INTELLIGENT PERSONALIZED AIR TRANSPORTATION SYSTEM (IPATS)

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Executive summary

The goal of IPATS is to personalize Air Transportation System and fill the communication gap, which exists on interregional national and European destinations with underdeveloped transport network, located in a distance longer than 300 km, and where implementation of others modes of fast transport (high-speed rail, traditional airlines) is irrational due to too low flow density travel and where road transport is too disadvantageous in individual, social as well as ecological dimension. Furthermore the objective of such system is to avoid the ever increasing congestion on European roads and to offer an alternative for current transport system. Achieving this objective involves the need to integrate Information & Communication sub-system which enables interaction between Users (passengers) and Providers through internet and mobile networks This paper describes this new idea, its operational concept, system, which must be developed and assumptions for future investigation.

1. INTRODUCTION

The results of EPATS study (European Personal Air Transportation System) [1,2] show, that there is a real opportunity to shift a substantial part of long distance passengers trips by personal car to small aircraft transportation system and that the potential demand for EPATS aircraft in 2020th could reach 100 000 units. Condition for the achievement of such values is to approach the cost of travel by small aircraft and car. Analysis shows that it is possible through better use of aircraft, and this goal can be achieved by using new information and communication technologies to improve the flow of information between provider and customer.

The major goal of IPATS is to use this opportunity to realize the potential demand and to fill communication gap, which exists on interregional national and European destinations with underdeveloped transport network, located in a distance longer than 300 km, and where implementation of others modes of fast transport (high-speed rail, traditional airlines) is irrational due to too low flow density travel and where road transport is too disadvantageous in individual, social as well as ecological dimension

A key aspect of IPATS is the application of net-centric model for transferring information of all types and for improving transportation management process See Figure 1.

The effect of implementation of network-centric management (NCM) will be the possibility of creating various business models and an easy access to the IPATS transportation services for a wide audience. This will reduce transportation costs through the possibility of: adaptation of aircraft type to the passengers needs, plane-sharing and co-owner, increase of annual flight hours, better utilization of seats, decreasing of empty flights, optimization of itinerary etc.

At the most global level, the objective of the IPATS is to reduce economic disparities substantially that exists locally, regionally and nationally in EU.

The IPATS concept of operations utilizes small aircraft for public, corporate, business and personal transportation, for point-to-point direct travel between smaller regional, auxiliary and general aviation airports and between hubs and small airports. The IPATS would operate within the Single European Airspace System (SEAS) infrastructure, specifically among about 2000 public-use landing facilities. While scheduled air carriers serve just about 400 of these facilities, from which only 43 hubs handle 85% of the European air traffic and operates at the limits of their capacity

The general concept of IPATS is to add to the System Wide Information Management (SWIM) currently deployed Air Traffic Control and Management a comprehensive information and communication system which would manage the complex passengers transportation services process, improve customer – provider link and interaction and would enable efficient use of aircraft fleet and consequently the price of service available and inexpensive charter flying.

The idea of inexpensive charter flying got energized because of the activities of NASA scientist Bruce Holmes, who was the driving force behind the conceptual Small Aircraft Transportation System, or SATS. NASA's research effort was aimed at all facets of technology that would be required to move travelers between small airports outside the airline hub-and-spoke system, thereby relieving the congested hubs and, in the process, reviving general aviation and providing access to a wider public. The effort was aimed at new airframe and engine designs, a new-generation, advanced navigation and airspace management system. Too, it encouraged a revolutionary cockpit environment that replaced the standard instrument panel with advanced digital graphic displays, thereby enabling a single pilot to manage a jet aircraft in any weather. The advent of very light jets, which followed when Williams International and Pratt & Whitney Canada began development of ultra-small turbofans, was expected to allow operators to provide better, faster service. Unfortunately the SATS research and development does not include studies on complex relationships and linkages between market demand and supply and their impact on technologies and implementation schedule.

Modern European society's need to travel is constantly growing. The extension of the European Union to 27 members will further intensify this development. However, current transport modes have limitations and are already suffering from congestion in some places: highways and most large airports are congested or could quickly reach their maximum capacity. Conversely, other airports, especially in Eastern Europe, are generally unused. Moreover, society is evolving: passengers are becoming more demanding in terms of time and cost, but their behaviour is also changing: individualisation is gradually becoming the byword, meaning that people want to have a choice. Future mobility therefore cannot be entirely satisfied by current transport systems, such as hubs, railways or highways.

A new transport mode [2] is thus needed.

2. SMALL AIR TRANSPORTATION SYSTEM − STATE OF THE ART

The basic factor having a restraining effect on SATS development is the price of transportation services, which exceed by many times costs of personal car usage.

Provided that price of 1 vehicle-kilometer (taxi) is ca. 0.5 €, the price of flight on 4-5 seats airplane will be from 1 to 10 € per vehicle-kilometer, depending what type of aircraft will be used and what business model will be operated.

However, if the comparison will be limited to operational costs referring to one vehicle kilometer, by assumption of car mileage of 20 000 kilometer yearly and aircraft annual flight hours of 800 flight-hours, then operational costs of the 1 vehicle km done by car will stay on the similar level of 0.5 € and the operational costs of airplane will get closer to cars' costs and will amount from 0.5 to 2 € per kilometer.

Report EPATS D1.1 "Report on European Business & Personal Aviation Data Base and Findings - Chapter. 3 Calculated DOC and current price of air-taxi services" and EPATS Report D4.2 "Operating Cost Analysis"

Reasons of high costs of small aircraft transportation services underlie mainly in a way of their usage (business model) and in the operational personal costs.
In particularly these are:

- Level of small aircrafts annual flight hours: air taxis, corporate, business and private, calculated as a ratio of real annual flight hours to the recommended annual flight hours (it is assumed to be 1800 flight hours yearly); this ratio is really small and is between 5 % for private aircrafts to 40% for air taxis.
- Large share of empty flight resulting from a need of redeployment of aircraft from the quarter base to the airport, from which the journey starts and vice versa. For currently located air taxis' companies in Poland, this share amounts more than 50% of aircraft's annual flight hours. See: SATS Report R3.1 "Charges for usage of public long-distance public mode of transportation – current state and trends" The similar situation can be noticed in other EU countries. It results from the fact, that few air taxis' companies have their bases on the large airports and in order to serve the connections between other airports, they need to reach them.
- Large costs of technical maintenance of airplanes results from the small fleet and a lot of different types of aircrafts,
- Small level of load factor, what cause adequate increase of service prices.
- Large share of administration and marketing agency costs,
- Large costs of crew salaries caused by the necessity of employ 2 pilot, as it is required by the regulations.

Development of small aircrafts' transportation is conditioned by lowering generalized costs of journey to the level similar to the costs of traveling by car.
A realization of this postulate is possible via:

- Applying of Business Model, which ensure removing of reasons for high air services costs, mentioned above in the point from a to e.
- Implementing Net-centric management and services ordering system
- Solving safety problem, connected with need of implementation of single pilot crew on all airplanes with 4-19 seats, which are designed for commercial passenger transportation. Moreover, introduction of changes in regulations CS23 and JAR-OPS 1 (elimination of reason "f").

It is worth to mention, that lowering production cost and aircraft's price will have influence on the reduction of transportation services costs only to some not large extent. The price of aircrafts will have a meaning mainly by during investment decisions. The share of price in the general transportation costs, expressed by the depreciation of the investment, is relatively small and if the usage is as recommended, it will amount only few percentages of general costs. Only if the annual flight hours is low, this share will increase and will constitute considerable amount of costs.

The costs of usage of private personal aircraft will always be higher than costs of personal car's usage, even if prices of their purchase will be similar. It results mainly from the fact, that both mode of transportation are used in different way. For example, if resulting from people mobility, vehicle-kilometers will amount 20 000 km (therein a share of long-distance journeys will be 4 000 km), then all fixed costs (amortization, insurance, garage) will be related to the full mileage. If on long routes an owner substitutes a car with an airplane, then the benchmark for calculating costs of 1 vehicle-kilometer for the airplane will be 4 000 km and for the car 16 000 km. Hence, fixed costs related to the vehicle-kilometer will be repeatedly higher than for a car.
Potential vehicle-kilometers (technically and economically justified) of a personal car comes to

20 000 carriage kilometers yearly, whereas of a personal aircraft will be between 150 000 and 500 000, depending on the type of the aircraft (assuming rational aircraft flight hours of 800 hours yearly).

From comparison of above-mentioned figures, it can be seen that from economic point of view, owning a private personal aircraft is not cost-effective and may be only motivated by prestigious and hobby reasons or can be reasonable in cases, when time value of the owner is very high and costs of transportation are less important.

This situation may change in the future, when a hybrid vehicle will be developed, which will be used not only as ground but also as air transportation or will take off and land vertically or on a short distance, still keeping the features of aircraft in the flight (like speed and energy effectiveness). At the same time costs of its development and usage will not be much different from the costs of car. The topic of the R&D of such vehicles is European projects "Out of the box" and "PPlane".

State-of-the-art assessment

Above mentioned circumstances cause, that more often (particularly in USA) small aircrafts, even the cheapest ones, are bought and used jointly, what produces not only decrease of investment's contribution of particular buyers but also significant reduction of owners' usage costs. By current level of traveling on long-distance journeys, in order to use fully the transportation capacities of small aircrafts, joint purchase and usage should be done by bigger group of people (several to few dozen people, depending on the intensity of traveling). By such groups of people, it is clear, that even the best flight share management, is not able to fulfill all requests of the owners in 100 %. Taking into consideration random demand on flights and a need of achieving maximum probability of satisfying co-owners' necessity of traveling, there are two ways of solving this problem: decrease the amount of airplane's co-owners, what leads to the increase of costs or rise the number of jointly bought and used planes by respectively larger group of people. Second solution is more profitable but it demands more complicated organization and management model. It requires also an answer for the question – by which amount of aircrafts, of a proper type and with suitable amount of co-owners, the probability of flight's realization by each of them in demanded time period will be sufficiently high and will come for example to 0.95. Development of such models will be one of the objectives of business model elaboration.

Implementation of public small aircrafts transportation on interregional routes with small traffic density, require different business model and aircrafts characteristics that will allow to eliminate the reasons for high transportation costs, mentioned above in sub-points "a" to "e" and in consequence it will ensure profitability of system functioning.

It is assumed that characteristics of small aircrafts will change evolutionary as the results of new technologies and realized researches and appropriate changes in the regulations. In the first phase of IPATS implementation, existing on the market up-to-date business piston, turboprop and jet aircrafts will be used. However, they need to fulfill operational requirements of current JAR-OPS 1 regulations. Gradually, the aircrafts will be modernized, mainly in the field of further improvement of economic, ecological and safety parameters. One of such parameters concerning economic will be allowing for single crew on all aircrafts with max. 19 seats, provided that an autopilot will enable self-steering and automatic landing.

Main areas of upgrading will be related to avionics, propulsion system, CNS system (implementation of results of works done within the framework of program SESAR) and steering and positioning. Simultaneously, but little bit shifted in the phase, new design of aircrafts will be introduced on the marked. They will be more economic and adapted to the larger number of users, based on the new materials and technologies. It is predicted, that in Europe the biggest development and implementation of these aircrafts will be in years 2020-2030, as a result of research works and the pressure of the users market of developing IPATS.

3. IPATS OBJECTIVES AND CHALLENGES

There are two important challenges of transport defined in the framework of European Research Area and undertaken by IPATS:

- First – to give travelers a free choice of transport mode according to their need, and limited by their time value
- Second – to follow "European energy strategy for transport" in order to improve energy efficiency of all modes of transport

Furthermore the goal of IPATS is to personalize Air Transportation System and fill the communication gap, which exists on interregional national and European destinations with underdeveloped transport network, located in a distance longer than 300 km, and where implementation of others modes of fast transport (high-speed rail, traditional airlines) is irrational due to too low flow density travel and where road transport is too disadvantageous in individual, social as well as ecological dimension.

Another important goal is extending daily range (daily accessibility indicator) for intensive activity jobs, where people go to another place, do their business for a few hours, and return home. For most of people, the daily radius of action equals c.a. 200 km and is limited by the capabilities of a car travel. Only for limited number of connections, generally between European capitals, thanks to high frequency of high-speed rail and airlines, this radius may reach a length of 1000 km. If traveling by small piston aircraft the radius may be extended to 1200 km, but usage of a very light jet enables passengers to reach all regions of Europe within one day trip. The goal is to enable origin-destination travel at about four times the speed of car at the same costs. Personal speed is a vital factor in the advancement of transportation capabilities, and ultimately the advancement of societies.

At the most global level, the objective of the IPATS is to reduce economic disparities substantially that exists locally, regionally and nationally in Europe. Such economic disparities result from the inequitable distribution of accessibility in constrained nodal and network based infrastructure. The European highway and hub & spoke are clear examples of such constrained infrastructures. The on-demand, point-to-point access capabilities of IPATS reduce these constraints.

One of the most important issues arising during new transportation system design process is securing network activity above the critical level of economic efficiency.

The solution requires a thorough knowledge on current and forecasted passenger mobility distribution and intensity. This knowledge is usually scarce or hard to find in the low flow areas, e.g. between remote regions. It is one of the reasons why air, as well as surface modes transport network develop in these areas, where flow is intensive and well recognized.

This effects with transport networks development in already well developed areas and leaving behind, in fact, the larger share of population. This discrepancy can be reduced by adjustment of transportation service to individual population demand.

Preliminary analysis shows that it becomes possible by introducing small aircraft air transportation services supported by information system and ordering network, that enables interoperability and aircraft pooling at low density interregional passenger flow. On one hand, the system satisfies instant access to high speed transport, on the other, it enables optimal aircraft utilization and higher load factor, by timely and directional transport demand pooling and adjusting to it aircraft type, each time. Introduction of such a system will most probably revolutionize behavior of travelers and modal split.

Aircraft design analysis requires clear aircraft mission requirements and estimates of the number of vehicles to be produced in the program's life cycle. Mission requirements are traditionally setup by the aircraft design team in consultation with the customer (typically airlines for commercial vehicle development). The determination of the potential market for the vehicle to be designed is more challenging to define.

4. THE IDEA

The term ***Intelligent Personalized Air Transportation System*** refers to efforts to add to and in an effort to manage factors that typically are at odds with each other, such as costs an travel time, load factor and demand, tariffs and revenues, demand and supply to improve effectiveness and affordability.

A key aspect of IPATS is the application of net-centric model for transferring information of all types which allows for improving transportation management process, various business models and an easy access to the IPATS transportation services for a wide audience

The concept relies on Personalized Air Transportation System utilizing small aircraft (jet, turboprop, pistons) starting from airports, that are the most close to home. These aircraft, operating in nearly all weather conditions, could serve any kind of location, but their main point of interest would be serving inaccessible areas and interregional low density passenger flows.

IPATS will help to meet the ever more mobile and demanding society needs by increasing passenger choice. This system recommends an alternative to private car mode. It is also a means to make a stronger aeronautical Europe by developing technologies needed for this kind of aircraft and by strengthening General Aviation. Lastly, EPATS should increase the operational capacity and the efficiency of air transport systems.The IPATS concept is mainly based on:

- Using existing information & communication technologies, and a broad public access to the Internet and mobile networks.
- Using the already existing local and regional airports network (more than 2000), especially located on the periphery of European main transportation infrastructure, in the areas with low level of accessibility indicator
- Using new technologies concerning aerodynamics, materials, propulsion, communication, navigation and control based on satellite systems
- Adjusting aircraft fleet, operational structures and transportation management to local emand and interregional passengers flow,
- Creating friendly legal and economic conditions, promoting unification, standardization and integration of maintenance network

Introducing SESAR's „lifecycle of Business Trajectory in which Trajectories will be expressed in all four (4D) dimensions" provides full information on where the aircraft are (air or on the ground), what their flight plans are (long Term, Mid/Short Term, Execution, Post flight) and what their routes are and number of passengers on board. In SESAR's ATM system, all aviation system components cooperate and possesses a full 4-d information about others. There are also no technical barriers to include an intelligent customer–provider information &communication sub-system, which task would be optimal use of IPATS system and optimal mode choice for customer.

Implementation of such sub-system will bring several significant advantages:

- Knowledge diffusion concerning small aircraft transport possibilities
- Increase of share of people participating in air transport sector
- Cheaper flights: fly one-way, pay for one-way only, similar to urban taxi cubs
- Increase of the transport system energy and economy efficiency through better fleet allocation with multiplied annual volume and high load factors,
- Better use of airspace
- Facilitation in air traffic management and its monitoring
- Increase of regional accessibility levels
- A general outlook of IPATS system is shown on figure 1.

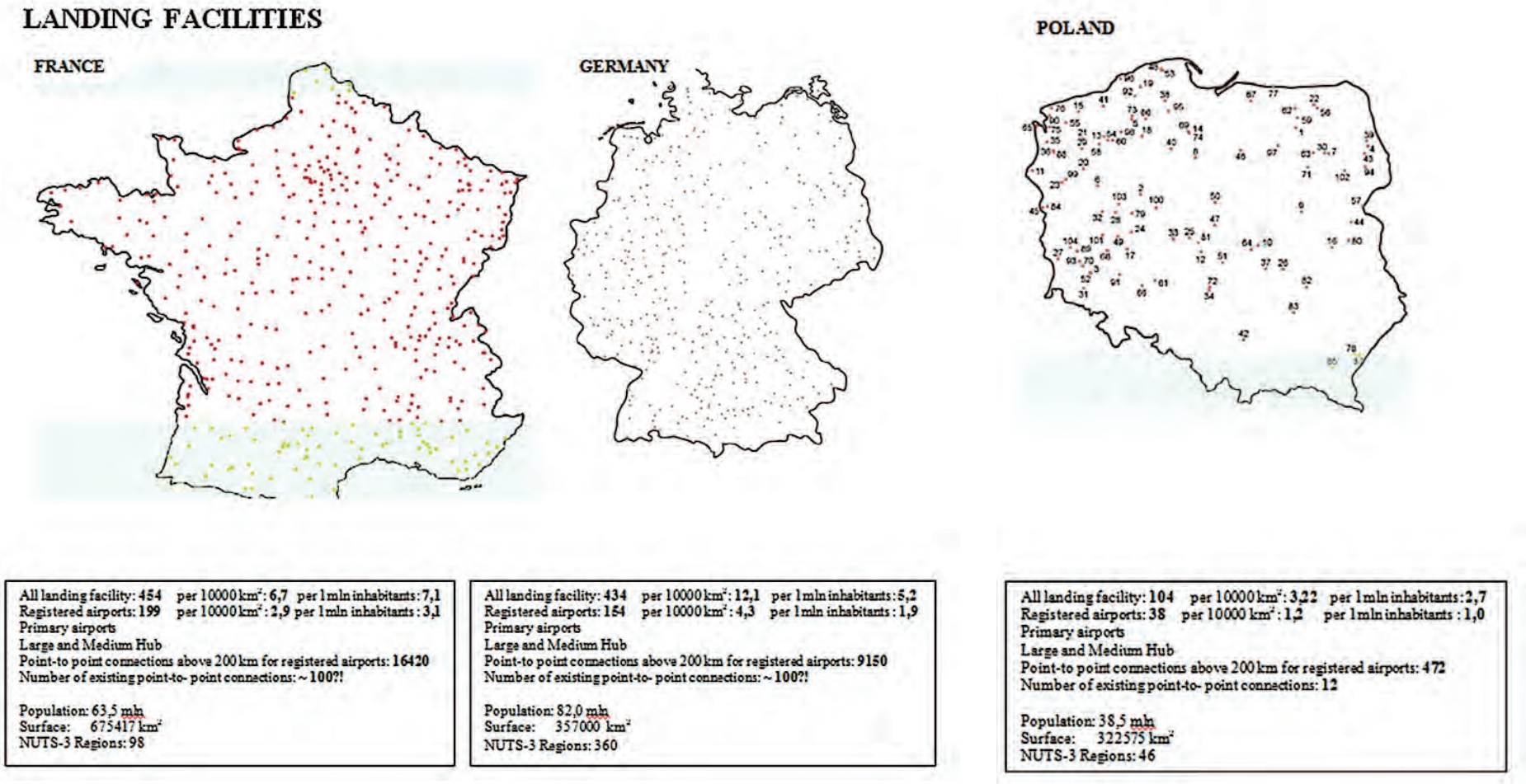

Fig. 0. Multimodal potential accessibility
(by European Spatial Planning and Observatory Network, Project 1.2.1, http://www.espon.eu)

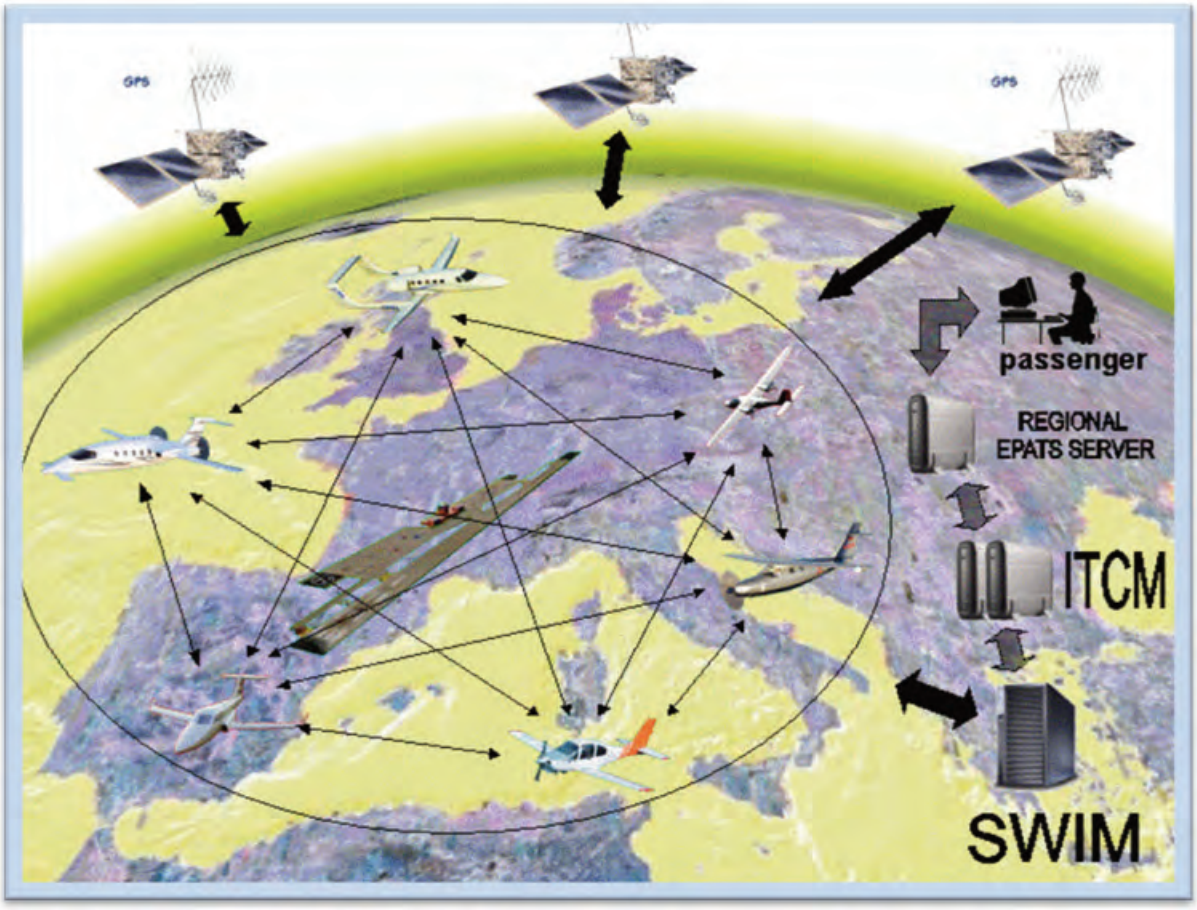

Figure 1. IPATS general outlook

5. OPERATIONAL CONCEPT

One of the main features of IPATS system conception is taking advantage of the internet network, introducing interactive air transport service ordering and tailoring it to planning and execution of business trajectory network described in D3 SESAR Chapter 2 The ATM Target Concept [13]

The Intelligent Transportation System will employ a Net-Centric method i.e.

Participating as a part of a continuously-evolving, complex community of people, devices, information and services interconnected by a communication network to achieve optimal benefit of resources and better synchronization of events and their consequences.

System functioning scheme is shown on the chart below (Fig. 1.).

The Information & Communication sub-system enables interaction between Users (passengers) and Providers (TMC) through internet and mobile networks.

This system connects a customer directly to the Regional Station of Transportation Management Center TMC, which is the Provider and plans IPATS system service.

Through the network a customer orders air transport from his origin to destination providing name of the airport of departure and arrival, date and time of departure and arrival, number of passengers, baggage, comfort class and other data relating to the order

TMC, gathers and analyses all orders, associates passengers and itineraries and adjusts to them the optimal aircraft type (the least costs type), which may realize the order. The customer is informed about aircraft type, date and hour of flight departure and arrival, pick up time (when door-to-airport transport provided) and service price.

Depending on the number of orders for a given ininerary, given day and hour, and passengers requirements the TMC offers adjusted services and appropriate aircraft. It could be a small, 4-seat aircraft with one passenger on board as well as a 19-seat airplane fully occupied.

A flight may be ordered in various advance time. Earlier order allows more passengers going the same direction at the same time and, therefore, the ticket price could be lowered by using a larger aircraft (keeping load factor close to 100%). The system allows, also, for ordering on a very short time notice if the customer is counting on empty seats in larger aircraft flying the same Business Trajectory.

The system gains new capabilities and leads to higher productivity, higher accessibility and satisfaction of passengers. It enables adjusting connections, schedule time and aircraft type to personal needs, and makes possible to accommodate fleet to regional demand and better aircraft utilization, both in terms of flight hours yearly and load factor. In consequence the system contributes to more effective air traffic and fuel consumption and transportation costs per pas.km reduction.

The functions of IPATS Transportation Management Center includes:

- managing data-link with Regional Stations,
- monitoring passenger traffic,
- collecting and recording data,
- managing data in real time,
- collecting statistics about EPATS-ITN performance,
- others to be defined

6. ASUMPTIONS AND NEEDS OF STUDIES AND RESEARCH

Creating such a system assumes:

- A fleet large enough and a wide range of aircraft types satisfying various customer needs (from cheaper pistons to expensive jets)
- Creating European Central Data Base of IPATS aircraft including technical-operational data and transport service prices
- Creating Central Data Base of IPATS airports (which will be also utilized on board for safety purpose in emergency case – see SOFIA Program)
- Full information on current status of every aircraft in the system (from extended SWIM featutes): where it is, what is its flight plan, how many passengers it has according to the plan and further information required for constant flight plan update
- Creating Customer – Service provider interfaces, optimization models and software allowing for optimal choice of air connection for certain group of passengers, certain route and certain time through dialog between Customer and Service provider's Server.
- Designing and creating IPATS Management System combined with SESAR's Wide Information Management
- Designing internet network connecting Central European Server IPATS with all other components of the system and SWIM server (Results from DELIS project could be used [14])

6.1 Full information on passenger flow density of interregional travels should be a support for system realization. The support is expressed by number of passengers travelling in a year, month and day, from region "i" to region "j" with purpose "p", using mode "m", of income (wealth) category "v" (Nij,p,m,v(y,m,d)). Such information has to be provided for rational estimation of aircraft fleet structure. It is why we stress the significance of mobility surveys and analysis for appropriate transport mode development and particularly IPATS. To obtain such information, new methods of interregional traffic surveys should be employed, for example utilized in the Intelligent Ground Transportation System which use of Floating car data.

6.2 Small aircrafts missions and requirements. Three type of missions could be expected: 1) 1-19 passengers, short hops point-to-point, range 300-900 km, 2) 1-19 passengers, point-to-point and possible stop, range 500-1200km, 3) 1-9 passengers, multiple stops in one day or one long run, range 1000-2500 km. There is a question, what kind of airplanes will realize planned

missions and how they will change during time. For many fundamental questions regarding design solutions of future small aircrafts designed for passengers' transportation, there is no straightforward and unanimous answer. To the questions belong inter alia: Do piston and turboprop propulsion still have chance for development? Should single engine airplanes be allowed for passenger transport? Can an automatic pilot substitute a co-pilot? Should crash landing systems be implemented? Should size and equipment in the cockpit be standardized? Should design regulations be the same as for passenger airplanes? etc. To these questions also inquiries regarding avionics, automation, diagnostics, technology etc. have to be added.

The answers on these questions can be obtained through appropriate studies and research.

Forecasting of IPATS aircrafts design characteristics should be defined on the basis of inquiry survey. In such way, also previous results of R&D carried out by countries and EU programs, should be taken into consideration. Moreover, expected effects of future scientific and research activities of these institutions also should taken into consideration. It is important to have in mind that in the closest view, the most likely is a prognosis based on real research and technological achievements. However, in the further view credibility of the prognosis is dependent on the state of advancement of research works and on circumstances allowing for positive results. Hence, it is important during taking prognostic opinions to ask, on what basis the opinion is given.

The objectives of elaboration of technical requirements should be:

- Identification of features, which should characterize small aircrafts designed for passenger transportation, which will be designed, certified, and put into production in years 2010-2020 and widely exploited during next several dozen years.
- Introducing a category of small aircrafts designed for passengers' transportation in regulations CS-23 (substituting a category of local transportation aircrafts – commuter, which includes two engines turboprop aircrafts with max. 19 seats by Small Airplane Passenger Transportation (SAPT) Category, which contain propeller and jet aircrafts with max. 19 seats), taking into consideration the implementation of new aircrafts types and new technologies.
- Providing recommendations for European GA industry, regarding the trend of development of small aircrafts and establishing a basis for designing, certification and implementation and at the same time creating synergy conditions, which allow for faster development of this category of airplanes.

Current regulations CS-23 (Certification Specification) regarding GA aircrafts include package of airworthiness codes and acceptable means of compliance as well as guidance material to be used in the certification process. The code is applicable for the following categories of airplanes: Normal, Operational, Acrobatic and Local Transportation (earlier commuters), limited to two-engine turboprop aircrafts with less than 19 seats.

None of these aircrafts' types, fulfill today's passenger aircraft requirements, with the exception of, in some way commuters, which includes only two-engine turboprop aircrafts. To the Normal category airplanes belong today's tourist aircrafts and propeller business and taxi aircrafts. However, this category does not include jet aircrafts and it does not meet actual airplanes requirements, designed for passenger transportation. In many cases, they are not coherent with them, e.g. for local transportation aircraft the passenger weight of 86 kg (190 pounds) is assumed, whereas for the airplane of Normal category it is 77 kg (170 pounds). In the second part of CS-23 "Acceptable means of compliance" given methods concern mainly propeller aircrafts with low speed. There is no place in it for researches of subsonic and transonic jet aircrafts.

Forecasting of development of Air Traffic Management and Control Systems of air traffic will be based on results of SESAR project.

6.3 Business model should be developed and shows the benefits, which result from IPATS implementation.

IPATS system includes numerous different subsystem elements which are working in close cooperation and each of them opens a new market and a new business. These are: airports network, Aircraft Operators, ATM-ATC System, Logistics Organizations, Customers – Providers Services network, Aircraft Service & Maintenance, GA Manufacturers. The Business Model represents various aspects of business, including its purpose, services, strategies, infrastructure, organizational structures, trading practices and operational processes and policies. It contains different components like value proposition, value network, revenues generation, etc. It deals with innovative products which diffuse into the society and economy.

The business model is based on the developed business and marketing strategies, utilization of the values chain of activities and on the innovation diffusion process. IPATS is a very complex and large system depending on the development of technologies, economy, synergy and other transportation system.

Process of creating Regional Small Aircraft Transport System is a long-term, innovative, diffusion process. It will be generated under favorable conditions, if local community is aware of its real capabilities, wherever opinion that flying small aircraft is expensive and reserved for VIPs and very wealthy people. Still too many people associates aviation with something not common and not very safe. Very few are aware though, that modern aircraft consume less fuel per passenger kilometer, provide less expensive travel and better safety than cars. Therefore, it is very important to widely disseminate knowledge of modern small aircraft's real capabilities and possibilities of their development.

Most favorable conditions for Small Aircraft Transport System development are present in regions without fast communication connections, with airfields and functioning General Aviation at the same time, where aviation communities are strong. Such regions are common in every EU member state. In Poland such regions are, i.e. regions of Rzeszów, Mielec, Bielsko, Opole, Lublin, Koszalin, and Mazury and so on. In these regions there are reasons to start Small Aircraft Transportation.

It is anticipated, that carrier organizations and IPATS aircraft fleet home-bases, providing transport services for people will be set up in every region. Such base would consist of various types of aircraft adapted to population's income and needs: piston, turboprop and jets, with 4 to 19 seats. Initially modern aircraft, available currently on the market will be used, and as system develops, according to anticipated plans, these airplanes will be replaced with new types, designed with 21st century capabilities and needs on mind. It is predicted that such gradual replacement of aircraft fleet might start in the twenties. At that time small aircraft transportation will be available for medium class population.

A new organizational model of Regional SATS and alliance structure is needed. It should consist of semiautonomous business units that are responsible for their own profitability. Such company must balance the autonomy of the business units with the need to coordinate some of their activities. Companies enter alliances to effectively meet the needs of cooperation and personal transportation coordination. Such alliance is also needed to assure aircraft maintenance and Flight Operation Quality Assurance (FOQA).

The Business Model should include:

6.3.1 Comparative analysis of transportation parameters and their influence on the environment of land vehicles and aircrafts

It is assumed that implementation of new personal transportation system cannot worsen its influence on the surroundings in comparison with other existing means of transportation.

Means of transportation have impact on the environment via:

- Pollutants emission, mainly greenhouse gases, CO2 resulting from burning hydrocarbon fuels (in this paper it will be reduced to the amount of CO2 emission).
- Decreasing of energy non-renewable resources (oil, coal, gas).
- Decreasing of raw material resources (iron ore, copper ore, clay, wood etc.).
- Environmental pollution with usage wastes (tires, oils, acids, metals, materials, etc.
- Occupation of grounds used for roads, highway, railways, airports and their pollution.
- Generation of noise.
- Generation of accidents.

Taking into consideration, that the main task of SATS is to substitute personal cars with small aircrafts on long journeys (300-1500 km), as a main fulfillment conditions of balanced transportation development rule, it has been assumed that in comparison with car transportation SATS should be:

- More ecological and energy-saving.
- Safer.
- Similarly available (for most people time of reaching the airport by car should not exceed 30 minutes and general costs of journey should not be higher).

It is assumed, that indicators of these aims' accomplishments will be:

- Reduction of fuel usage and emission of CO2, other gases and particulate matter per passenger kilometer. Decreasing general journey costs, inter alia external transportation costs per one passenger kilometer.
- Increasing mean of transportation effectiveness in full development cycle (mass of used materials and grounds per passenger-kilometer).
- Decreasing of accidents ratio in count for one passenger kilometer.

The analysis goal is to show, that using current technology level and in current conditions of usage, these indicators are more favorable for SATS than for personal car transportation. It is assumed, that the development of both means of transportation towards improvement of these parameters will be occurring in the similar tempo and the differences between them will stay on the same level.

6.3.2 IPATS infrastructure, system functioning and added values

The goal of the IPATS system is to fill the communication gap, which exists on interregional, national and European destinations with underdeveloped transport network, located in a distance longer than 300 km, and where implementation of others modes of fast transport (high-speed rail, traditional airlines) is irrational due to too low flow density travel and where road transport is too disadvantageous in individual, social as well as ecological dimension.

The objective is to enable origin-destination travel between all European regions at speeds considerably higher than car speed at equivalent costs. Personal speed is a vital factor in the advancement of transportation capabilities, and, ultimately, the advancement of societies.

This task will describe actual state of infrastructure of the airports in the EU with particular consideration of small and unused airports and condition of airspace management and ATM. Furthermore, there will be introduced proposals of airports' networks development, where IPATS aircrafts will operate and perspectives of development of common European sky and ATM systems, which result from works on SESAR project and take into account implementations of new IPATS system.

An idea of system operation will be based on net-centric architecture, using internet network, GSM network and satellite communication and navigation. A project of this system will be developed in the framework of WP4. On European scale, system operation will be established on connections of operational and marketing tasks of particular regional sub-systems, which will be modeled in task T3.3. In task T3.2 all functions, realized by system will be described and

it will be specified by what means was it done. Furthermore, all data, needed in system management (Data Basis of Network Server), will be indicated, as well as source of information of them.

6.3.3 Value proposition

In chain of activities of individual IPATS elements carrying added value there are: industrial companies, research centers, airports and service base, ATM-ATC, carriers, technical service and maintenance stations, flying schools.

Final values of this chain of actions are: value of products and services, employment, time saved during travels, added values resulting from increased access of people from remote areas to material and cultural goods, equalization of chances of region's economic development, decreasing excessive personal car transport development, which is getting more detrimental to environment, (terrain for building roads and highways, fuel consumption, exhaust gas and noise pollution, accidents), relieving air travel congestion in large airports areas and decreasing effects of traffic congestion.

6.3.4 Business Model of regional IPATS system – example

It is anticipated, that in every region with airfield and proper conditions activities will be performed to create a local small aircraft transportation system. Such activities should be initiated by local authorities, economic organizations, owners and administration of airports, small carriers, aviation organizations, etc.

It is assumed, that in the development of Business Model of regional IPATS system – example, there will take part representatives of local authorities and businesses of specified regions.
A model should be based on real premises of considered regions and it will include:

- Data regarding passenger traffic, generated from influence area of investigated regional airport to other regions of the country and Europe, particularly passenger car traffic.
- Discussion of strategic plans, concerning plans on passenger transportation network development and idea of implementation IPATS in other country's regions.
- Description of detailed business and transportation models and forecast of IPATS aircrafts demand in next three 5-years periods.
- Concept of creation of regional aircraft fleet and financing them.
- Analysis of adaptation costs of local airport to the requirements of IPATS.
- Analysis of opportunities for providing technical and personnel conditions, which will allow for creating aircrafts' fleet and its management on the local airport and as well for ensuring operation of Regional IPATS Logistic Center.
- Project of Regional IPATS Implementation Plan.
- Analysis of costs and opportunities for the investment project, connected with the implementation of IPATS.

7. NET-CENTRIC MANAGEMENT SYSTEM

The core of network-centric system is a suitably programmed Central Server (look: Figure 2), where the information on transportation process parameters (aircraft positions, weight, planned routes, status of seats reservation and service order, etc.) is gathered in real time and it will be the basis for the information optimization by specialized programs.

Information about aircraft positions are passed on through GPS, whereas the data about other flight parameters (passengers number, flight time, amount of take-offs and landings, pilots work time, etc.) are passed on through board devices, which register chosen parameters and send them on-line to the Central Server, using for that special transmission channels, e.g. GPRS (General Packet Radio Service) in the GSM network.

In the future phases of development, a function of aircraft positioning and other flight management and control functions will be done by complex information management system – SWIM – System Wide Information Management, which is planned to be implemented in the framework of European Program SESAR in year 2020.

A package of choosing the optimal mode of transportation can be found on the server and it gives customer an opportunity to choose among different options of ground and air transportation. Criterions of optimization in this package will be minimizing generalized travel costs, planned for the client. It contains costs of transportation, accommodation (hotels, traveling allowances and other expenses connected with a journey) and time value of passenger, lost in the journey (estimated by the customer).

Package managing seats reservation will allow to associate the reservations of the customers with the same or similar itinerary and link their execution in one flight, by plane, which will be the best chosen to the number of passengers and planned route. Thanks to current information about all planned and realized flight routes within the framework of IPATS network, reservation may be also linked with operational plans of other flights with the same routes taking passenger en route.

Program of optimal usage of private and co-owned aircrafts is a tool allowing to rational usage of private aircrafts, designed for personal transportation and giving fundamentals for economic calculations, needed by creating the most favorable models of co-ownership and usage of aircrafts bought by larger number of buyers.

Access to the Data Base or application programs, concentrated in the Central Server is obtained in the web browser, in any place all over the world, through special software (after entering login, password and generated security code).

Participant of the SATS transportation process after logging into the system will receive on the web site an access to different structures attached to him/her. Participants may have various amounts of access accounts with different entitlements. This system provides a possibility of connecting all participants of transportation process.

Access to the data and application programs, designed for the customers of SATS services and for the general public is available from any web browser, without the need to log in.

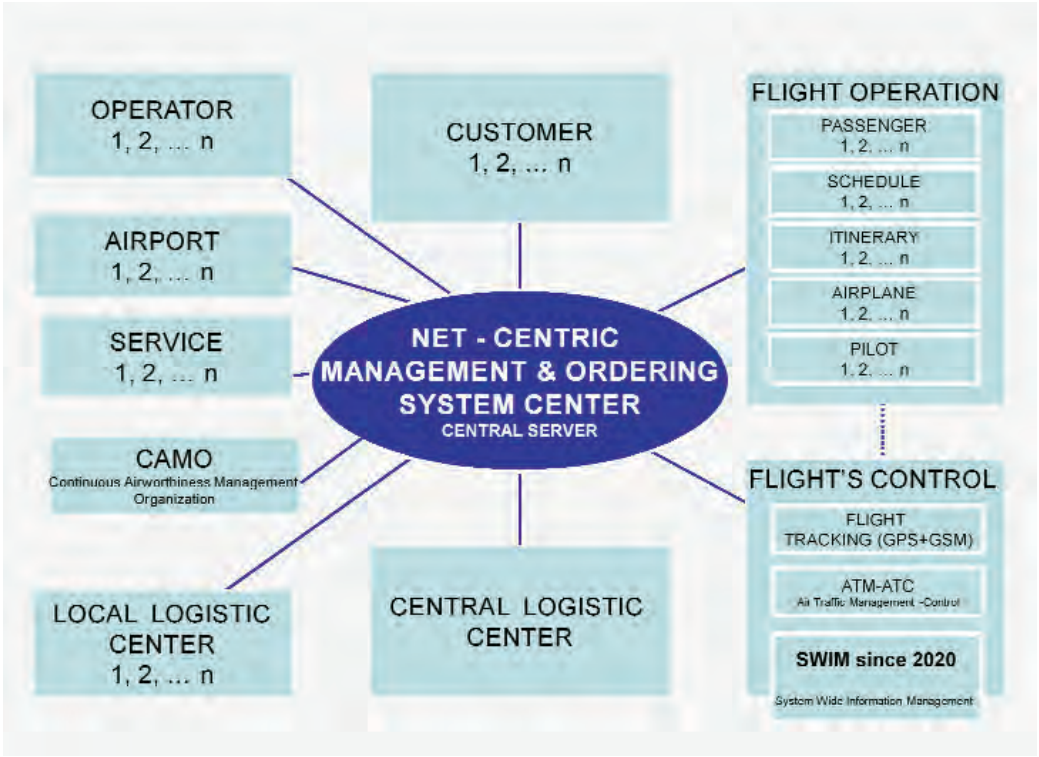

Figure 2. IPATS Net-Centric Management System

8. CONCLUSIONS

From a technical point of view, increasing the accessibility of high-speed mode of transport and replacing long distance car trips by more efficient and safer small aircraft is fully achievable. Prerequisite for achieving this is to align their costs

Aside the characteristics of the airplane, the most significant impact on air transport costs are: the annual flight hours, load factor, fleet and continuous airworthiness management. Of key importance for these factors are:

- Adaptation of the aircraft fleet structure to the passenger flows, which must be the subject of separate studies
- The creation of flexible business models corresponding to social needs
- Coordination of activities of entities involved in the transport process
- Integrating maintenance and Continuous Airworthiness Management Organization

The introduction of net-centric management system and interactive customer-provider information & communication system

The development of these activities needs the EC cooperation and support and a series of public and private partnership

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