EPATS AIRCRAFT MISSIONS SPECIFICATION

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Executive summary

These missions requirements for EPATS aircraft have been developed taking into account the future needs of the market analysis carried out under the project EPATS. Aircraft mission requirements are derived from passenger traffic and the level of wealth of the population. A wide range of public revenue, operating costs of different types of aircraft and passengers flow rates cause the need for appropriate diversification of types of aircraft operating in the System.This paper presents the results of these analysis

1. INTRODUCTION

With the expanding European Union and ever greater mobility in and between its member States, alternatives to long distance car trips and scheduled air transport need to be considered. Even with the emergence of high speed railways, these benefit only the large cities. With this in mind, general aviation can provide an alternative. Small aircraft providing affordable, personal air transport services will greatly improve accessibility and economical potential between central and remote areas. This will also alleviate ground traffic and relieve the already congested air traffic at large commercial hub airports by allowing operations from smaller non hub airports. People will be able to travel to and from destinations closer to their home and work in a more efficient way.

WHAT IS EPATS?	
EUROPEAN	Born and operate in Europe
INTERREGIONAL	Links All European Regions (NUTS 2, NUTS 3)
INTERACTIVE	Links All actors (Customers – Providers) in real time by network
DAILY-ROUND-TRIP	High-speed and point-to-point connection lead to high daily radius of action
AFFORDABLE	Accessibility to small airports and low generalized cost trip make the system affordable
SAFE	News aircraft, operational and air traffic management technologies makes the system safe
PERSONALIZED	Adjust aircraft fleet and operations to passengers flow and population personal needs
AIR-FREE-FLIGHT	Automated Air Traffic Management in Single European Sky ATM environment (SESAR project)
TRANSPORTATION SYSTEM	

2. EPATS AIRCRAFT CATEGORIES AND THEIR MAIN MISSIONS

The EPATS aircraft performances vision is based on analysis of forecasted market needs, evaluation of existing aircraft, trends in technology development, and on the existing knowledge and long experience in aircraft design. Trade off studies and costs analysis was made to verify it.

The EPATS aircraft fleet consists of the following aircraft categories:

Piston aircraft

It will comply CS-23 requirements for normal and commuter category with news amendments concerning reinforced safety and environment The dominant position of piston aircraft (70% of all, nowadays) will gradually decline together with population income increase in favor of jets. The cheapest, available in price of high class personal car, one engine aircraft will partially replace car in travels on distances 300-500 km as a private aircraft. These aircraft will be piloted by user bearing a VFR, private pilot license the most often, although they will comply EPATS requirements and have IFR capacity for commercial operation.

Two-engine aircraft will operate as an air-taxi with costs comparable to a ground taxi. These will be used for one day business trips on routes connecting remote, peripheral regions on distances 300-700 km. The aircraft will be piloted by VFR/IFR commercial pilots. Their customers will be mainly small enterprise managers.

Turboprop aircraft

It will comply CS-23 requirements for normal and commuter category with news amendments concerning reinforced safety and environment 9 – 19 - seaters, operated by small carrier companies will serve direct, regular air connections, characterized by low intensity of traffic (5000 – 10 000 passengers yearly), between peripheral regions on distances 300 - 1500 km, to hubs. These aircraft will also provide charter service on routes with low, irregular flow of passengers (tourism, seasonal travel to work abroad, sport, cultural events, etc.). Costs of travel using these aircraft should be comparable with costs of traveling by low-cost carriers and should be available to most of the citizens.

Jet aircraft

It will comply CS-23 requirements for normal category with news amendments concerning reinforced safety and environment and jet propulsion. Two main categories for utilization is planned: Small 3 – 5-seaters, Very Light Jets with maximum take-off weight below 5000 kg will be used as airtaxi providing transport from any to any region in country or the EU and as executive (the aircraft should be viewed as a productive machine). Cost efficiency could be reached by high value managers and 7 - 9 - seaters will operate in the area of whole Europe as a corporate and business airline charter - regularly scheduled flights between city pairs deemed profitable.

The structure of EPATS aircraft fleet, the types of operations and regulations and dominants missions are shown in diagram below Fig. 1.

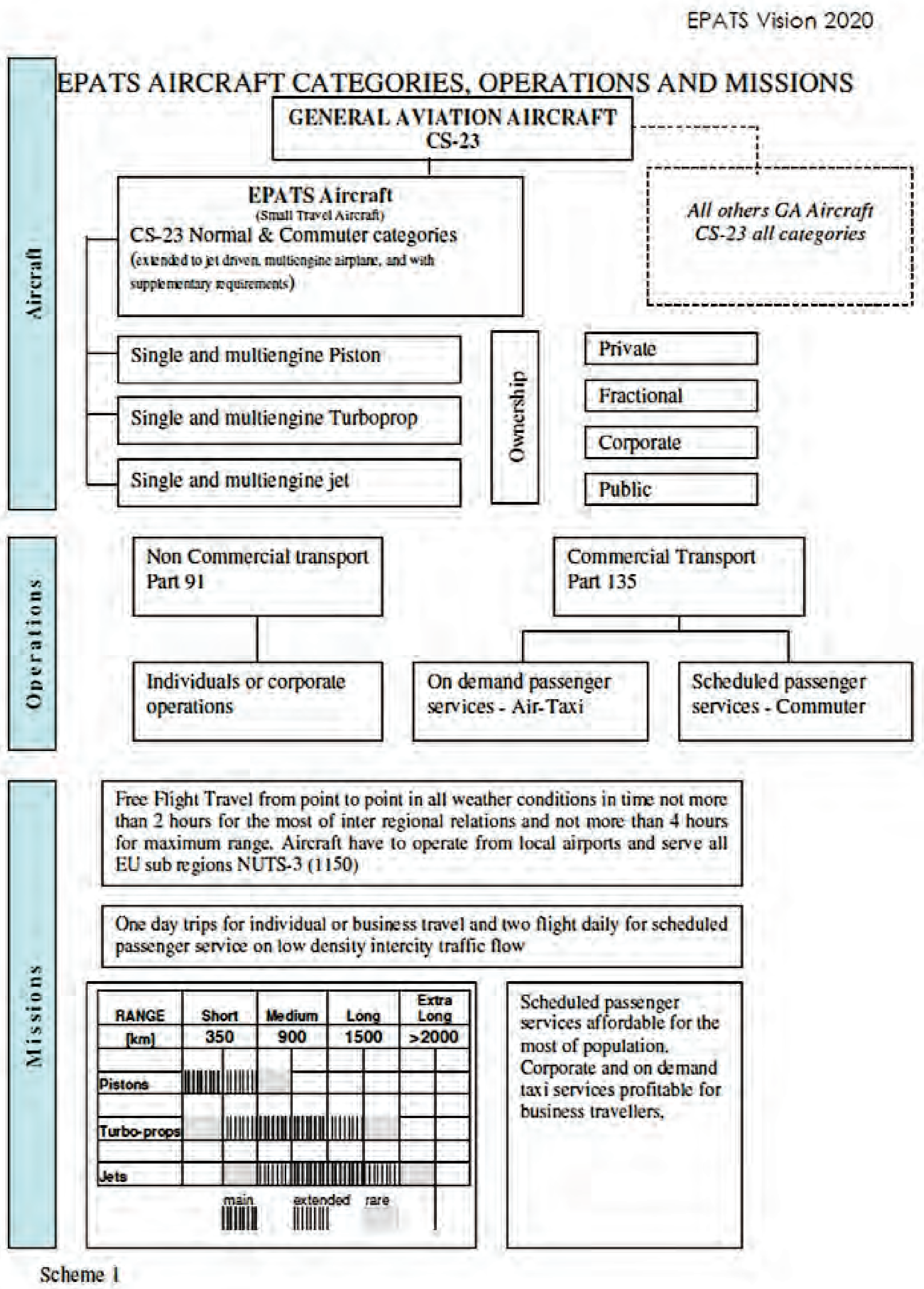


Fig. 1. EPATS aircraft categories, operations and missions [1]

3. MISSIONS REQUIREMENTS

Mission requirements for commercial personal aircraft are derived from the potential demand for high-speed transport and possibilities for satisfying it. Demand for transport modes is generated by population mobility. The choice of mode depends on its accessibility and individual preferences of traveler, which, apart from out-of-pocket costs, are the outcome of multiple determinants. The most important of the determinants are the following: time of travel, comfort, safety, preferences. All of the determinants have some monetary value, which may be expressed by financial costs or benefits. Passenger is likely to pay more if his travel time is shorter (value of time) or his travel comfort is higher (comfort value) or pay less at the expense of preferences or safety.

Finding the right mission for a transport mode is done by the determination of serviced routes (ranges), time (speed), capacity (passenger seats), level of comfort (cabin size, toilet, pressurization, vibrations, noise, flight quality), frequency of service, operational conditions, estimation of limits of travel: costs, energy consumption, construction, operation and environmental regulations. These tasks are an outcome of the forecasted passenger flow, that is estimated between locations (regions, cities) in the environment of existing transport infrastructure (roads, train, airports) and for passengers with the respective income distribution (value of time).

There are the following relations:

- ranges are determined by the distribution of length of connections between serviced airports,
- speed and level of comfort are determined by the length of connections and travelers income distribution,
- number of seats and frequency of service are determined by the passenger flow intensity, operational conditions are determined by the current and forecasted airport infrastructure and air traffic control and management state.
- Cost limitation is derived from population income distribution (which percentile of population benefits from the proposed mode of travel).
- Energy consumption limitation is a consequence of sustainable transport policy. It is assumed that the energy consumption of EPATS aircraft needed for one passenger-kilometer per time unit will not be significantly different from personal car.
- Interregional connection distribution, population income, passenger flow intensity, diversification of airport infrastructure and air traffic management and control systems determine one optimal choice for mission requirements and limitations for every interval. The more diversified aircraft types, the better fit for demand. However, in practice, the higher diversity generates higher manufacture and operation costs; these are the reasons for aircraft type limitation, together with their elasticity for specialized versions adjustments. A possibility to provide an easy function adjustment (number of seats, level of comfort, range) to the labile transport demand constitutes one of the main instruments of carrier operation cost decrease.

Main parameters of mission requirements are:

- **number of passenger seats** of a given type of aircraft developed from the number of trips done between respective regions by passengers having income correlated to the cost of travel by a given type of aircraft,

- **aircraft speed** as a function of travelers time value, distances, airport accessibility, time of waiting (passenger is interested in door-to-door time of travel, it is rational, therefore, to increase average speed, simultaneously limiting block speed that generates costs mainly),

- **typical mission profile**, see Fig. 3

- **aircraft range**, which comes from the distribution of serviced routes (interregional connections) see Fig. 2,

- **start and landing characteristics** adjusted to the existing regional and local airport network covering possible modernization plans,

- **comfort level** (cabin space, toilet, pressurization, noise level, vibrations, ride quality,…), estimated at a number of levels depending on the average time of flight, target passenger income interval and generally accepted standards,

- **flight conditions** depend on the existing and forecasted state of airport infrastructure, airspace structure and air traffic control and management systems. For second stage of EPATS development (2025), the conditions will be determined during SESAR project realization and EPATS airports requirements estimation. During the first stage of EPATS (2015) flight conditions will not be significantly different from the present practice.

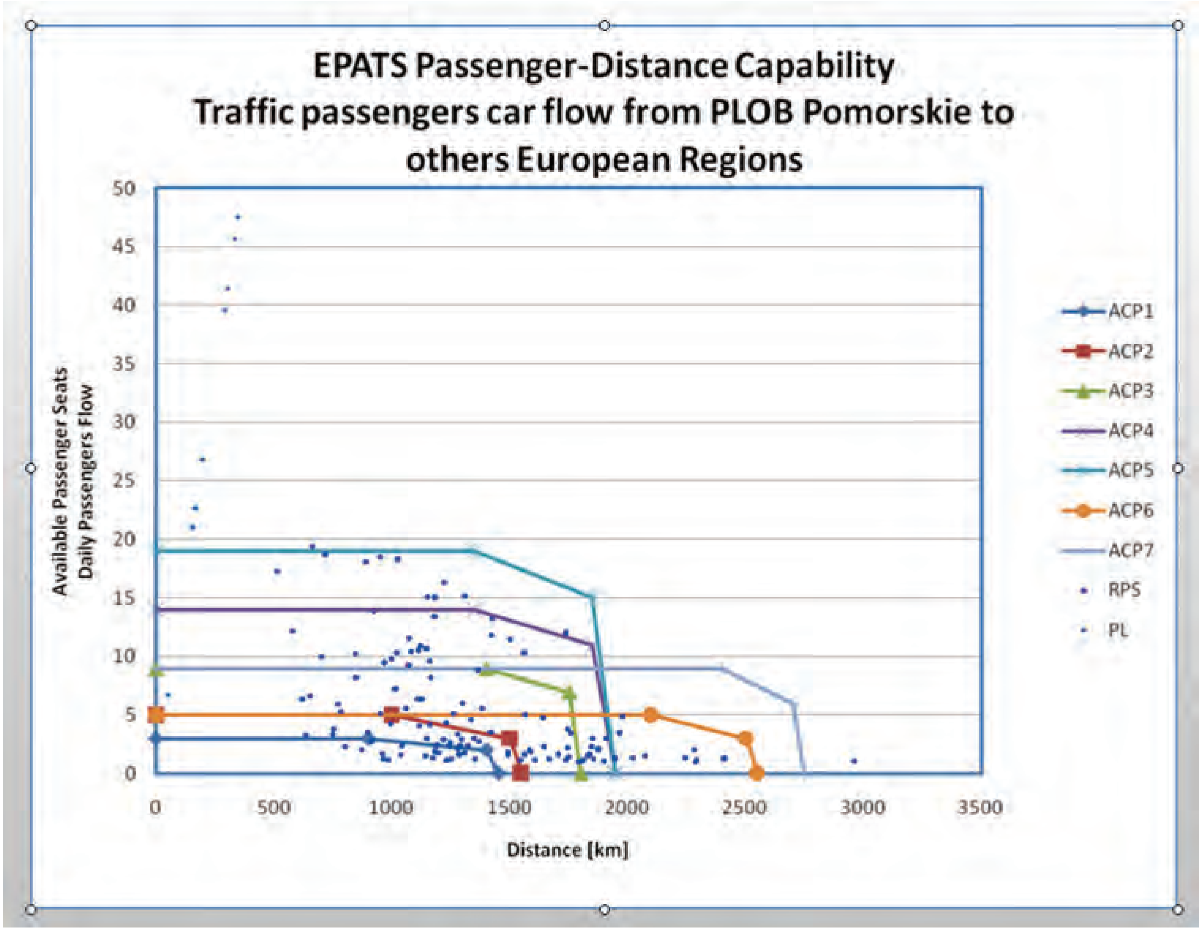


Fig. 2. EPATS Payload-Range Capacity against a background of passengers-ranges shifted from passenger car traffic from Polish Region NUTS2 PL0B (Pomorskie) to all others European Regions (source ESPON [5])

Points in Figure 2 indicate the average daily volume of passenger flows traveling by car from Polish Region "Pomorskie" to other regions of the country and the EU expressed by their distance. Data were taken from the European project ESPON. Graphs show the capacity of different types of aircraft expressed by number of passenger seats available, depending on the range. Figure gives an overview of the categories of aircraft - expressed in number of seats and range – that would be needed to replace the existing road traffic to air traffic in an effective manner.

The mission requirements constraints are:

- specific energy (fuel) consumption (as a measure of sustainable transport development conditions),
- aircraft price (limited by market demand),
- operation costs (limited by users economic efficiency),
- maintenance (labor hours per flight hours),
- life cycle,
- regulation requirements concerning aircraft construction (FAR-23, CS-23), operation (FAR-135).

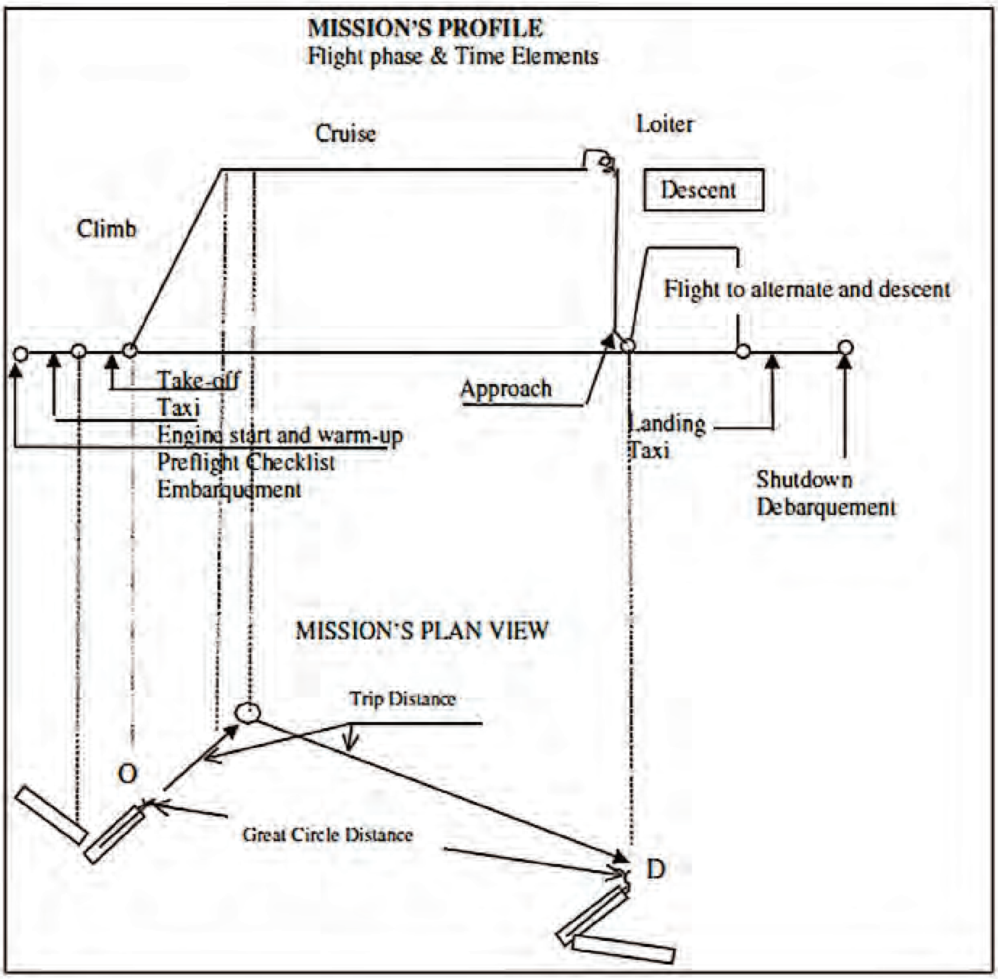


Fig. 3. Typical aircraft missions profile.

Recommended technical characteristics.

Technical Specification for aircraft are derived from mission requirements and their technical feasibility. They describe characteristics of an aircraft, that are necessary to achieve mission requirements and concern design tasks: crew, configuration, weight, size, propulsion system, performance, control, equipment, avionics, modular construction that allows to fit different configuration, etc. TS is a result of project studies and mission feasibility analysis as well as assumptions concerning possibilities of planned research-development programs realization. Technical specification for EPATS aircraft family will be prepared in the context and with the feedback from:

- airport infrastructure requirements,
- future ATM-ATC requirements.

Tab. 1. EPATS BASELINE AIRCRAFT PERFORMANCE (VISION 2020)

Aircraft Class	Single Engine*	Twin Engine Piston	Twin Engine Turboprop		Twin Jet	
Class Number	1	2	3	4	5	6
Primary Missions	Private and Business trips and Air-Taxi-on demand passenger services for mid class (short range)	Air-Taxi-on demand passenger services for mid class (short range)	Commuter-on demand and scheduled passenger services on low density passenger flow, affordable for population majority	Commuter-on demand and scheduled passenger services on low density passenger flow, affordable for population majority	Private and Business trips and Air-Taxi-on demand passenger services for high value managers	Commuter on demand transportation and Private Business trips and Air-Taxi-on demand passenger services for high value managers
Seating**	1+3	1+5	1+9	1+19	1+5	1+9
Cabin With [m] High [m]	>1.30 >1.30	>1.30 >1.30	>1.80 >1.70	>1.85 >1.75	>1.50 >1.50	>1.60 >1.60
Lavatory	No	No	Yes	Yes	Yes	Yes
Pressurized		No	Yes	Yes	Yes	Yes
All weather perform	Yes	Yes	Yes	Yes	Yes	Yes
TO Weight [kg]	<1300	<2000	<5000	<7200	<2700	<6000
Cruising speed [km/h]	350	>350	>550	>550	>750	>750
Cruise altitude[FL]		80-200	150-250	150-250	250-300	250-300
BFL [m]	<600	<600	<1000	<1000	<1000	<1000
Range Full Payload [km]	>1000	>1000	>1500	>1500	>2500	>2500
SFC at Ver [l/seat.km]	<0.035	<0.035	<0.04	<0.03	<0.08	<0.07
DOC [Euro/seat.km]	<0.15	<0.12	<0.20	<0.15	<0.35	<0.30
Price [1000 Euro]	<200	<400	<1700	<4200	<1000	<3000
Specification***	CS-23A	CS-23A	CS-23A	CS-23A	CS-23A	CS-23A
FIXED OPERATION TIME						
Pre-flight Check-list Engine start warmup	5	8	8	12	12	12
Embarquement	1	2	1	4	1	3
Climb to criuse level (CT)	10	20	20	20	20	20
Eng. Shutdown, parking	1	2	1	2	2	2
Debarquement	1	2	1	4	1	3

* Concerns both piston and turbo engines[1]
** The first figure means air-crew number as well as command station, the second the certificated number of passenger seating
*** A -means with news amendments concerning reinforced safety and environment for travel aircraft
* A single engine aircraft is assumed to be at the same safety level as multi engine airplanes and be approved for commercial transport of people (air-taxi). In order to do it, such an aircraft in case of engine failure has to catch up on the limited propulsion redundancy by other means of safety. Apart from enforcing propulsion reliability, emergency-landing possibilities should be extended, both, in classical as well as unconventional meaning (e.g. using a parachute emergency system). Preparing for such a possibility requires lower aircraft weight and speed in comparison to a multiengine aircraft. Such aircraft is estimated to have less than 1500 kg, cruising speed lower of 350 km/h and with the stalling speed of no more 100 km/h enabling safe emergency landing. In practice, this condition may be rationally fulfilled by the light, propeller driven aircraft.

Tab. 2. EPATS aircraft avionics equipment list [4]

	ENGINE	**ENGINE PISTON**	**ENGINE TURBOPROP**		**ENGINE JET**	
Class number	1	2	3	4	5	6
CMOMMUNICATIONS						
dual 8.33 kHz VHF radio	√	√	√	√	√	√
SWIM dual data link	√	√	√	√	√	√
WiMax			√	√	√	√
broadband services					o	o
NAVIGATION						
dual GNSS/w SBAS	√	√	√	√	√	√
dual DME	√	√	√	√	√	√
RVSM					√	√
P-RNAV FMS	√	√				
4D RNAV FMS			√	√	√	√
ILS receiver(s)	√	√	√	√	√	√
SURVEILLANCE						
ADS-B In/Out 1090ES	√	√				
enhanced ADS-B			√	√	√	√
TAS	√	√	√		√	
TCAS II				√		√
ELT 406 MHz	√	√	√	√	√	√
FDR & CVR				√		√
TAWS-B	√	√	√		√	
TAWS-A				√		√
lightning detection (sferics)	√	√				
weather radar			√	√	√	√
HUMAN MACHINE INTERFACE						
IFD (PFD/MFD/audio/AP)	√	√	√	√	√	√
HUD/SVS/EVS					o	o
EFB	√	√	√	√	√	√

Equipment list

A summary of the proposed avionics required for EPATS is provided in Table 1. This is listed per aircraft class and class number; please view Table 1 again for mission roles and aircraft specifications defined for the various classes. Check marks (√) represent equipment that is needed to enable EPATS to fly in the SESAR airspace of the future as well as to fulfil the envisioned mission. For the upper class twin jets, an (O) mark represents an option for these aircraft class. Because these twin jets perform the high value executive mission, the options are available to satisfy customer demand where necessary. [4]

4. REQUIREMENTS FOR NEW TECHNOLOGIES

The technical level of General Aviation aircraft, including small aircraft used for passenger transport is significantly different from the technical level of passenger and military aircraft. It is forecasted that the increased demand for small aircraft for passenger transport will need to use news technologies. Based on the results of studies conducted in the framework of the European project EPATS and other related projects, such as: ESPON, CESAR, SESAR, SATS, NextGen, it can be expected that the technological development of small aircraft will progress very quickly. Comparing to the reference list aircraft the EPATS 2020 aircraft characteristics will differ as follow:

- Increased comfort: lower noise and vibrations, smoother flight (improved ride quality due to active control), larger and more ergonomic cockpit (especially in single engine aircraft).
- More intuitive and easier to fly
- Single control station – one pilot flight crewmember (possible thanks fully Automated flight control and air traffic management system)
- All Electric Aircraft configuration and fly-by-wire
- Implementation of lighter and smaller, highly reliable propulsion systems requiring less maintenance and manufactured at significantly lower production costs.
- Implementation of piston engines fueled by bio-fuels.
- Increased propellers efficiency (more than 0,85).
- Using new technologies and materials in airframe to decrease weight and manufacture costs.
- Using module components increasing possibility of equipment retrofit and aircraft type adaptation to meet market demand. The baseline aircraft should give possibility to produce derivative versions (for example: different fuselage length will have common wing, empennage, cockpit, engine,…)
- Introducing higher level of equipment and structure elements unification and standardization.
- Decrease of minimum speeds (through new aerodynamic solutions).
- Reducing the chance of "pilot error" and if an accident occurs, more crashworthy.
- Increasing flight safety through introduction of more rigorous requirements of CS-23 for EPATS aircraft (including some CS-25 regulations).
- Automated flight control and air traffic management system (allowing one pilot crew).
- Integrated flight management system (flight planning, alerts on restricted air space, air traffic control frequencies and terrain variations, report fuel capacity and weight allowance, inform about weather,…). Easy access to flight information and situation by PFD (Primary Flight Display) and MFD (Multi Function Display) use.
- Reducing fuel consumption through more efficient power systems, lower airframe weight and new aerodynamic solutions
- Lower purchase price – reached thanks to new technological solutions applied in respective stages offull life cycle, increased production scale and appearing cooperation possibilities in the EU
- Lower operating costs – through lower fuel consumption, costs of purchase and maintenance.

5. EPATS AIRCRAFT REQUIREMENTS DEVELOPMENT PHASE

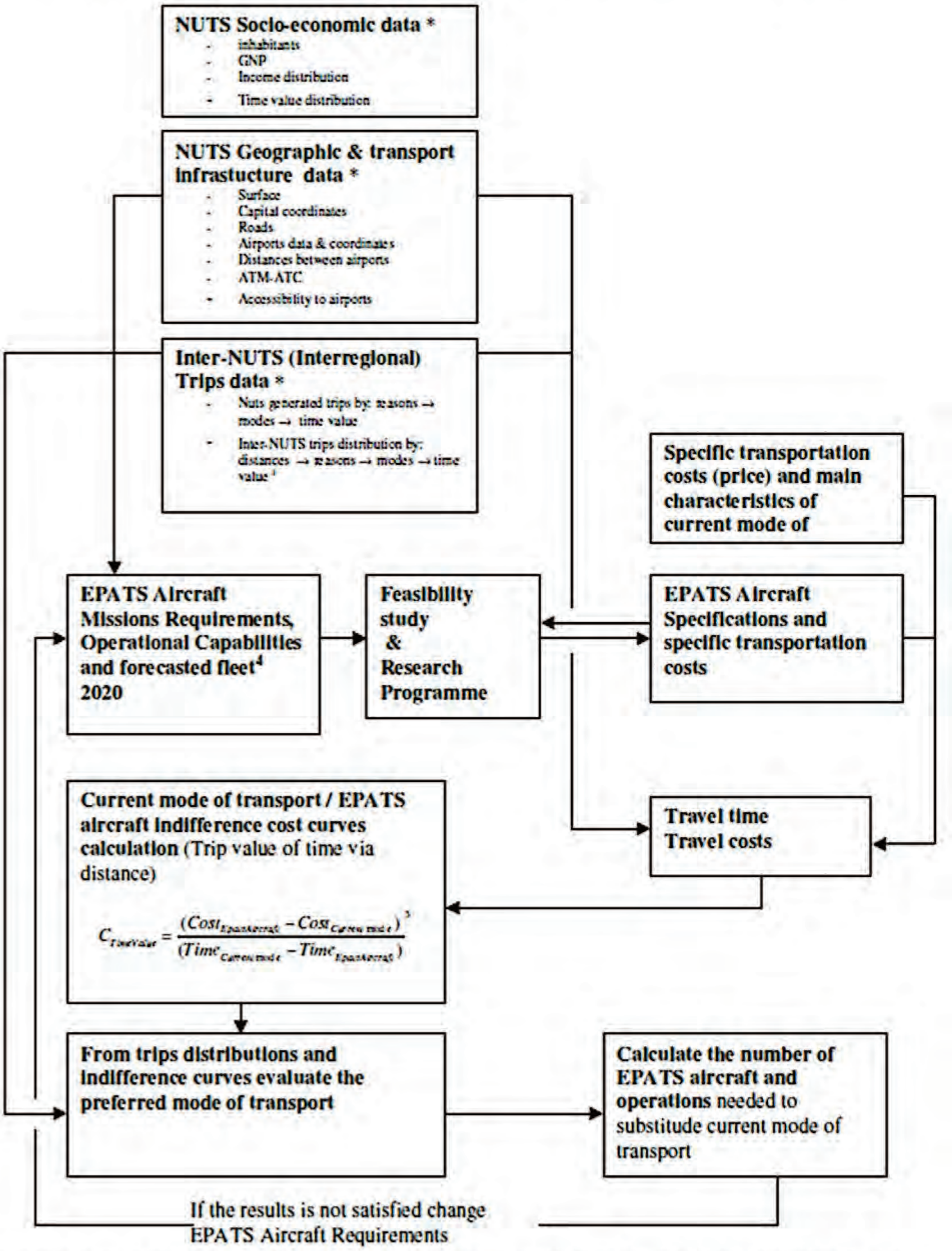
The Operational Requirements of EPATS aircraft will be elaborated in two phases. At the first phase of EPATS development (2015) the ATM-ATC and Operational Capabilities of the aircraft will be similar to that of current advanced small aircraft. See Reference Aircraft below.

At the second phase the proposed ATM-ATC and Operational Capabilities Envisioned for 2020 are conformable to those of US SATS and they are:

- Aircraft will be capable of operating in low–visibility conditions airports without radar cover or assistance from air traffic control towers. Aircraft will require neither ground-based navigation aids nor approach lighting.
- Aircraft operations will be contained within existing airport terminal areas and protection and noise exposure zones. Operations will be environmentally compatible with communities near airports.
- Operators will vary widely in training, experience, and capability, having skills ranging from those required to pilot an airline to those required to drive an automobile. Automation and new flight control concept will replace human manipulation and decision making as primary control inputs. Onboard computers will provide realistic, real time tutorials and training, even during flight.
- Digital data link capabilities will provide the operator and aircraft with real-time and integrated weather, traffic, and airport information for dynamic modifications to flight plans.
- Interactions with air traffic management and control will be largely automated and will not require positive control. Aircraft will operate autonomously, providing guidance for self-separation from other aircraft and obstacles. EPATS users will interface with air traffic services only to the extent that they operate in controlled airspace and airports. A fully digital communication system will be in place, alleviating frequency congestion difficulties. Aircraft separation and sequencing will be accomplished by interaction of aircraft systems using the Global Positioning System (GPS) and automatic dependent surveillance and broadcast messages (ADS-B).
- Primary navigation service will be provided by GPS at all altitudes. Terrain and obstacle databases with data up-link capabilities, automation, and intuitive displays of the information in the cockpit will aid operators in avoiding collisions. Dynamic approach procedures will be calculated by onboard computers in real time to any runway end or touchdown point.
- New materials and engine and airframe designs, as well as mass production of aircraft, will allow for greatly reduced aircraft acquisition, maintenance, and operating costs. Ride smoothing and envelope-limiting protections will ensure ride comfort and safety.

Cost limitation is derived from population income distribution (which percentile of population benefits from the proposed mode of travel). Energy consumption limitation is a consequence of sustainable transport policy. It is assumed that the energy consumption of EPATS aircraft needed for one passenger-kilometer per time unit will not be significantly different from personal car.
Interregional connection distribution, population income, passenger flow intensity, diversification of airport infrastructure and air traffic management and control systems determine one optimal choice for mission requirements and limitations for every interval. The more diversified aircraft types, the better fit for demand. However, in practice, the higher diversity generates higher manufacture and operation costs; these are the reasons for aircraft type limitation, together with their elasticity for specialized versions adjustments. A possibility to provide an easy function adjustment (number of seats, level of comfort, range) to the labile transport demand constitutes one of the main instruments of carrier operation cost decrease.
The diagram below shows the process of creating requirements for aircraft and determining demand for them.

EPATS aircraft missions requirements and potential demand scheme



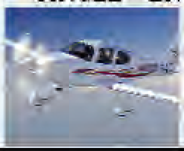
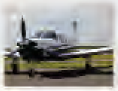
* For current year and 2020 forecast. Data sources: ESPON, EUNET, DATELINE, SCENES, EUROSTAT and others

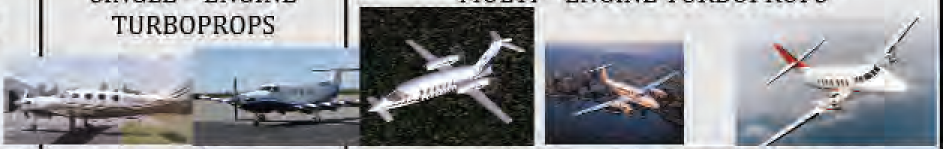
1. Calculated using Gravity Model
2. From statistical data and calculation
3. Travel costs includes transportation cost and accomodation costs
   Time travel includes all elements of time from origin to destination
4. Taking the replacement need of existing old business and personal aircraft (above 20 years) into account.

6. REFERENCES AIRCRAFT AND VISION 2020

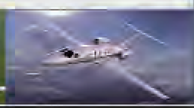
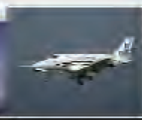
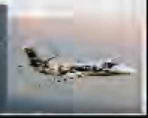
In the initial period of implementation of EPATS the existing aircraft and airports network will be used. In the tables below are included these planes, which are closest to meet the missions requirements, and which are susceptible to modernize equipment and systems of CNS, as assumed Vision 2020 and a timetable for implementation of new ATM services Among the most important parameters that were taken into consideration when choosing the reference planes were: specific fuel consumption and direct operating costs .

The list of aircraft included in the tables does not exhaust all possible planes for use in the EPATS

EPATS AIRCRAFT REFERENCE LIST PART 1	SINGLE – ENGINE PISTONS		MULTI – ENGINE PISTONS	
				
Manufracturer Model	Cirrus SR-22	Piper Saratoga II TC	Diamond DA-42 Twin Star	Piper Seneca V
Price [1000€]	274	425	395	567
Certification Year	2000	1997	2004	1996
Characteristic				
Seating	1+3	1+5	1+3	1+5
Dimenations Internal [m]				
Lenght	3.3	3.16	3.40	3.15
Width	1.24	1.24	1.10	1.24
Hight	1.27	1.07	1.00	1.07
Cabin Volume [m^3]	5.197	4.193	3.740	4. 179
Power				
Engine	Teledyne Continental IO-550-N	Textron Lycoming TIO-540-AH1A	Thielert Centurion v. 2.0	Teledyne Continental TSIO-350-RB
Price [1000€]			30	
Output [kW]	231	224	99	164
Weight	187	245.8	149.6	149
SFC			0.22	
TBO [h]	2000			1800
Weights [kg]				
Max. TO	1542	1633	1786	2154
Max. Payload				426
Useful Load	531	516	532532	562
Max. Fuel	301(251 usable)	301 usable	2651(Jet-A)	332
Performance				
Max. Cruise Speed [km/h]	343	343	335	300
Service Celling [FL]	175	200	160	150
Rate of Climb [m/min]	426		390 (1702kg)	446
TO Distance to 15 m [m]	486	552	527 (1702kg)	671
DOC (pax^km)	0.105	0.082	0.177	0.140
SFC – Block [litre/(pax^km)]	0.044	0.040	0.050	0.059
Range				
Range (max. payload) [km]	1502	1563	1696	1533



EPATS AIRCRAFT REFERENCE LIST PART 2		SINGLE – ENGINE TURBOPROPS		MULTI – ENGINE TURBOPROPS		
Manufracturer Model		Epic Dynasty	Pilatus PC-12	Piaggio Avanti II	Beechcraft King Air 350	BAE Jetstream 32EP
Price [1000€]		1.444	2.24	5.85	4.422	
Certification Year		2008	1994	2006	1990	1997
Characteristic						
	Seating	1+5	1+9	1+9	2+15	2+19
Dimenations Internal [m]						
	Lenght	4.57	5.16	4.55	5.94	7.39
	Width	1.40	1.53	1.85	1.37	1.85
	Hight	1.49	1.47	1.75	1.45	1.8
EST.	Cabin Volume [m^3]	9.833	11.005	14.731	11.800	24.009
Power						
	Engine	P&WC PT6-67A	P&WC PT6A-67B	P&WC PT6A-66B	P&WC PT6A-60A	Garett TPE331-12
	Price [1000€]					
	Output [kW]	895	895	2x634	2x783	2x761
	Weight	230	234	213	216	182
	SFC	0.333	0.332	0.377	0.333	0.333
	TBO [h]	3000	3500	3000	3600	5000
Weights [kg]						
	Max. TO	3314	4740	5466	6804	7360
	Max. Payload	613	1123	907		2042
	Useful Load		1673	1950	2531	2400
	Max. Fuel	856-1070	(1227)		1639	1469
Performance						
	Max. Cruise Speed [km/h]	630	500	737	576	491
	Service Ceiling [FL]	310	300	410	350	250
	Rate of Climb [m/min]		480	899	832	
	TO Distance to 15 m [m]	488	(917)	(1295)	(1006)	1432
	DOC (pax^km)	0.269	0.186	0.250/	0.109	0.119
	SFC – Block [litre/(pax^km)]	0.070	0.052	0.009/	0.003	0.043
Range						
	Range (max. payload) [km]	2870	2583	2453	1737	915

EPATS AIRCRAFT REFERENCE LIST PART 3		SINGLE – ENGINE JETS 	MULTI – ENGINE JETS 				
Manufracturer Model		Diamond D-Jet	Eclipse 500	Cessna Citation Mustang	Eviation EV20 Vantage	Grob SPn	Cessna Citation Encore+
Price [1000€]		1.060	1.126	1.881	2.407	5.800	6.290
Certification Year		2007	2007			2008	
Characteristic							
	Seating	2+3	1+4/5	2+4	2+8	1(2)+8	2+9/11
Dimenations Internal [m]							
	Lenght	3.53	3.76	2.97	5.26	5.10	5.28
	Width	1.42	1.42	1.42	1.65	1.52	1.47
	Hight	1.44	1.27	1.37	1.57	1.64	1.45
EST.	Cabin Volume [m^3]	7.218	0.781	0.778	13.020	12.713	11.254
Power							
	Engine	Williams FJ33-4A	P&WC PW610F	P&WC PW615F	Williams FJ44-1AP	Williams FJ44-3A	P&WC PW535B
	Price [1000€]						
	Output [kW]	6.99	2x4.0	2x6.5	2x8.77	2x12.5	2x15.12
	Weight	136.2			208.8		
	SFC				0.475	0.456	
	TBO [h]		3500	3500	3500	4000	5000
Weights [kg]							
	Max. TO	2300	2719	3925	4200	6300	7634
	Max. Payload				908		
	Useful Load	1018	1039	1444	1907	2205	2917
	Max. Fuel		765	(1171.3)	1249		2449
Performance							
	Max. Cruise Speed [km/h]	583	685	630	790	754	793
	Service Celling [FL]	250	410	410	410	410	450
	Rate of Climb [m/min]		1044	917.4	914.4	1320	
	TO Distance to 15 m [m]	620	714	(947.9)	762	(914)	(1073)
	DOC (pax^km)	0.208	0.282 /	0.305	0.200	0.282	0.253 /
	SFC – Block [litre/(pax^km)]	0.094	0.1041/	0.147	0.009	0.103	0.1122 /
Range							
	Range (max. payload) [km]	1426	1426/1019	1865	2226	3093	2139

EUROPEAN PERSONAL AIR TRANSPORTATION SYSTEM – EPATS VISION 2020				
EPATS Components		Current state (2008)*	Preparatory, Research &Development Phase (2020)	Implementation Phase (2030)
AIRCRAFT	Airworthiness Standards	FAR-23 (JAR-23) Normal and Commuter category	Enhanced CS 23 Standards	Personal Aircraft Airworthiness Standards
	Aircraft Types	Single and multi-engine pistons, turboprop and jet aircraft	4 to 19 seatings, single and multi-engine pistons, turboprop and jet aircraft	New Technically Advanced Small Aircraft (TASA)
	Sructure	Mainly metallic structure with thousandth parts. Design concept from 1960th Related structure weigh: 100 – 150 kg per seat Related structure cost: ~250 Euro per kg	Integral components – lower number of parts, mainly composite, automatically formed and/or monolithic part produced from a single metallic block mechanically or chemically Module structure and versality Crashworthiness features requirements Optimized relationship between size, weight, fuel capacity, engine thrust and EPATS missions requirements. Reduction of weight: 20 % Reduction of manufacturing cost: 30%	New Technically Advanced Small Aircraft (TASA)
	Aerodynamics	Aerodynamics concept from 1960th Poor ride quality (Levels of vertical and lateral accelerations as a airplane response to atmospheric turbulence) Lift-drag ratio at cruising speed: 7- 12 Max lift coefficient: 1,8 – 2,2	High / low speed capability via the variable geometry airfoil (in the form of high lift design on leading and trailing edge). High low speed performance and high effectiveness at cruising speed Improved response to atmosphere turbulence (better ride quality) Lift-drag ratio at cruising speed: 10- 15 Max lift coefficient: 2,5 – 3	New Technically Advanced Small Aircraft (TASA)

	Flight Control	Mechanical or hydro - mechanical	Fly-by wire control systems (to be certified to DO-178 B adopted by FAA) (with hydraulic or electric actuator) and Full Authority Digital Engine Control (FADEC) Pilot fly-via-computer	New Technically Advanced Small Aircraft (TASA) with fly-by wire flight control system. New concept of flight control surfaces to make control difficulty level comparable to driving a car.
	Propulsion[1]	Gasoline Piston engines, SFC: ~0,2 l/KM h Related weight: 0,8 kg / KM Price: 65k. $ for 200 KM Propeller: Effectiveness: 0,70-0,80 Turbine engines (800k $ for 1000 daN of thrust)	Compact diesel piston engines running on jet fuel (Jet-A) and bio-fuel, having low fuel consumption (<0,2 l/KM.h) and low mass to power ratio (< 0,8 kg/KM), low vibration and noise levels, meeting ecological requirements. Propeller: Effectiveness: 0,80-0,90 FADEC Small turbofan jet engines with thrust 250 – 800 daN, mass to thrust ratio about 0,12 kg/daN and specific fuel consumption below 0,5 kg/daN.h meeting noise and emissions requirements. FADEC	Piston engine price comparable to car engine price. Jet engine price reduced by an order of magnitude. Introducing hybrid propulsion system - of ECATS (Environmentally Compatible Air Transportation System) project.
	Avionics[2]	In older aircraft dozens of instruments, gauges and swiches to monitor Communication, navigation and flight control based mainly on radio and radar In the last year new avionics systems was introduced. See: avionics reference list [2]	Communication, navigation and flight control based mainly on satellite systems (Galileo); Multi function autopilot (performing flight management and instructor role) linked with fly-by-wire system Intuitive flight desk design. Easy to operate color flight parameters and multifunction displays (monitors) and Head Up Display allowing color visualization Voice threat warning systems (prohibitive proximity to other aircraft or ground objects, deviating from planned flight path) See table 1 EPATS avionics equipment list	New avionics to ensure compliance with SESAR project and: - missions capabilities, - autoland system

	Systems Ice protection systems Lavatory system Emergency systems On-Board Diagnostics System	 Equipped Not equipped Not equipped Not equipped	 More effective ice protection system Equipped for aircraft with more than 6 seatings Automatic emergency flight Back system[3] On-Board Diagnostic System linked with Flight Operation Quality Assurance Center (FOQA) [4]	New Technically Advanced Small Aircraft (TASA)
	Performances Requirements See EPATS Aircraft Missions and Requirements	See Table 2 Reference aircraft	See: Scheme 1 EPATS aircraft categories, operations and missions Table 1 EPATS aircraft missions requirements Fig. 1 EPATS Pyload-Range Capacity	New Technically Advanced Small Aircraft (TASA) fulfilling missions requirements
	Comfort	Unsatisfied level of cabin interior noise and vibration, restricted cabin size and poor ride comfort particularly for pistons. Levels of vertical and lateral accelerations as a airplane response to atmospheric turbulence is considered as severe for pistons, moderate for turboprop and slight for jet.	Cabin size and furnishings in new technically advanced 4-6 seating aircraft similar to car. Interior noise and vibration reduced to appropriate level (say 75 dB). Implementation of Anti Noise Control (reduction). Improved Ride Control Index and implementation of ride-control system (coupled with fly-by-wire control)	New Technically Advanced Small Aircraft (TASA)
	Security and Safety	The corporate jet accident rate of 0.08 accidents per 100,000 departures compares favourably with the scheduled airline rate of 0.112 for hull loss and/or fatal accidents per 100,000 departures of jet aircraft over 60,000 lbs and 0.241 for non-scheduled and all other operations of jet aircraft over 60,000 lbs	Accident rate of EPATS aircraft comparable with scheduled aircraft. due to: - fully automated control system (Digital Fly-by-wire, FADEC, autopilot) - Automatic emergency flight Back system - On-Board Diagnostic System and FOQA - Crashworthiness features - Automated ATM and digital CNS - More effective ice protection system - More restrictive CS 23	

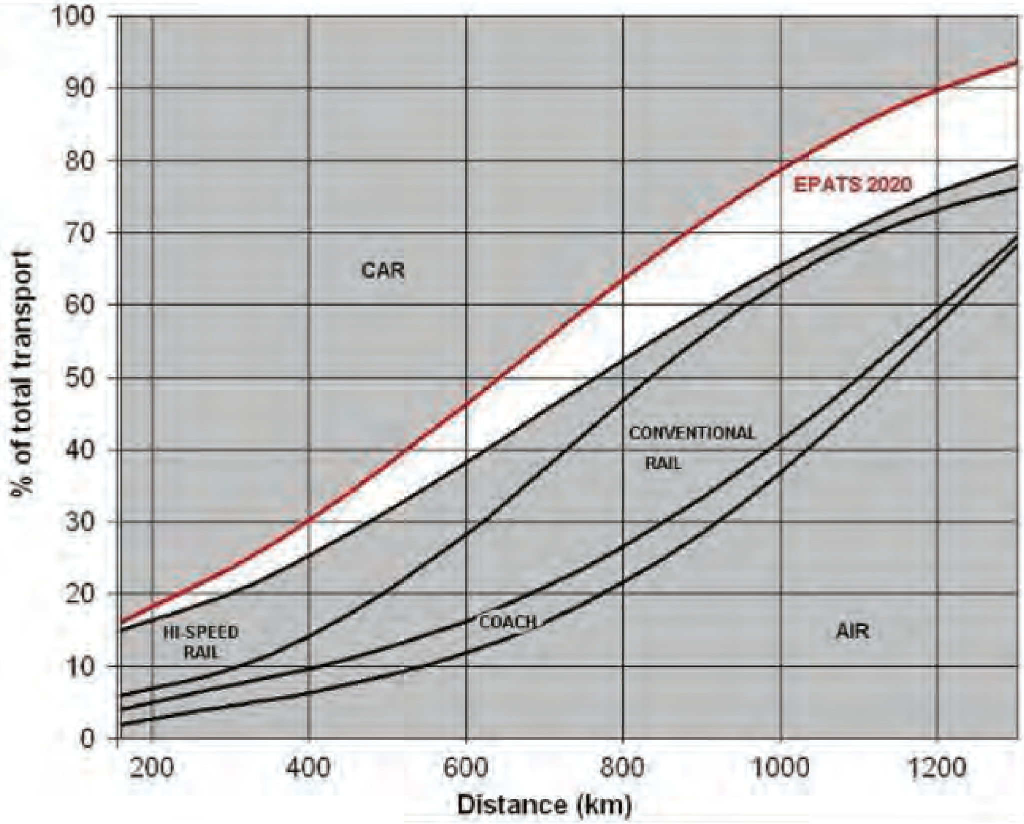
	Maintenance To maintain and improve airworthiness	Maintenance man-hours required per flight hour: 0,5 – 2 TBO: 2000 - 3000	Performance of overhaul, repair, inspection, replacement, modification as well as Flight Operation Quality Assurance (FOQA) and Maintenance Resource Management (MRM) are standardized and centralized	Maintenance man-hours required per flight hour: 0,25 – 1 TBO:> 5000
AIRPORTS		There is about 2200 landing facilities from which only 43 main airports handle 85% of the European air traffic. The remaining , in which 1336 paved and 737 IFR, are weakly utilized.	The increase of airports number is not envisaged. Only successive modernization is assumed. For EPATS operation 3 groups of landing facilities are predicted: • Typical controlled regional airport in every NUTS 2 region with aircraft fleet suitable to regional passenger traffic and with technical and operational maintenance service • SATS airport with low passenger flow, no carrier base, 1 airstrip with artificial surface at least 1000 m long, no lights, no control tower, providing minimum service. • Airfield for emergency landing, meeting specific requirements Most of abovementioned airports will emerge from aero club and others airfields as a results of regional community and authorities initiative.	Successive adaptation to EPATS requirements in each NUTS 3 region are planned
ATM	ATM – ATC	Radio-electronic equipment (radio communication, radar approach systems and ILS), lights on airstrips and taxi ways, VOR/DME stations ATM-ATC manages 9 mln flights a year	New Air Traffic Control system designed for SATS, which will operate below air space operated by air lines (below 7000 m) and separated from airliner traffic. Main features of new ATC system for SATS are: • Air traffic control enroute and in airports' MTA are separated • Aircraft position In flight is determined by satellite system and information on air traffic is delivered to pilot through system of transponders and pilot is warned if approaching 15 km radius visually on monitor and acoustically. • In the area of large airport control and management of air traffic is transferred to airport control according to specific procedures. In SATS airport area pilots control flight path according to specifically elaborated procedures adapted to newly implemented communication, navigation and air traffic control technologies. Full information on traffic situation in air and on the ground will be displayed on monitor.	Fully operational European air traffic management and control system SATS, based on "Open Sky" and „Free Flight" rules. Ability to land on airfields with no lights, control tower in nearly all weather conditions. SESAR project implemented. ATM-ATC manages 52 mln flights a year

OPERATIONAL SYSTEM	Operators and Customers – Providers Interactive Booking System	About 2500 aircraft , from which 1190 are commercial aircraft (mainly turbine) operated by 866 air-taxi companies employing 25 980 peoples, The remaining are Corporate and Owner operated. The customers of air-taxi are major corporation and larger business (60%), Governments (20%) and others wealthiest clients . Air-taxi companies offer on demand flight from point to point and operate from about 200 airports. The relationship Customers-providers goes through Brokers by phone and internet With the appearance of VLJ's a new type of Next Generation Air-Taxi Company is born (see Air-Taxi Association ATXA, www.atxa.com) and a new neutral booking engine on Connect IT Technology are being created. New using VLJ's Air-Taxi Company are coming on market.	In the first phase of development EPATS will be based on existing advanced airplanes. The fleet structure will be adapted to the passengers flow and their value of time – from cheaper piston to expensive jet. In every NUTS 2 (267) region bases of EPATS commercial Operators offering transport service suitable to needs and wealth structures of population will arise. They will operate in the framework of Public Interactive Transportation System supported by local community and authorities. The EPATS commercial operations (which meet FAR 135 standards) provide services: On demand and air-taxi services by aircraft and by seat, subscription flights and scheduled flight on connection with low (below 30 passengers by day) but periodically stable passenger flow. The system will operate from and to all European airports that meet a set of standards defined by EPATS Association – expected to be 1100 at the end of first phase The number of personal aircraft operating in the European small aircraft transportation system is expected to reach 3 200 units and the number of flights 2, 4 mln Community economic development alliances, which include the airport authority, municipalities, chambers of commerce, and others organizations as well as air-taxi company and small aircraft Carriers in the implementation of EPATS magnet program will lead, step by step, to Regional EPATS Association emerging and finally to EPATS Association, which will collect Operators and Contributors and manage Interactive Transportation System Network New type of "customer adaptive" business model. Advanced System Technology for Real-Time Operations (known as ASTROautomates and manages every aspect of the company's operations, end to end. This includes customer reservations, billing and membership management; flight records and training; flight planning and scheduling; pilot electronic flight bag (EFB); DayPort field information; and maintenance control.	New technically advanced aircraft will emerge and create new business advantages. As a results of systematic and exhaustive interregional mobility surveys, data about passengers flow will be more trustworthy and structure fleet planning more reliable. This permits to invest more in the aircraft fleet deployment. Demand prognosis shows the potential of market for 90 000 EPATS aircraft, from which 55% piston's, 20% turboprop and 25% jet These aircraft will operate from airport of each NUTS 3 (1150) sub region and link them with each others The EPATS Interactive Transportation Network will be linked with SESAR System Wide Information Management (SWIM)

PILOT TRAINING		Few pilot schools owning flight simulators and several tens of centers authorized to give flight training. Traditional training methods. Low level of computers usage. Acquiring pilot license cost is thousandth Euros and with IFR authorization cost is many times higher.	Adapting training programs to new piloting and navigation technologies and new Air Traffic Management and Control procedures. Lowering pilot training costs by wide usage of simulators, personal computers and internet. Implementing wide aviation education of the society.	Complete change of training methods. After acquiring the license, instructor is replaced with autopilot, which signals all mistakes and corrects pilot's actions. Training is available to wide range of population and acquiring pilot license becomes similar to getting a driving license. Population with pilot license is many times bigger
MARKET	EPATS transportation demand [5] EPATS Fleet [5] EPATS aircraft production in EU	2,5 mln passengers 2 mld passenger.kilometers 2150 aircraft in which: 1100 pistons 300 turboprops 750 jets 660 aircraft in which: 438** pistons 151 turboprops 71***jets	4 mln passengers 3 mld passengers kilometers 3200 aircraft in which: 1600 pistons 450 turboprops 1300 jets	43 million flights per year Demand prognosis shows the potential of market for: 90 000 EPATS aircraft, 50 000 pistons 16 000 turboprops 24 000 jets

MODAL SPLIT FOR INTERREGIONAL TRIPS I EU

* It concerns only GA used for transportation purpose: aero-taxi,, personal, business and corporate aircraft, commuter with seatings less 19.
** Mainly Diamond aircraft
*** Dassault Falcon aircraft



7. CONCLUSIONS

The EPATS requirements derives from utility and expense of air service, and these ultimately must be judged on the basis of its cost, safety, and convenience relative to other forms of travel, factoring in the potential savings in time, lodging, and ground transportation and the additional business opportunities that such direct service can provide.

Like in a car transport, to ensure broad access to personalized air transport, the range of aircraft types must be accommodated to the market demand and include both piston and turbine aircraft.

There is a need for further work on requirements. It is particularly important to carry out extensive surveys. Agree and adopt common requirements on small passenger planes determines the implementation of a joint UE development program

It is crucial to initiate or support currently done research on traffic flows even stronger, not only from EPATS point of view, but also due to rational planning of the EU transport development reasons. The continuous research should include all EU regions and sub regions. Lack of this perspective is a significant flaw in strategic spatial planning and an obstacle for transport initiatives, including Small Aircraft Transportation System.

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