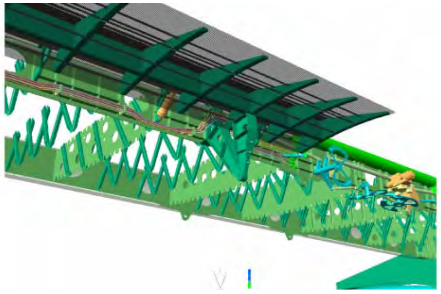
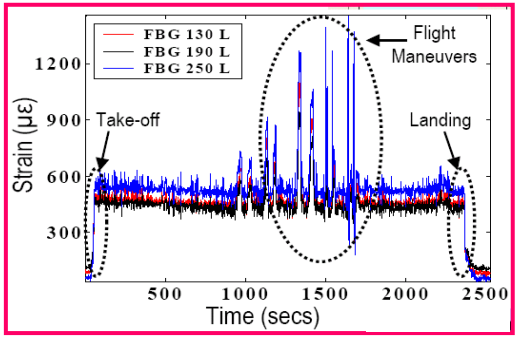
Airframe (weight < 20% , Cost < 30%, maintenance < 50%)

- Composite airframe
  (Fuselage, in addition to wing & empennage)

New topologies and Design concepts

- Crash requirements
- CFRP wind shield, pressure bulk head
- Lightning protection improvements
- Complex fitting development
- Reduce parts count
- Reduce cost
- Structural health monitoring





Avionics Technologies

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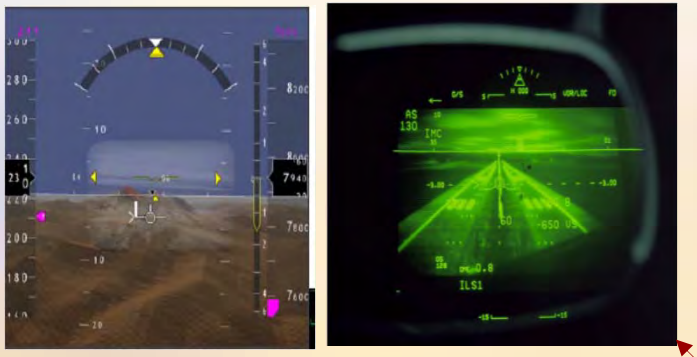
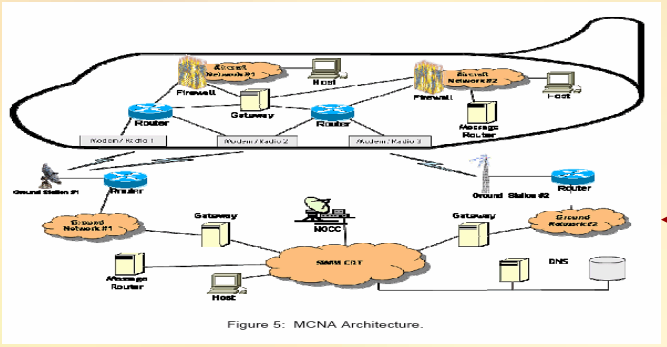


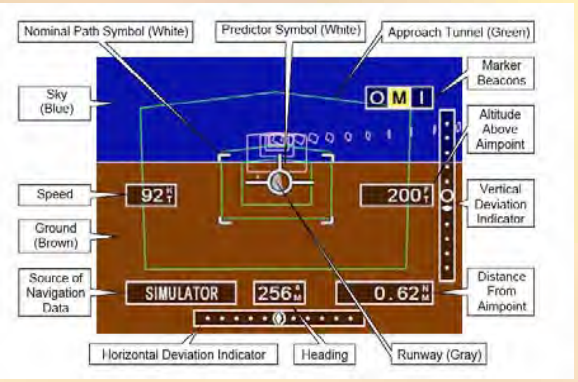
SVS & EVS

Smart Glass Cockpit

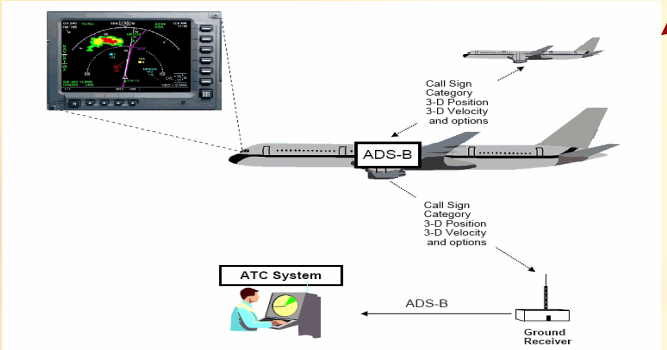
Head Up Display



Advanced Comm Tech

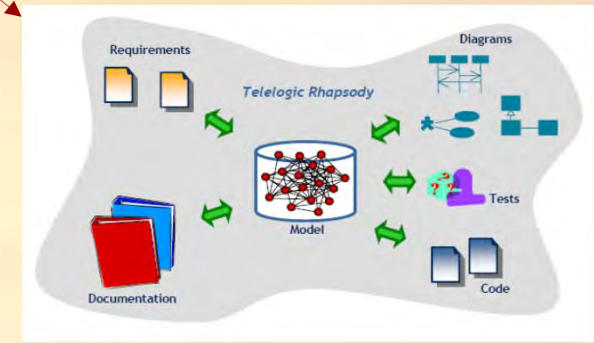


HighWay In The Sky



Automatic Dependent Surveillance – Broadcast (ADS-B)

WAAS/LAAS/SBAS



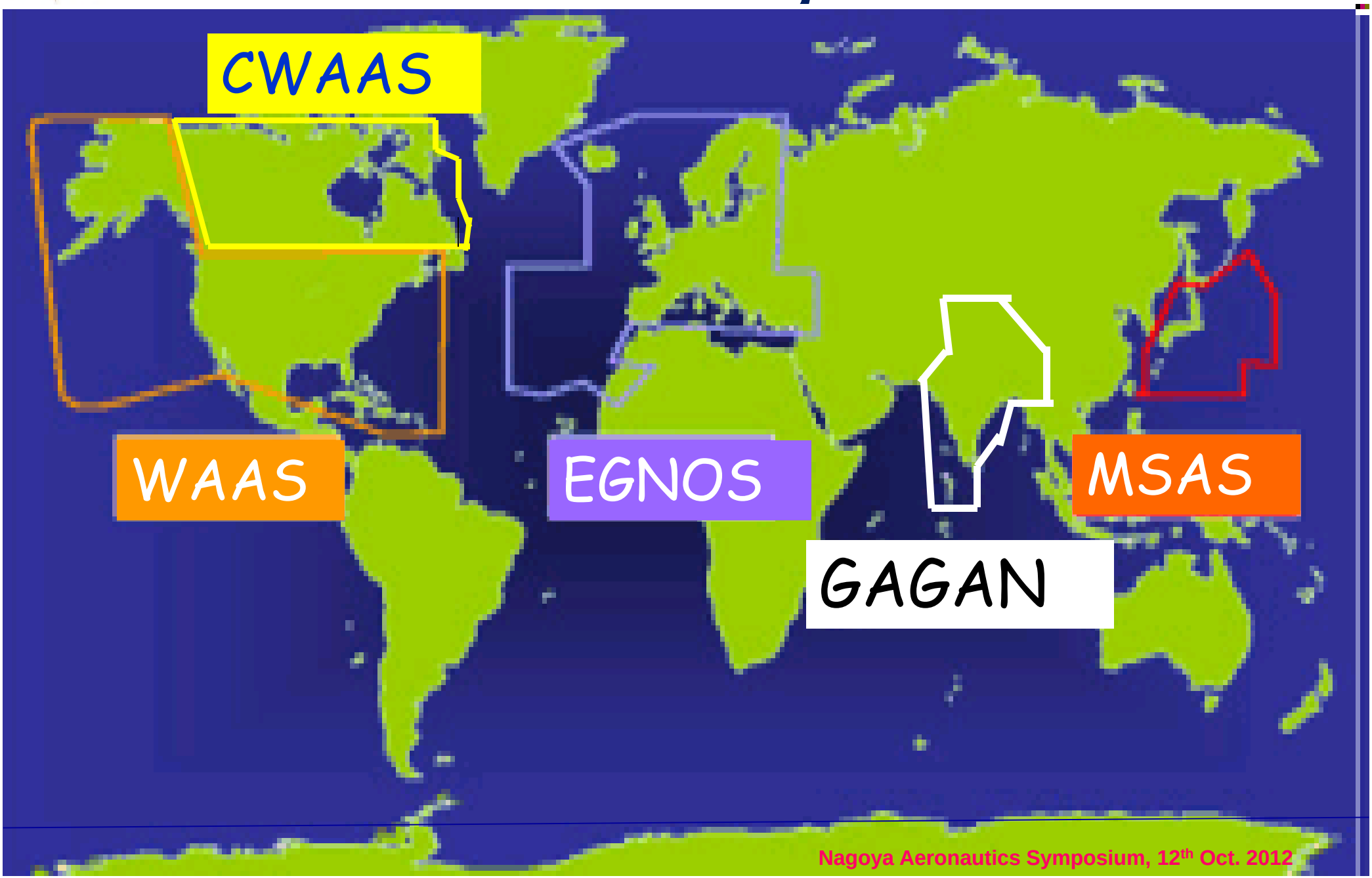
Tool Based Automation

Avionics Technologies For ATM

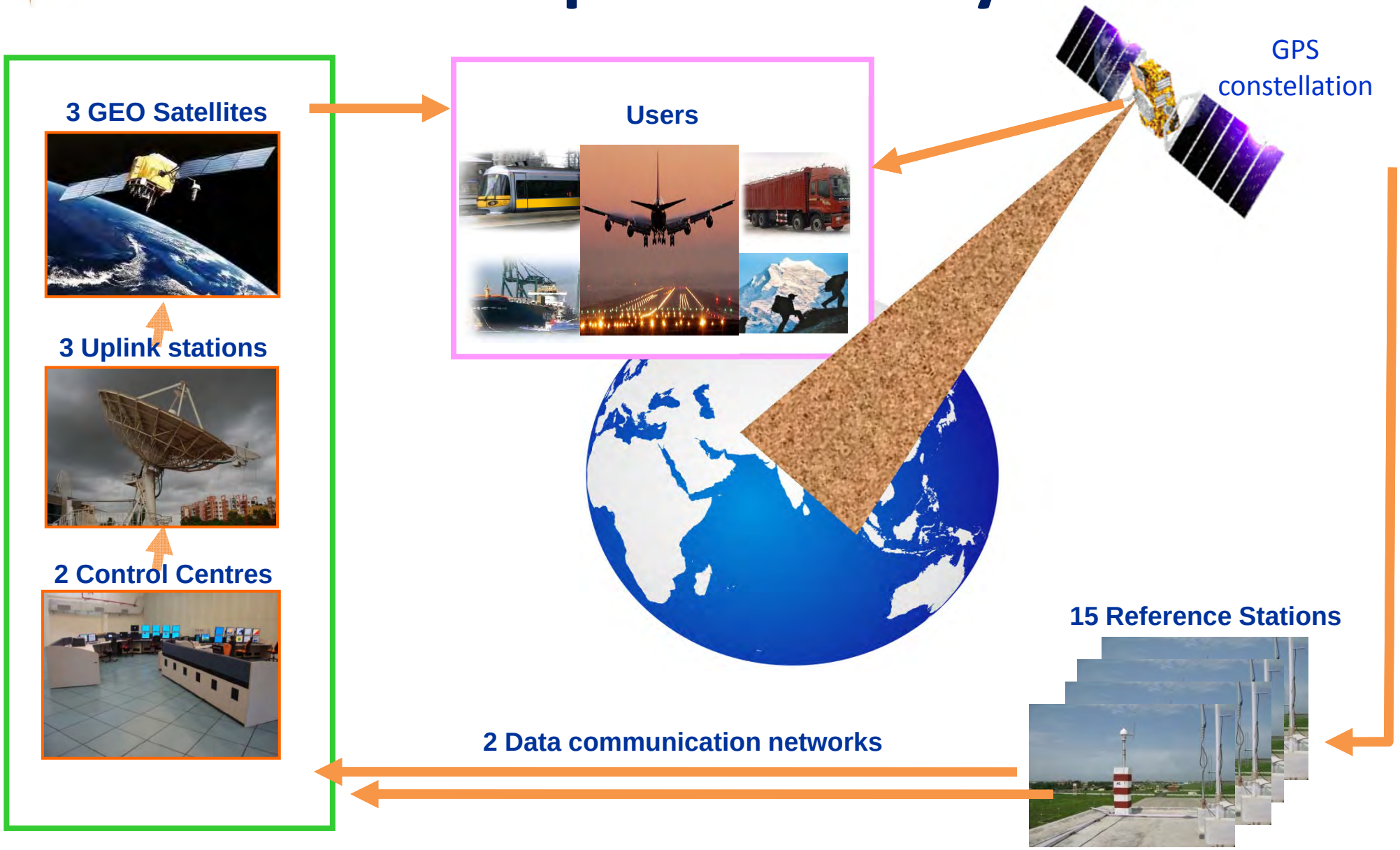
Satellite Based Navigation System for Indian Skies : GAGAN

A S Ganeshan
Navigation Systems
ISRO & AAI

SBAS In Voque



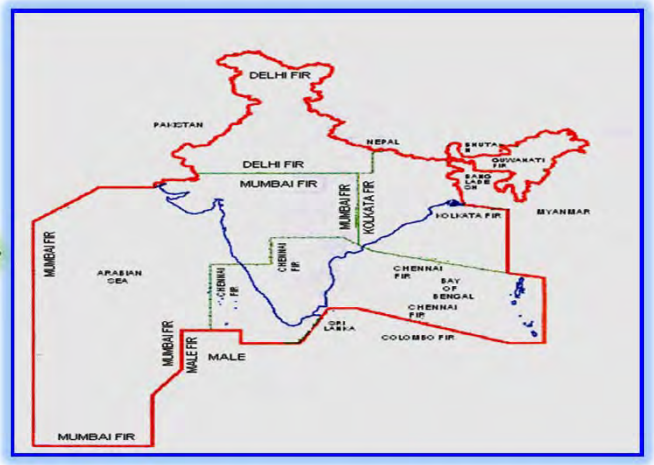
GAGAN Operational System



GAGAN Final Operation Phase

Realize a certified and operational SBAS to provide air navigation services of

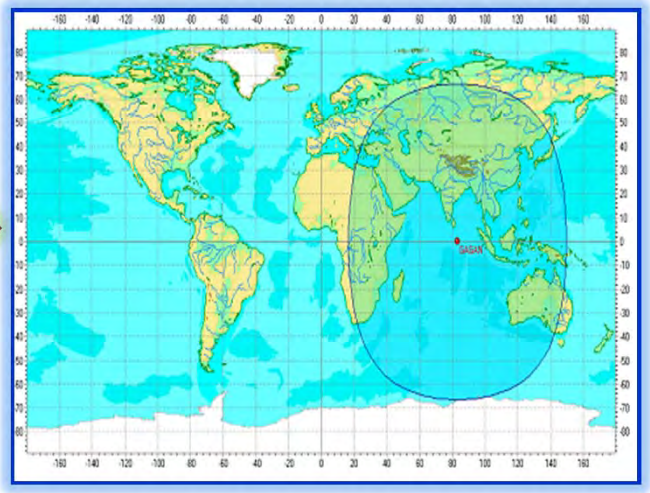
- RNP 0.1 en route navigation within India FIR
- APV-1/1.5 precision approach over landmass of Indian FIR



Common coverage of GAGAN GEO satellites

(55°, 82° & 83°) is beyond Indian FIR (GSAT-8, GSAT10 & GSAT-15)

GSAT-8 launched on 21-May'11 . Space Segment uses SBAS PRN code 127. GSAT-10 launched on 1-Oct'12



Signal-In-Space available since 15-December-2011

GAGAN certification by DGCA 3rd quarter of 2013

Compatible and Interoperable with other SBAS to provide Seamless navigation

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Application of Bio Fuels for Aviation

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1. Bio Jet Equivalent to Aviation Fuel (JET A1) from Jetropa Oil

Under Global innovation and Technology Alliance (2010)-DST Indo-Canada Industrial R&D Programme

Status : Technology Proven and setting up Pilot Plant for large scale production under progress

2. Bio-Fuel Production from Marine Micro Algae

Project initiated in April 2010 under the CSIR-New Millennium Indian Technology Leadership Initiative in collaboration with the MoES

Status : 200-km. test-run of a Tavera fueled by 100 percent algae-derived biodiesel & Pilot plant for large scale development / collaboration to convert bio diesel to bio jet for aviation

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Thank you