RELIABLE TRAFFIC SCENARIOS FOR VERY LIGHT JETS AND THEIR IMPACT ONTO THE AIR TRAFFIC CONTROL SYSTEM

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OVERVIEW

With a formal type certification of two Very Light Jets (VLJs) in 2006, the dawn of a new class of aircraft – defined as turbofan-powered airplanes with a maximum take-off mass (MTOM) between 2.3 t and 4.5 t – was launched. The emergence of VLJs has raised concerns about safety and Air Traffic Control (ATC) system congestion and proof of compliance to the current system.

This paper goes beyond the comparison of in-flight performance of available VLJs with current air traffic. Instead, a new customer-focused approach for drawing up VLJ traffic scenarios is presented. Therefore, three main customer groups for VLJs are identified: Private Pilots, Business Aviation and Air Taxi Operators. Impacts of every customer group on the ATC system are determined by analysing traffic samples. Thus, statistics regarding distribution of flight distances and airport/ airfield utilization are derived. A specific mode of operation is assumed for each VLJ user group to derive information on cruising altitude. Consequently, areas of common use (especially regarding Flight Level usage) of VLJs and conventional air traffic can be defined. As each scenario results in different needs to successfully integrate VLJs in the ATC system, several recommendations are put forward.

1. VERY LIGHT JETS AND PRIVATE AIR TRAVEL

The emergence of VLJs follows a strong growth in the field of private air travel. For instance, the European Business Aviation has been growing twice the rate in comparison to total traffic since 2001 [1]. Consequently, in 2005 Business Aviation did already account for 6.9 % [1] of all Instrument Flight Rule (IFR) flights in Europe. Especially flights by Business Jets grew disproportional high by 8.9 % in 2005 for Europe [1] and 8.5 % between September 2005 and August 2006 [2] worldwide. The similarities regarding both growth figures suggest worldwide reasons. Indeed, rising security needs, time-consuming security checks at major airports and increasing delays in scheduled aviation do play a major role in an accelerating market for private air travel. Moreover, an increasing amount of high wealth individuals results in a higher amount of prospective customers. Further, a decreasing price for similar value stimulates additional demand for aircraft manufacturers. As prices for entry jets used to be around 4.0 million $US (2006) (e.g. Cessna 525 Citation CJ1, [3]), VLJs decrease this envelope to 1.5 million $US (2006) (e.g. Eclipse 500, [3]). This also leads to a divergent customer structure. So the new class of VLJs is surprisingly dominated by the owner flown (Private Pilot) segment.

2. DEMAND AND SUPPLY FOR VERY LIGHT JETS

2.1 Prospective Customers for Very Light Jets

Remarkable demand for VLJs has been identified. Nearly 4,000 orders were placed by the end of 2006 worldwide. In Mai 2007, the company ETRIC started its VLJ operation business with more than 150 Eclipse 500 aircraft ordered for the Turkish market. On the other hand, many aircraft manufacturers are aiming for a market share. The low purchase price in combination with small operating costs make VLJs affordable for a wide range of different customers. FIG. 1 shows major groups. In addition, FIG. 1 summarizes the most important groups to customer categories: Private Pilots, Air Taxi and Business Aviation.

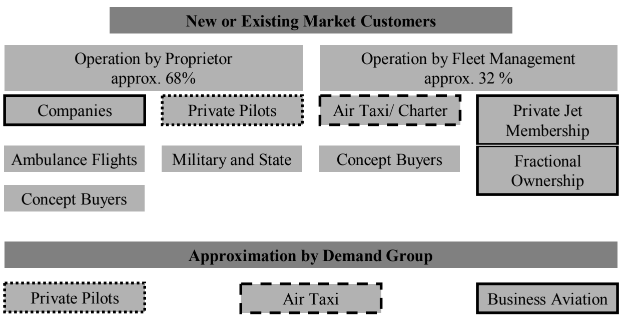

FIG. 1. Customer structure for VLJs

To analyse the travel demands for every customer category, the model group *Business Aviation* as a set of typical Business Aviation aircraft (e.g. Cessna 550) is introduced. This set of 25 different aircraft types was obtained from a market analysis in Germany. The same approach is used to define the term *Private Pilots*. The used set is calculated from a value benchmarking approach (cf. 4.2). *Air Taxi Service* is defined in accordance to the definition of the International Civil Aviation Organization (ICAO) as "a type of on-demand air service usually performed by small capacity aircraft on short notice in a very similar way to an automobile taxi service; or in some cases, a service operated on a scheduled basis with stops made only at points where passengers and cargo are to be picked up or discharged" [4].

The entire order volume for VLJs was analysed at the end of 2006: 68 % of all demand belongs to the owner flown Private Pilot segment, whereas Business Aviation and Air Taxi Operators only account for 32 %.

2.2 Definition of Very Light Jet and Characterization of Supply

Until 2005, the Cessna 525 Citation CJ1 used to be the smallest commercially built jet with a MTOM of 4.8 t. Improvements in various technologies enabled aircraft manufacturers to build even lighter aircraft with operating costs comparable to those of turboprops. Although no widely acknowledged definition has been established yet, most classifications define VLJs as turbofan-powered aircraft with a MTOM smaller 4.5 t [5]. It has to be noted that this threshold emerges from the mentioned historical perspective but not from an in-flight performance point of view. Consequently, the Cessna 525 Citation CJ1 shows similarities regarding performance figures in comparison to VLJs. Nevertheless, this paper still uses the stated classification.

2.2.1 Definition of Very Light Business Jet and Very Light Personal Jet

As the given definition of VLJs is rather broad, it seems to be reasonable to distinguish different types of VLJs. Especially for VLJs, engines are the most valuable part of an aircraft. Therefore, the amount of engines does *ceteris paribus* influence the purchase price. In addition, in-flight performance is influenced by the available thrust. Accepting this very rough approach leads to a possible customer distinction: On the one hand, customers do accept higher purchasing prices for better in-flight performance (e.g. higher cruising speed). This is mainly due to high opportunity costs (e.g. reduction of overall flight time for the business aviation, two engines). On the other hand, a reduced performance is accepted in exchange for a lower purchase price (e.g. Private Pilots, one engine). In conclusion, two subcategories can be defined. The Very Light Business Jet (VLBJ), which mainly aims for the target market of Business Aviation and Air Taxi Operators. As well as the Very Light Personal Jet (VLPJ), which target group mainly consists of Private Pilots.

2.2.2 Performance Figures of Very Light Jets

Over 15 different VLJs are currently developed all over the world. Most of these projects will not have enough funding to receive type certification and to successfully start production [6]. Therefore, only nine of the most promising (or already certificated) VLJs are chosen to estimate typical performance figures. These aircraft are:

- Eclipse Aviation: Eclipse 500
- Adam Aircraft Industries: A700
- Cessna Aircraft Company: Citation Mustang
- Embraer: Phenom 100
- Diamond Aircraft Industries: D-Jet
- Aviation Technology Group: Javelin MK-10
- Spectrum Aeronautical: Spectrum 33
- Honda Motor Co.: HondaJet
- Piper Aircraft Inc.: PiperJet

The current research uses just one in-flight performance data set for each subcategory of VLJs (VLBJ and VLPJ). The accompanied reduction of variety regarding different flying performance is feasible as most of the VLJ characteristics (except the Javelin MK-10 Executive Jet, which is intended to be used as military trainer) are sufficiently represented by TAB. 1.

Aircraft Characteristics	**VLBJ**	**VLPJ**
Passenger seats	6	6
MTOM [t]	3.5	2.3
Range (NBAA* IFR) [NM]	1250	1350
Max cruising speed (TAS) [kts]	380	338
Max service ceiling [FL]	410	300
Take-off distance required (MTOM, ISA**) [m]	994	723
Max rate of climb (sea level, ISA**) [ft/min]	3314	2700

TAB. 1. Characteristics of VLJs [3] [7]
* Range format of the National Business Aviation Association, Inc. (USA)
** International Standard Atmosphere

VLJs show strong similarities regarding in-flight performance to the upper end of today's high performance turboprop aircraft. Especially strong similarities exist regarding maximum cruising speed (e.g. Piaggio P.180 Avanti, Beechcraft King Air 350). Moreover, the maximum service ceiling (FL 410) of the Piaggio P.180 Avanti is identical to the one of VLBJs. Given these information could lead to the assumption that slowly cruising aircraft in high altitudes are a phenomenon ATC is already coping with. But as minimizing fuel flow is a secondary objective for the Business Aviation, this is not the case. As mentioned before, opportunity costs (e.g. time) are especially for business travellers very important. Exemplarily, flights with the Piaggio P.180 Avanti, a high-performance turboprop for the Business Aviation, take place in flight levels where the aircraft reaches its maximum cruising speed (around FL 300).

3. GROWTH FORECASTS FOR THE MARKET SEGMENT OF VERY LIGHT JETS

Several institutions have published market forecasts. Interestingly, even the forecasts which predict the smallest numbers, do estimate fairly high quantities. Consequently, when taken the already ordered amount of VLJs in account as well, it can be presumed that VLJs will play an important role in the very near future. Data supply from the manufacturers enabled to calculate a European VLJ share of 17 % [8] (FIG. 2).

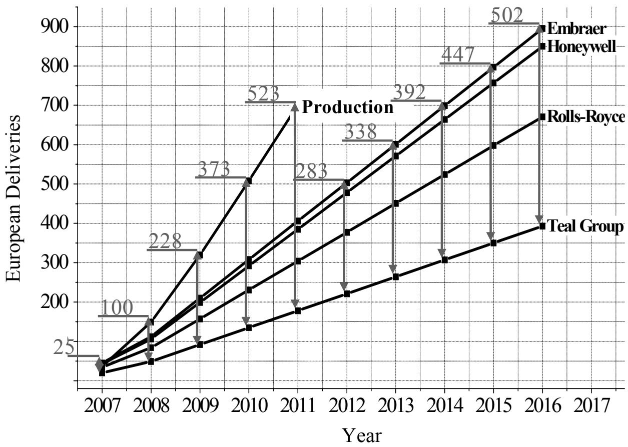

FIG. 2. Deliveries of VLJs in Europe
Growth scenarios of institutions and manufacturers are given for worldwide deliveries but have been reduced to the European share (17 %). The production curve indicates the announced deliveries from VLJ manufacturers for Europe.

Strong differences between the growth forecasts can be noticed. Variability is indicated by arrows pointing from the lowest to the highest prediction (cf. FIG. 2). For analysing the impact onto the Air Traffic Management (ATM) system, it is also necessary to state the amount of flights by VLJs. For that reason, three different growth scenarios are obtained from FIG. 2. The total production VLJ manufacturers are aiming for is set to be the high growth scenario. The forecast provided by Honeywell represents the base scenario. Low growth is symbolized by the Teal Group prediction.

In accordance to EUROCONTROL, flights are calculated by assuming 0.6 movements per day [9] for Business Aviation and Air Taxi. Private Pilots are expected to only use their aircraft 0.15 times a day [9]. TAB. 2 presents the amount of expected flights in Europe.

Flights per Growth Scenario			
Year	**High**	**Base**	**Low**
2008	21832	15522	7171
2009	46711	29104	13446
2010	74198	42686	19721
2011	102430	56268	25996

TAB. 2. Induced flights by Very Light Jets

FIG. 2 and TAB. 2 show a high uncertainty regarding growth figures. There are several reasons accounting for this. The typical VLJ customer is very prone to price changes (purchasing price and operating costs). This is basically caused by the customer segment VLJs are developed for. Most of the customers had not been financially able to afford a jet before. The price elasticity of demand of this customer group leads to disproportionately high drop in demand (over 1 %) in case of a price rise of 1 %. This so-called elastic demand implies some challenges for the manufacturers as their business model is based on a high volume production. If external conditions e.g. single-pilot operation, Air Taxi Business, competitive high speed trains and improved turboprops change negatively from the manufacturer's point of view, customers will not buy as much VLJs which are necessary to keep purchase prices down (economy of scales). However, higher prices reduce demand disproportionately high again. In conclusion, non of the presented growth forecasts (cf. FIG. 2) appears to be unrealistic.

4. TRAFFIC SCENARIOS

4.1 Research Design

The terms Business Aviation and Private Pilots are defined by different sets of aircraft. This is necessary to analyse traffic samples to identify typical flight activities (e.g. distribution of flight distances) for each group. Given the distribution of flight distances for every customer category and VLJ performance data leads to information on cruising altitudes. Moreover, identification of typical routes shows preferred airport types for every class. In conclusion, interactions of VLJs with current air traffic can be determined. Comparing VLJs in-flight performance with aircraft flying in the specified interaction space enables sufficient analysis of impacts and demands regarding the ATC system.

The third main customer category for VLJs has not been considered yet. As the kind of large scale Air Taxi network future Air Taxi Operators are aiming for does not exist today, it is not possible to derive flight information. Consequently, transportation needs are estimated: Potential customers of an Air Taxi Service operated by VLJs are expected to mainly consist of passengers who fly for business or private purpose. Whereas the motivation to fly certain legs tend to be similar between Business Aviation and *Air Taxi with business people aboard* (Private Pilots and *private individuals aboard*). Therefore, a straightforward approximation of typical Air Taxi traffic can be done by accepting legs of Business Aviation and Private Pilots for an Air Taxi network. To finally derive a sample of flights, it is necessary to set an appropriate share of each potential customer group. Apparently, the main market for Air Taxi Operators is presumed to be the transport of business people. Consequently, this research assumes a customer structure of 75 % business people and 25 % private individuals.

The set of aircraft used for Business Aviation is obtained from typically used Business Aviation aircraft in Germany. As most charter companies only operate very few aircraft, there is only little scope for assigning efficient aircraft to every flight missions: Long-distance business jets might transport passengers on short-haul if necessary. Consequently, no typical business aircraft is excluded from the set due to better range capabilities in comparison to VLJs.

Defining a typical group of aircraft for Private Pilots is more challenging. Naturally, not every Private Pilot is financially in the position of purchasing a VLJ. To define a typical set of aircraft for Private Pilots it is necessary to use value-benchmarking techniques.

4.2 Identification of Potential Aircraft which is Prone for Replacement Investments with the Relative Value Index

The price of an aircraft is only a vague reflection of its utility or value. Instead, the product value induced by an aircraft depends on the individual preference structure of the consumer. Customers of Business Aviation for instance prefer high cruising speeds but do not draw intense attention to fuel consumption. In contrast, Private Pilots accept weaker performance (e.g. lower cruising speed) to minimize operating costs (e.g. fuel consumption). The Relative Value Index (RVI) estimates the value of a product (based on multiple assumptions) for a certain customer category. A higher RVI expresses a higher product value. The RVI is given as following [10]:

$$RVI_i = \prod_{j=1}^{n} v(g_{ij})^{\gamma_j} \quad \begin{bmatrix} j \in \text{Natural numbers} \\ i \in \text{Natural numbers} \\ \gamma \in \text{Positive real numbers} \end{bmatrix}$$

The RVI for a good i is the product of its utilities v for j attributes g. Naturally, every attribute g has a different evaluation γ in accordance to the needs of a certain customer group. Important attributes of an aircraft which are used for calculating the RVI are [11]:

- Maximum cruising speed
- Take-off distance required
- Fuel consumption per seat-mile
- Cabin volume per passenger
- Available seat-miles

FIG. 3 shows several aircraft types with their corresponding price and RVI. In addition, the most important VLJs can be found in FIG. 3. Rational customers will always prefer products which are cheaper as a competitive good if it has an equally or even higher RVI (or have the same price and a higher RVI). In conclusion, all aircraft shown in the grey area of FIG. 3 are dominated by VLJs in their value/ price combination.

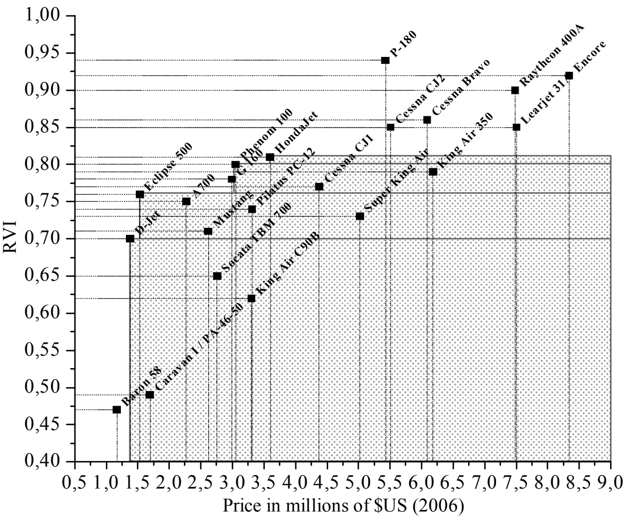

FIG. 3. Value benchmarking with the RVI

Most of the Private Pilots flying today with one of the aircraft in the grey shading (cf. FIG. 3) are expected to switch to a VLJ if their current aircraft needs to be replaced. It is necessary to point out that this might only occur for these pilots which do not have certain requirements regarding in-flight performance (e.g. short take-off distance due to runway length limitations). Nevertheless, the identified inferior aircraft from FIG. 3 can be used to forecast the amount of VLJs to expect regarding replacement investments: Exemplarily, in Germany the total amount of 194 aircraft was registered in January 2007. This figure supports the presented growth scenarios in chapter 3.

It is necessary to point out that the set of aircraft representing Private Pilots is similar regarding range and overall flight time for a given leg in comparison to VLJs: Lower cruising altitudes for turboprops compensate disadvantages concerning a smaller cruising speed. Therefore, flight time differences for legs smaller 500 NM are just a few minutes. In conclusion, aircraft identified for Private Pilots does not restrict their needs today (distance, flight time) in comparison to the possibilities offered by VLJs (TAB. 3). For that reason, the used set of aircraft for Private Pilots does sufficiently represent their flight habits.

Characteristics	**Aircraft set for Private Pilots**	**Typical VLPJ**	**Typical VLBJ**
Max Cruising Speed (TAS) [kts]	280	338	380
Range (NBAA IFR) [NM]	1155	1350	1250

TAB 3. Comparison of the identified set of high-end turboprops which are prone for replacement investments with different types of VLJs [3]

In addition, the assumed considerations of Private Pilots buying jets instead of turboprops are not unique. Similar development took place in Business Aviation in the late 1960s. With the market entry of the first jet-driven business airplanes heavy business turboprops vanished from the market in just a few years. Nowadays Private Pilots can be expected to trade up to turbofan-powered aircraft. This is mostly due to lower purchasing prices in comparison to today's high-end turboprops.

4.3 Traffic Scenarios

4.3.1 Traffic Distribution

Take-off requirements of VLJs are very modest. Given the condition of a Take-Off Distance Available (TODA) longer than 700 m, a paved runway and a minimum wide of 18 m (commercial operations) leads to 154 possible airfields in Germany. FIG. 4 suggests a homogeneous distribution throughout the country. Similar conditions can be expected in other European countries.

FIG. 4. Public German airports with a paved TODA longer 700 m and a minimum runway wide of 18 m

89.5 % of all airfields in Germany are suitable for VLJs. Assuming that all of these airfields would be used results in 23,562 possible city pairs. In contrast, scheduled carriers all over Europe service 30,000 [1] city pairs. Identifying these potential often leads to the assumption that traffic distribution of VLJs is unpredictable which implies challenges for the Air Navigation Service Provider (ANSP).

Analysing the traffic data for the mentioned aircraft sets leads to different results. FIG. 5 shows the LORENZ Curve of traffic distribution for Business Aviation and Private Pilots.

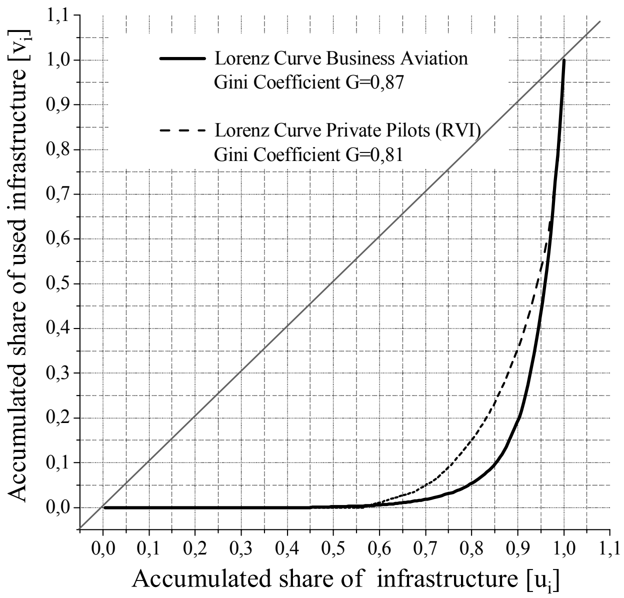

FIG. 5. LORENZ Curve of traffic distribution for Business Aviation and Private Pilots in Germany

If the traffic had been equally spread between the different airfields in the used flight data, the two curves would be identical to the principal diagonal. In addition, the Gini Coefficient (as a measure of heterogeneity) confirms the convexity of both curves: Flights of Private Pilots and Business Aviation are very concentrated to certain spots. At least for the Private Pilots this is not caused due to TODA requirements.

Analysing traffic distribution more closely shows that Business Aviation is part of coordinated (respectively schedules facilitated) airports, whereas Private Pilots do prefer smaller local airports with less dense traffic. An important transportation demand for the Business Aviation is identified between major airports and airfields in rural areas. If an airport cannot match the required flexibility of a business flight, Business Aviation tends to bypass to smaller airports and airfields in the region. As the total traffic is steadily growing, Business Aviation will keep on shifting to smaller airfields near the major airports. FIG. 6 shows the traffic distribution for the Business Aviation in Germany. As stated before, the most frequently flown legs are between the most important economic centres. Moreover, demand for Business Aviation only exists in regions with strong industry establishments. A similar distribution can be assumed for other European countries.

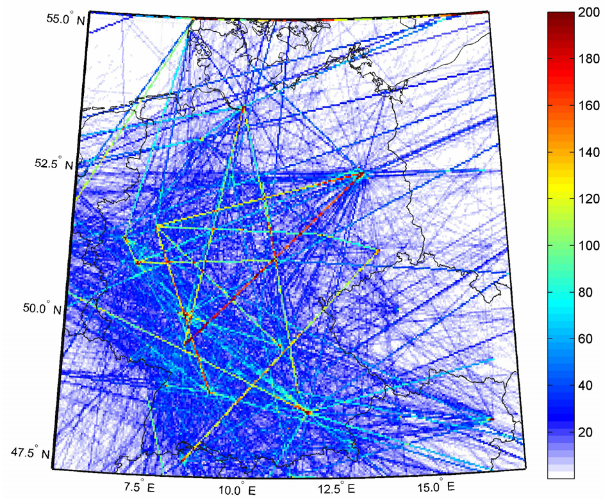

FIG. 6. Example of traffic distribution of Business Aviation in Germany (September 2006)

In general, traffic is stimulated by socioeconomic factors. There are not many Private Pilots who can afford high priced turboprops (or VLJs) in regions with high unemployment rates and low *per capita* income. FIG. 7 proves this assumption as the main traffic for Private Pilots does not take place in rural areas.

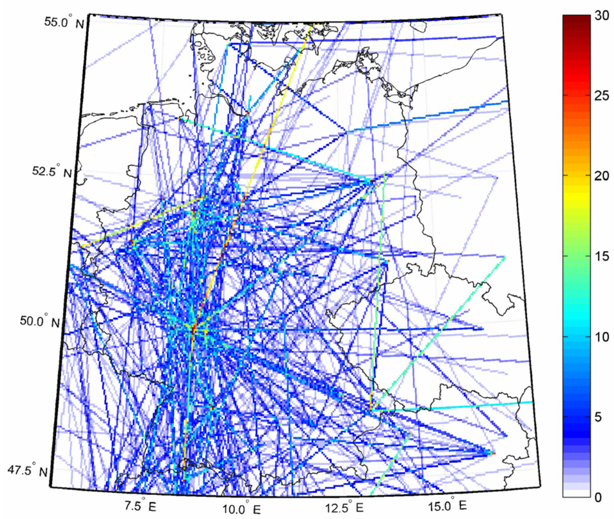

FIG. 7. Example of traffic distribution of Private Pilots in Germany (June 2006 and October 2006)

In conclusion, prospective VLJ traffic has to be expected at major airports as well as at smaller airfields in agglomeration areas. In addition, VLJ traffic will also take place between already highly frequented city pairs.

4.3.2 Flight distances

FIG. 8 and FIG. 9 show the distribution of flight distances for a given customer group. To extract significant differences only the most often flown lags are identified for each customer group.

Hereinafter, a typical flight distance refers to the envelope between lower quartile (25 %) and upper quartile (75 %) for each distribution.

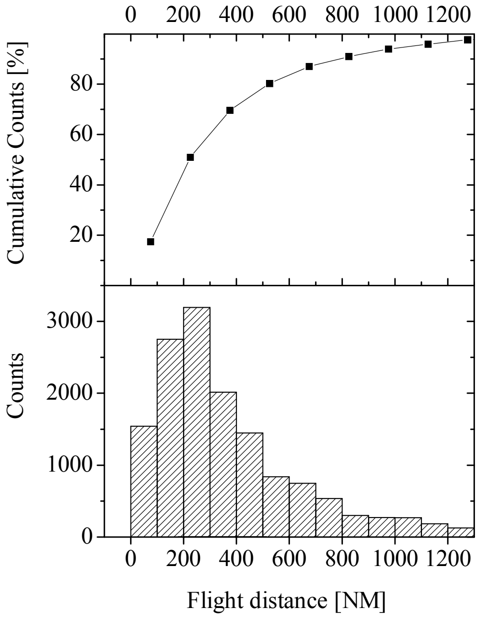

FIG. 8. Distribution of flight distances for Business Aviation (September 2006) in Germany

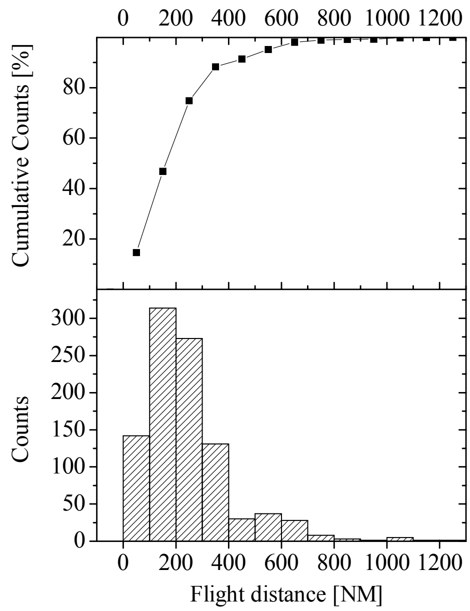

FIG. 9. Distribution of flight distances for Private Pilots (June 2006 and October 2006) in Germany

4.3.4 Cruising Flight Level

The altitude during cruise represents the interaction space of VLJs with other aircraft. Different flight distances result in divergent cruising flight levels. FIG. 10 shows the fuel-efficient cruising altitudes for a typical VLBJ and VLPJ. Characteristically flown distances are indicated for every customer group. In addition, flight level utilization is shown in the background.

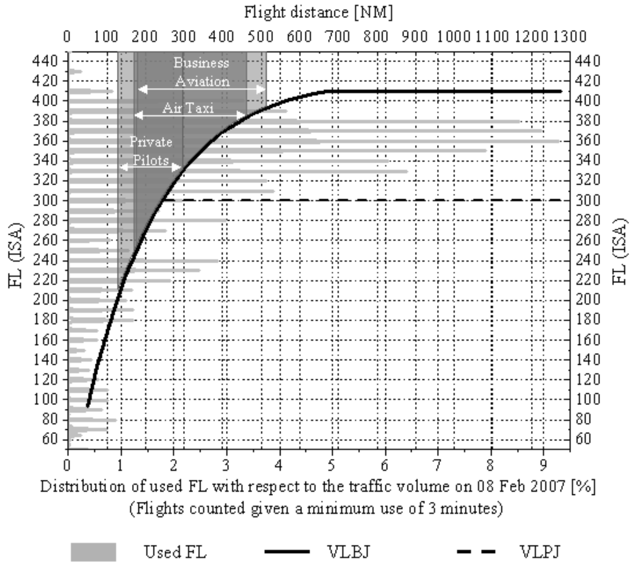

FIG. 10. Fuel efficient flight levels for VLBJ and VLPJ and typical flight level utilization

4.3.4.1 Scenario "Very Light Jet Market Dominated by Private Pilots"

It can be observed that the most frequently used flight levels of the current air traffic are between FL 310 and FL 380 (cf. FIG. 10). Assuming a usage of a VLPJ for Private Pilots intends very little interaction with this main traffic flow. In contrast, a VLBJ flown by Private Pilots would already be flying in the lower part (ca. FL 330) of the main traffic flow; however, not in the busiest altitudes.

4.3.4.2 Scenario "Very Light Jet Market Dominated by Business Aviation"

VLJs operated by Business Aviation are assumed to fly in and partly above the main traffic flow. This results in a higher amount of potential interactions with other aircraft in comparison to market domination by Private Pilots.

4.3.4.3 Scenario "Very Light Jet Market Dominated by Air Taxi Operators"

Air Taxi Operators are expected to mainly fly in the main traffic flow. Due to the assumed high amount of business travellers using an Air Taxi Service (75 %), only a small difference exists in contrast to cruising altitudes of Business Aviation. Therefore, a high amount of interactions with other aircraft can be supposed as well.

Given these information about interaction space, it is possible to contrast in-flight performance of VLJs in the regarding altitudes in comparison to other traffic.

4.3.5 Comparison of Cruising Speeds

FIG. 11 shows the range of cruising speeds for 41 typical aircraft in Europe. As this is a static comparison, no information about how often a certain type of aircraft and therefore how frequently a cruising speed occurs can be drawn from FIG. 11. Nevertheless, the figure identifies new conditions from an ATC perspective: Due to its low operating Flight Levels, the typical VLPJ fits in today's diversity regarding cruising speeds. In contrast, the VLBJ leaves this envelope. Consequently, there has not been a commercially built aircraft before with similar low cruising speeds in high altitudes.

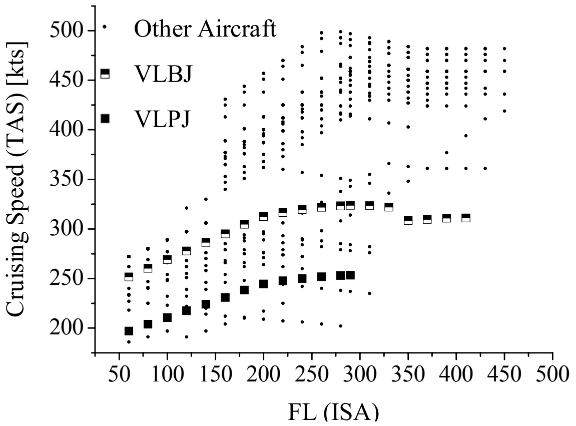

FIG. 11. Cruising speeds of the 41 most common aircraft types in Europe in comparison to VLBJ and VLPJ

5. AIR TRAFFIC CONTROL REQUIREMENTS

In comparison to today's large aeroplanes (according EASA CS-25 certification) VLJs have a considerably lower climb speed, a reduced rate of climb and a lower cruising speed.

5.1 Integration of Very Light Jets in Approach Control Sectors

As stated in 4.3.1 VLJs will not only use airfields but also some major airports. Due to their in-flight performance, VLJs tend to use a disproportional large amount of capacity. To reduce the negative effects, VLJs should use Standard Instrument Departure (SID) routes which are currently already used for aircraft with weak climb performance (e.g. turboprops, Airbus A340-200). Moreover, SIDs can be restricted for VLJs by the Route Availability Document (RAD).

5.2 Integration of Very Light Jets in Area Control Center Sectors

Due to the unique in-flight performance of VLJs controller training should be conducted within a short period of time. Especially safety awareness should be promoted.

5.2.1 Scenario "Very Light Jet Market Dominated by Private Pilots"

As already stated most orders for VLJs are from the owner-flown segment. As VLPJs have a limited service ceiling, Private Pilots do not enter the main traffic flow. Some Private Pilots have ordered VLBJs. Nevertheless, due to the short legs, it can be expected that only very few VLBJs will interact with traffic which is considerably faster. Therefore, Private Pilots are assumed to just put little strain on the current ATC system.

5.2.2 Scenario "Very Light Jet Market Dominated by Air Taxi Operators and Business Aviation"

Especially Business Aviation and Air Taxi Operators might occasionally rely on fuel-efficient flight profiles to avoid time-consuming stopovers for longer flight distances. Therefore, it is necessary to clear them for high altitudes as well (above FL 310). Otherwise, the success of the VLJ market would be hampered. Nevertheless, the aim of a successful integration should also be led by the idea of an overall surplus value for the entire society and hence not to imply disadvantages for the Non-VLJ traffic.

One solution can be the definition of additional airspace, especially designed for VLJs. Besides, a further dualisation of Air Traffic Service (ATS) routes would help to integrate slower VLJ traffic. Further, offset procedures are possible for specified ATS routes. Both help to reduce interferences caused by slower VLJ traffic. As the European airspace already lacks airspace capacity, further suggestions will have to be taken into account as well.

Due to the additional work caused for an air traffic controller by handling heterogeneous traffic, VLJs do need a disproportional high amount of capacity. Consequently, user charges should be appropriate to the caused costs for the Air Navigation Service Provider (ANSP) and for the society (opportunity costs for delays caused by VLJs for Non-VLJ traffic). Alternatively, higher user charges for often-requested (fuel-efficient) flight levels could help convincing VLJ pilots to accept higher fuel flow in lower altitudes with less traffic.

If VLJ traffic should have an extraordinary negative effect on the entire ATM system, it could prove necessarily to restrict VLJ traffic on certain ATS routes by the RAD. On the other hand, a new airspace class above airspace C (e.g. starting at FL 300) which is reserved for large aeroplanes according to EASA CS-25 certification only could avoid slowly flying VLJs in the main traffic flow.

With an increasing amount of VLJs Air Traffic Flow Management (ATFM) would need adjustment. A potential algorithm could aim for achieving similar cruising speeds to reduce air traffic controller work. Moreover, high speed differences between aircraft should be anticipated for by reducing the control capacity for a certain sector.

SUMMARY

This work is contributing to the current discussion regarding impacts on ATM due to VLJs with a new customer-focused approach. Moreover, the very broad definition of VLJ is split into two different aircraft types: On the one hand, the so-called Very Light Personal Jet (VLPJ) with just one engine which has been developed for the owner-flown Private Pilot segment. On the other hand, the Very Light Business Jet (VLBJ) with two engines which is aiming for a market share in the field of Business Aviation and Air Taxi Operators. The different target group is basically due to increased in-flight performance (two engines) in comparison to the VLPJ. As the VLPJ has its service ceiling at FL 300 it is expected that only few interactions with the main traffic flow will occur. Consequently, only little additional strain will be put on the current area control system. In contrast to VLPJs, VLBJs will be part of the main traffic flow above FL 310. Their extraordinary low cruising speed will reduce capacity due to increased ATC workload. Several suggestions are put forward: For instance offset procedures for VLBJs to enable faster traffic to bypass and introduction of an ATFM algorithm to predict reductions of capacity due to heterogeneous cruising speeds.

Both VLPJs and VLBJs will increase delays at airports (approach control): A reduced rate of climb and low speeds during climb will need a disproportional high amount of capacity. For that reason, it is for instance required to restrict VLJs to SID routes which are designed for similar aircraft (e.g. turboprops).

Which of the drawn up scenarios will prove to dominate in the future can currently not foreseen. Certainly, there will not be a single scenario dominating. Nevertheless, the order volume of Private Pilots was significantly high with 68 % at the end of 2006. As this also states the distribution of the next to come deliveries, there will not be a sudden additional strain on the ATC system. Because Private Pilots are assumed to just occasionally interact with the main traffic flow. Nevertheless, if for instance the Air Taxi business model proves to successfully work, the amount of VLBJs operating as Air Taxi could strongly rise.

ACKNOWLEDGEMENTS

This work was supported by the German Air Navigation Service Provider DFS Deutsche Flugsicherung GmbH. The authors would like to thank for the provided assistance. However, any views expressed are those of the authors and not of DFS Deutsche Flugsicherung GmbH.

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