Abstract: Design of Hypersonic Airline Networks with respect to Passenger Demand and Flight Routing

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A methodology is presented to design and assess basic operational aspects of hypersonic airliners. Initially, a database of global airline ticket sales is used to identify promising origin-destination pairings for hypersonic transportation. The encountered demand is pooled to be served by so-called Stratoports that are strategically spread all over the globe. To connect the Stratoports, overwater flight routes are designed with the help of mission simulation and sonic boom carpet computation in order to prevent the boom from making landfall. This work was done in the context of the European Union project STRATOFLY.

I. Introduction

STRATOFLY deals with designing an airliner that has a cruise speed of Mach 8, up to 300 seats, and antipodal range. Whereas most of the work focuses on technical aircraft design, we draft probable scenarios of airline networks with the help of operational, economic, and technical data.

Figure 1: LAPCAT MR2.4, the aircraft design basis for STRATOFLY

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II. Work description

For the final paper, we will do the following work steps:

1) Assessment of the global market for airliner tickets (particularly Business and First Class), drawn from a commercial database; extrapolation of passenger numbers to an assumed date for an established airline service (e.g. 2050); pooling of passenger numbers to adjacent (currently 17) Stratoports, located on the coast or offshore

Stratoport Pairing	City Pairs	Two-Way Pax	GC Dist. [nmi]	Rerouted Dist. [nmi]	Detour [nmi]	Detour [%]	Flights /Day
East Coast North - Europe	152	9.662.824	3081	3200	119	4%	109
China Southeast - Europe	58	5.495.105	5174	7700	2526	49%	20
Europe - West Coast South	87	3.778.311	4885	7000	2115	43%	20
Europe - Florida	77	2.470.419	3813	4000	187	5%	19
Australia Southeast - Europe	40	3.238.279	9194	9700	506	6%	17
Africa South - Europe	32	2.084.518	5129	6000	871	17%	16
China Northeast - Europe	85	6.800.618	4711	7800	3089	66%	14
Brazil Southeast - Europe	26	1.501.370	5026	5200	174	3%	11
China Southeast - West Coast South	11	1.703.623	6297	6500	203	3%	11
Europe - Japan	42	1.645.630	5194	6000	806	16%	10
Asia Southeast - Japan	5	1.203.244	2813	2830	17	1%	10
Asia Southeast - Europe	51	2.665.797	5778	8700	2922	51%	9
China Southeast - East Coast North	17	1.547.720	7030	9000	1970	28%	9
Australia Southeast - China Southeast	17	1.565.345	4042	4800	758	19%	9
Brazil Southeast - Florida	10	1.444.057	3745	4700	955	26%	7
Europe - Rio de la Plata	17	937.151	6006	6000	-6	0%	6
Asia Southeast - Australia Southeast	11	1.208.424	3447	4600	1153	33%	6
Brazil Southeast - East Coast North	7	845.361	4146	4900	754	18%	6
China Northeast - East Coast North	19	1.711.480	6094	9000	2906	48%	6
Australia Southeast - Japan	8	915.129	4307	4800	493	11%	6
China Northeast - West Coast South	9	1.188.980	5365	6400	1035	19%	6
Africa South - Arabia East	5	755.933	4123	4600	477	12%	5
Asia Southeast - East Coast North	10	816.995	8245	10100	1855	22%	5
Arabia East - Asia Southeast	10	898.573	3077	3400	323	10%	5
Asia Southeast - West Coast South	4	622.581	7558	7600	42	1%	5
Australia Southeast - China Northeast	12	1.023.913	4616	5500	884	19%	4
Australia Southeast - West Coast South	8	419.838	6539	6550	11	0%	4
Florida - Rio de la Plata	11	1.152.200	3993	5800	1807	45%	4
East Coast North - India West	27	2.002.199	6647	11400	4753	71%	3

Basic market share	**20%**
Seat capacity	**100**
Load factor	**75%**
Flights/day/AC	**2**
Maximum detour	**100%**
Total flights/day	**409**
AC needed	**205**

Stratoport	**Flights/d**
Europe	254
East Coast North	150
West Coast South	55
China Southeast	54
Australia Southeast	51
Asia Southeast	46
China Northeast	36
Japan	35
Florida	34
Africa South	28
Brazil Southeast	26
Arabia East	15
Rio de la Plata	15
West Coast North	8
India West	7
Hawaii	3
Australia Southwest	1

Figure 2: Advanced demand analysis

2) Design of flight routes:
   - Flight path drafting in Google Earth
   - Mission trajectory simulation with proprietary tool Trajectory Calculation Module (TCM), using flight performance data (aero and engine maps, masses, etc.)
   - Sonic boom carpet calculation for the computed trajectories, using a proprietary code and taking into account real atmospheres including winds
   - Adaptation of flight paths, taking into account boom carpets, shores, islands, and settlements

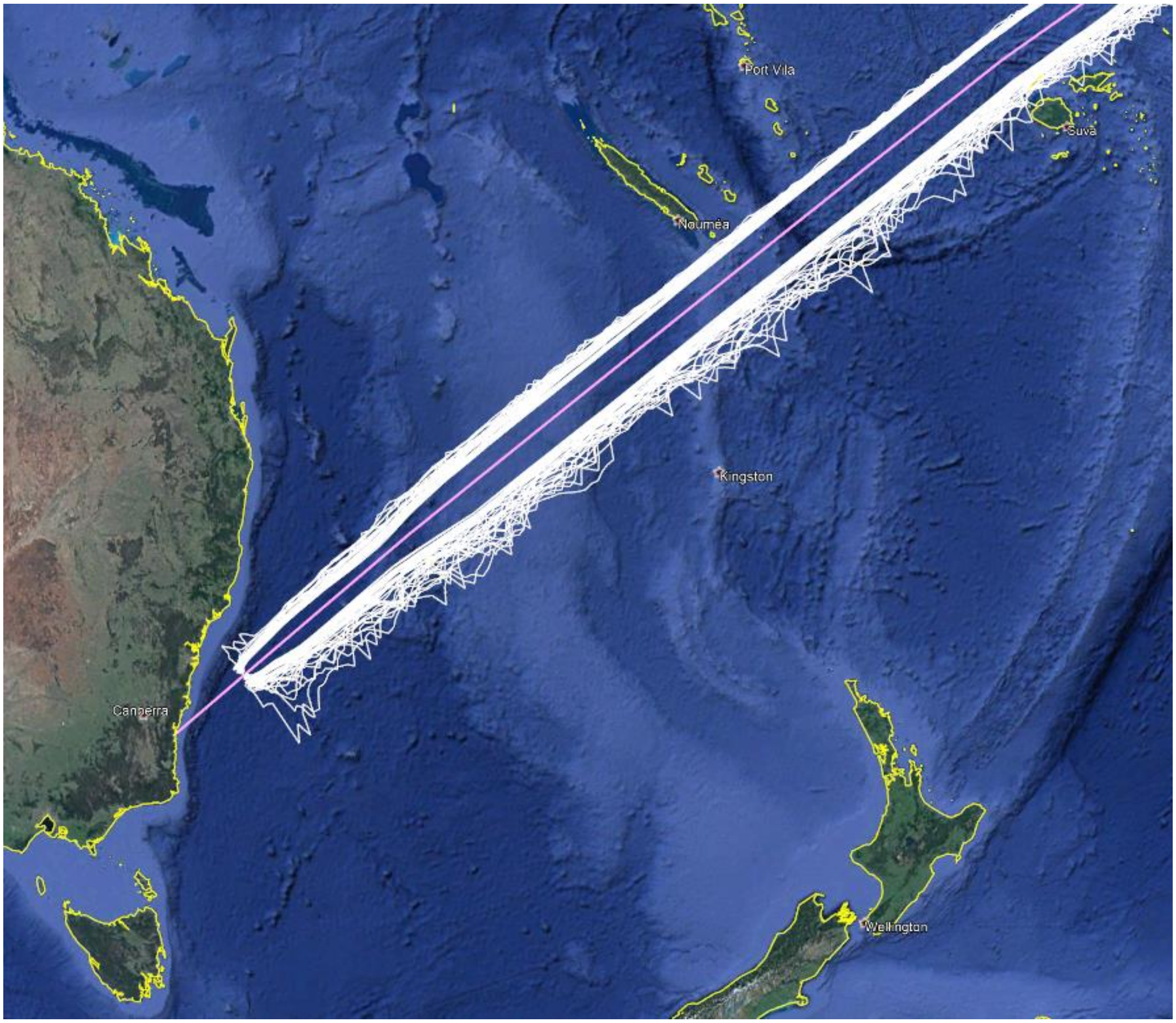

Figure 3: Sonic boom carpets for flight from Eastern Australia to U.S. West Coast

3) Assessment on the total addressable market, taking into account:
   - Expected passenger demand
   - Realized time savings
   - Parameters of hypothetical airline operations

III. Previous studies

- Liebhardt, B., Lütjens, K., and Gollnick, V., "Estimation of the Market Potential for Supersonic Airliners via Analysis of the Global Premium Ticket Market," 11th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, 2011; AIAA 2011-6806, http://elib.dlr.de/75274/.
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- Liebhardt, B., Lütjens, K., Tracy, R. R., and Haas, A. O., "Exploring the Prospect of Small Supersonic Airliners - A Business Case Study Based on the Aerion AS2 Jet," AIAA Aviation Conference, Denver, CO, 2017; AIAA 2017-3588, http://elib.dlr.de/111925/.
- Liebhardt, B., Lütjens, K., Swaid, M., Müller, M., and Ladewich, M., „Sonic Boom Carpet Computation as a Basis for Supersonic Flight Routing," AIAA Aviation Conference, Dallas, TX, 2019; AIAA 2019-3387, https://elib.dlr.de/127429/.