HIKARI:
Paving the Way towards High Speed Air Transport

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02.06.2016
SUNJET 2 Forum
ILA Berlin, Germany

Project Organization and Starting Point

HIKARI

- 02.06.2016, Berlin

AIRBUS GROUP · esa · MBDA · AIRBUS DEFENCE & SPACE

ONERA · DLR · CIRA · AIRBUS

OXFORD ECONOMICS · NLR · cnrs · easn

JAXA · The University of Tokyo · IHI · JADC

METI
Ministry of Economy, Trade and Industry

SEVENTH FRAMEWORK PROGRAMME

The research leading to these results has received funding from the European Union Seventh Framework Programme (FP7/2007-2013), METI and MEXT.

MEXT
MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

Project Overview

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Project Objectives

- **Exchange, benchmark and understand**
  Build on momentum from high speed projects in Europe and Japan

- Make visions **converge** into
  Joint design guidelines and technology roadmaps

- Perform **technology studies** in 3 key areas: environment, propulsion, thermal analysis

Duration: February 2013 - January 2015

Budget: ~4M€ of activity

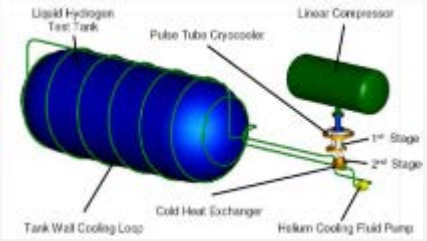
Project Outcome: Joint Design Guidelines

- **The market is sufficiently large** to allow sustainable airline operations **(>200** a/c in 100pax configuration**),** provided that HS flights are fed by **connecting network** and at **affordable ticket prices** (<= twice BC price)

- Range : **13 500km**, investigate opportunities for **supersonic overland**

- **Mach 5** is the best compromise speed

- **H2** but … LHC/CH4



- Passenger Capacity : **step-wise growth** small for 2030+ → larger 2050+ to accompany market growth and master risks

Meeting the market demand

by JADC & Airbus

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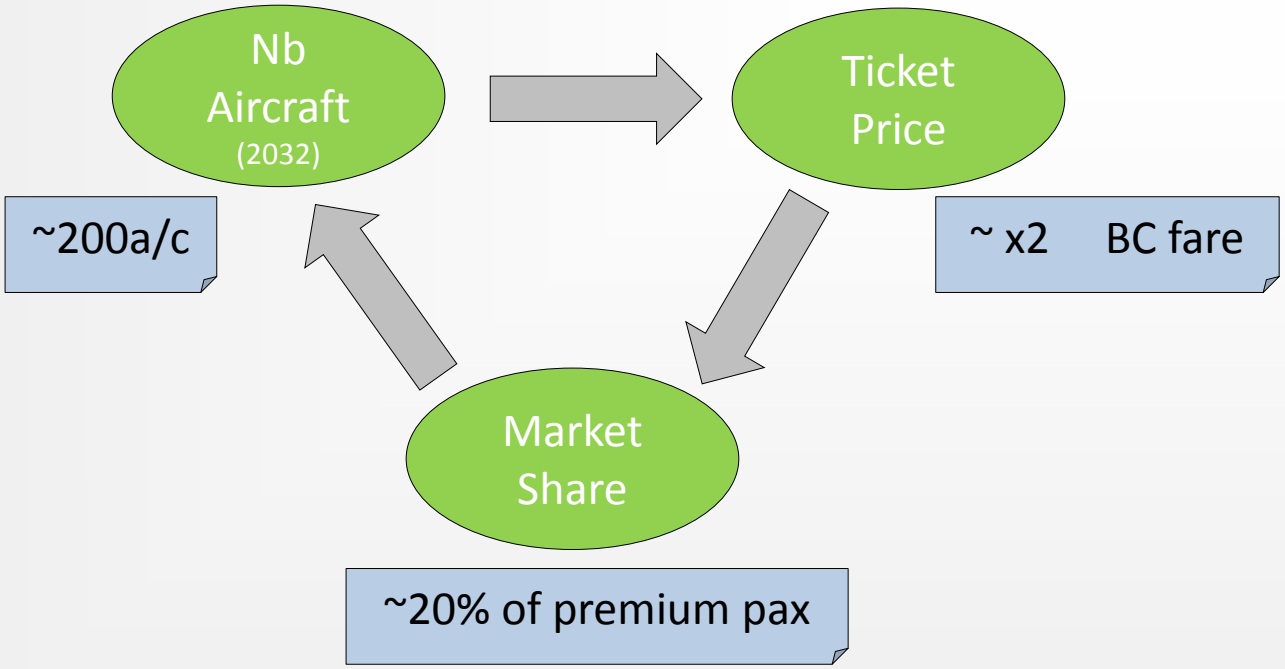
Commercial Requirements

Market Equilibrium



Ex: 100 pax a/c

Range and Sonic Boom Strategy

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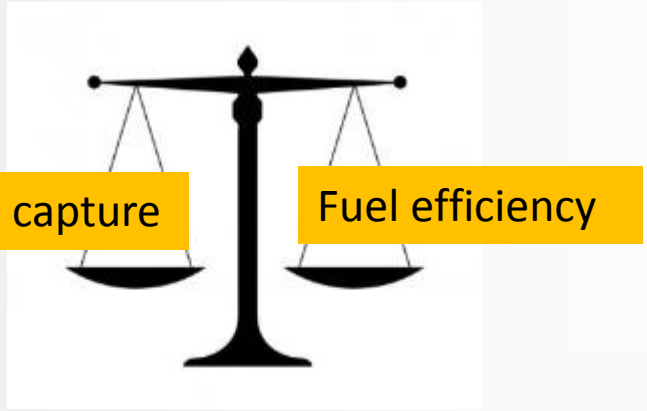
Commercial Requirements



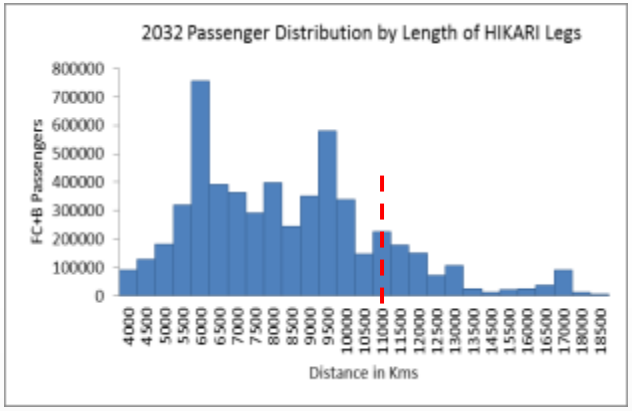


Figure 3: Passenger distribution w/o ERF

- Range: to capture 90% of the market, the required range is the following
  - **11500 km** [6200nm] with no ERF (Extended Range Factor)
  - **13500 km** [7300nm] when including the ERF
- ERF: Extended Range Factor (detour)
  - Not a big issue for time savings
  - Issue for fuel burn and vehicle sizing
- Recommendation
  - Investigate **low sonic boom** option to suppress the ERF

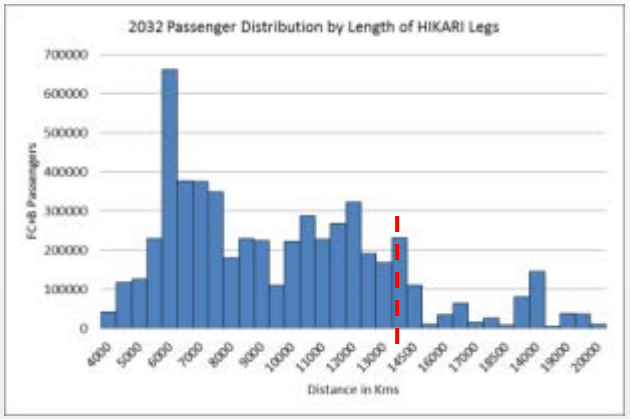
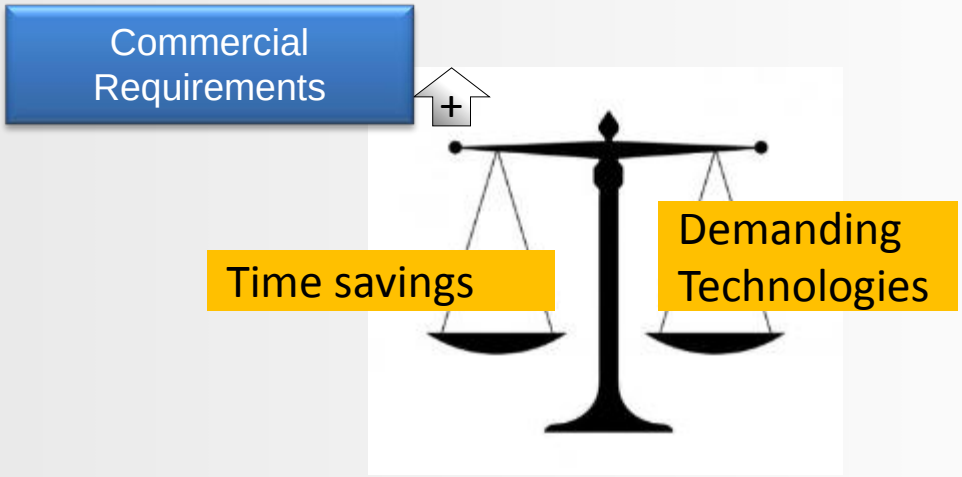


Figure 4: Passenger distribution w/ ERF

Speed



- Speed
  - **Mach 5** provides huge time savings against subsonic flight
    No large time benefit beyond this
  - **Mach 5** provides significant cruise phases (>40%) even for medium range and low acceleration

Mission	Delta from Subsonic to Mach 5	Delta from Mach 5 to Mach 8
11 000 km	**10.3 hours**	0.5 hour
14 000 km	13.2 hours	0.7 hour

- Technology Impact
  - Propulsion options at Mach 5 are larger: ramjet / PCTJ
  - Materials might be simpler / cheaper
  - More test facilities available

Passenger Capacity: Step wise approach

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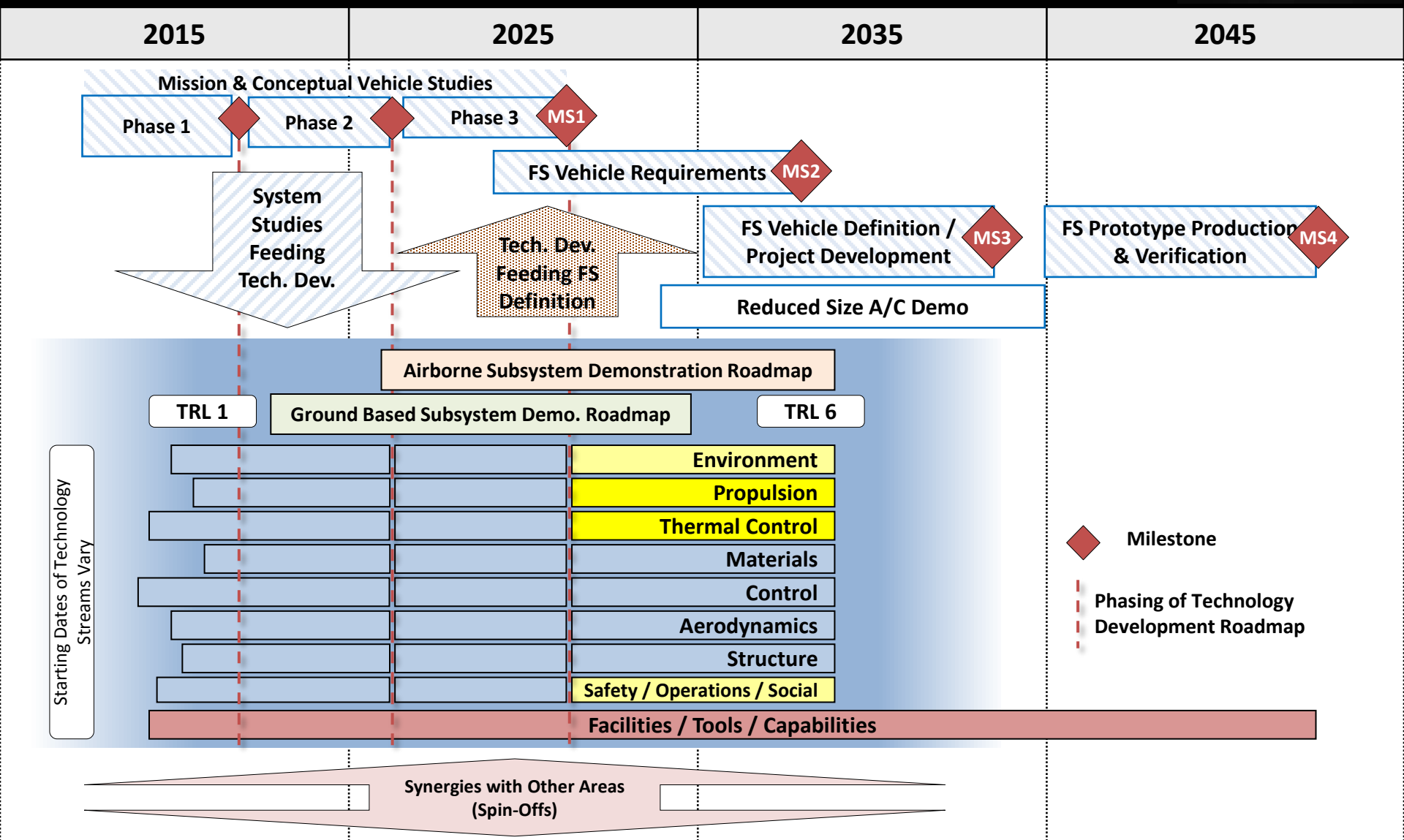
Commercial Requirements

2030-2035	2040-2045	2055+
Business Jet size 10 passengers	**Small airliner size 100 passengers**	**Large airliner size 300 passengers**
to initiate the business, as “niche” market first	to grow the market , with more ambitious technologies (leading to longer range and cheaper tickets)	to capture market growth and progressively develop towards a “mass market”

Main HIKARI Roadmap including Tech. Dev. Roadmap



Synergies and short-medium term benefits to other industries

Synergetic topic	Short/Mid-Term application
Massive **H2 production and use, incl. tanks**	Ground transportation, subsonic aviation (propulsion / fuel cell), space launchers
Thermal and energy optimization method (+ components: lightweight heat exchangers)	More electric subsonic aviation, ground transportation…
High temperature lightweight materials	Subsonic aircraft engines, space re-entry vehicles, space propulsion,
Atmospheric and climate modelling	Subsonic flights : polar trajectories, business jets…
Design **methods and tools for highly complex and integrated vehicles**	Aerospace vehicle design…
Design Rules evolution to allow high performance vehicles (single pilot…)	Subsonic aircraft, sub-orbital vehicles

Added Value of EU-JAPAN cooperation

- **PARTNERSHIP**
  - Getting to know each other (people / ways of working)
  - Build trust for long term partnership

- **DISSEMINATION**
  - Increase awareness of hypersonic transport to a worldwide scientific and deciders community

- **TECHNICAL**
  - Parallel independent analyses allowed key findings in the market research (role of connecting network)
  - Complementary skills allowed to cover full perimeter of activities
    (ex: PCTJ in Japan, thermal analysis in EU)
  - Convergence of views on single EU-JAPAN vision towards hypersonic flight and common technology roadmaps to achieve this goal

The team has identified a joint way forward and is ready to initiate HIKARI 2

Thank You !

Any question

http://www.hikari-project.eu

http://www.euronews.com/2015/03/02/hypersonic-airlines/

Thank you!

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The research leading to these results is being funded by the European Commission Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no 313987, the METI (Ministry of Economy, Trade and Industry) and other concerned Japanese authorities under the 7th Framework for Research and Technical Development.

Recommendations on the Way Forward

- Develop **a joint design** following the **HIKARI Guidelines**, driven by a chief engineer and a collaborative team

- Develop **critical technologies** identified in the **HIKARI roadmap**
  - **Thermal and energy** system management
  - **Low noise** and **low sonic boom**
  - **Propulsion**: PCTJ, turbo ramjet : investigate and down select
  - **High temp. lightweight materials**

- Proceed with **Joint demonstrators** following the **HIKARI roadmap**