FANTASSY

Future Aircraft design following the carrier-pod concept as an enabler for co-modal seamless transport, passenger safety and environmental sustainability

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Final Publishable Summary

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Executive Summary

For the air-transport of the future several pioneering ideas meant for introducing radical changes in the air-transport system have been proposed, requiring several innovations and individual technical challenges to be met towards their implementation. The idea investigated within the frame of the FANTASSY project is the design of the aircraft as a combination of a “carrier” and a “passenger pod”.

More specifically, a new aircraft configuration is proposed that accepts passengers or cargo through special platforms called "pods". Boarding/loading of the pods can be performed even before the carrier aircraft has landed. Pods are transferred to the aircraft by means of automated vehicles (either rail or automobile) and loaded on the aircraft.

Furthermore, the pods can be specially designed to be compatible with multiples modes of transport, thus accomplishing truly seamless intermodal travel. For example, pods can be coupled with rail carriages and transported with conventional railway to the airport terminal where they would be transferred to an airborne platform that is loaded on the carrier aircraft.

In summary, the aim of FANTASSY project is to propose ideas for future developments that answer to three key issues of air transport:

1. To promote the idea of inter-modality and seamless transition, bringing closer the concept of door-to-door transportation, by introducing the concept of the passenger pod that can be “exchanged” between the aircraft and rail vehicles.

2. To improve passengers’ safety by exploring the possibility to use the passenger pods as “escape capsules” in case of an emergency that threatens the survival of the craft and its passengers, either on the ground or in the air.

3. To serve the greening initiative by reducing taxing emissions as well as introducing a different approach in maintenance and system decommissioning as a result of increased flexibility.

FANTASSY explores a number of innovative ideas from a conceptual design perspective and going up to preliminary design and elucidates the possible needs of technological advances that may bring these concepts to reality.

Summary description of project context and objectives

FANTASSY brings in a number of ideas that can transform both the efficiency of the air vehicle and its mode of operation. The main focus is to achieve increased transport efficiency in terms of time, cost and environmental footprint. FANTASSY further extends the idea of modular aircraft to propose detachable cabin pods "cooperating" with a carrier aircraft. According to this idea, passengers are seated insight "capsules" or "pods" which actually function as loading platforms. Passengers enter the pod with their luggage while on the airport terminal even before the aircraft lands. After "boarding" is complete, the pods are transferred and loaded to the aircraft just after the in-coming pods are unloaded and led to the terminal. The efficiency in airport operations and passenger boarding is self-evident. More than this the pod can become the mean to implement seamless mobility. The pods (providing that size, weight and other requirements are satisfied) could also be loaded to railway or road vehicles achieving absolutely seamless inter-modal transport. The multi-modal passenger pods can help realize a radically new air transport system, "fused" with other modes of transport. Passengers can enter the pods in downtown terminals and travel to an airstrip with rail. As an answer to airport congestion, a network of airstrips set around large metropolitan areas can assist large airport hubs that are already close to their maximum capacity. The infrastructure investment in developing this airstrip network will be substantially low in comparison to expansion of existing airports as their "function" will be limited to refueling the aircraft and loading the pods.

While the target of the proposed research is to explore ideas that may facilitate technological improvements in the second half of the century, it is meant to be implemented in the present time. It is certain that the technological status in the aeronautical industry will be quite different from now, nevertheless several ideas and concepts that today are in very early stages of development, might become standard practices within 30 or 40 years from now. Having this in mind it is possible to consider a number of innovations that today appear to be in low Technological Readiness Levels to be available within the abovementioned timeframe. On the other hand, the basic concepts that comprise the core of the project are technologically possible even with current or near future capabilities. The question to be answered is whether these concepts are practical and economically viable. To this end, FANTASSY will attempt to evaluate the feasibility of the "carrier aircraft-passenger pod" concept following a well defined process. The scope of the FANTASSY project can be summarized to the following specific objectives:

- to define the form of the aircraft that will be the basis of the design exercise along with its possible mission profiles.

- to describe an overall air-transport system concept that will exploit the capabilities of the passenger pod based on the principles of "seamless mobility" and "door to door" services.

- to perform a preliminary design of the pod at least as far as geometrical configuration and basic structural performance is concerned.

- to investigate the technical implications of the emergency evacuation function of the pods.

- to access a series of technologies and materials now in early development stage that may be available in the future for application in the modular aircraft design.

Description of main S & T results/foregrounds

In the first period of the project, research has been focused on the identification of concepts and technologies that target the timeframe specified, i.e. around 2050 or even earlier. These include concepts developed by NASA, the Future by Airbus concepts, the Configurable Air Transport concept (Air-Force Research Laboratory) and many more. A comprehensive study of future aircraft configurations and other concepts available today that are relative to the project's objectives has been performed.

As a result of the studies during the first phase of the project, two preliminary aircraft configurations were proposed. One that employs external attachment of the pods (EPC-External Pod Configuration) and one that accepts the pods internally (IPC-Internal Pod Configuration). These two configurations were studied in order to determine critical performance parameters.

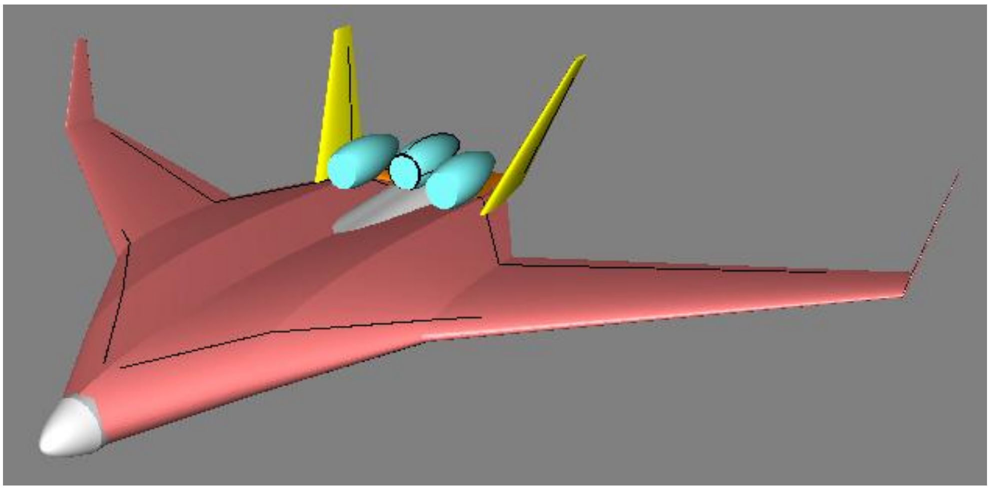

Figure 1: Early IPC,

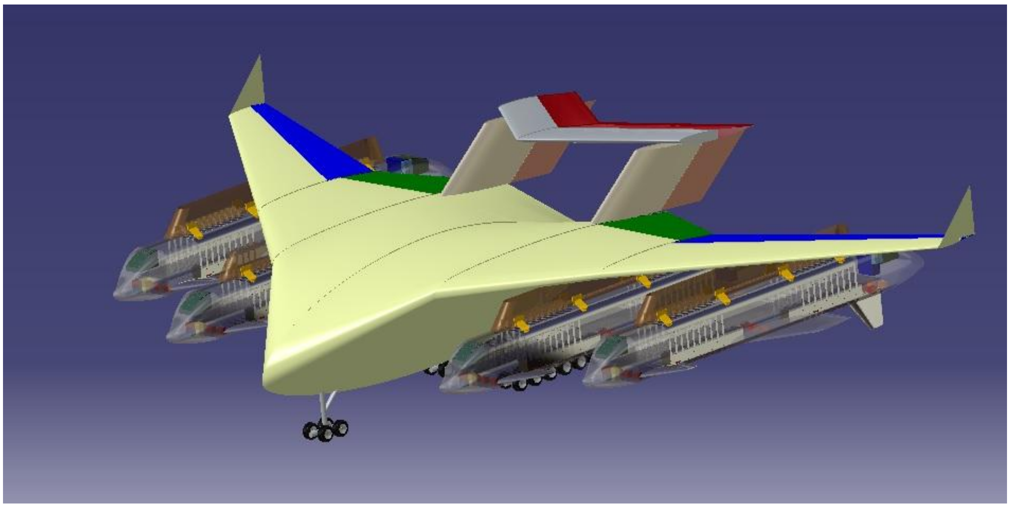

Figure 2: Early EPC

Following the design studies for the carrier aircraft and the pods, work was focused on the operational aspects of the novel transport system. Various concepts regarding the integration of the carrier-pod system into the air and rail transport systems were studied. Furthermore, ways to accomplish a seamless transfer between modes were investigated.

Passenger pod design

The passenger pod was designed according to the following specifications.

Characteristic	Specification
Modular design	compatible with both rail and air transport.
Cabin weight	maximum weight: 20 tons
Cabin length	maximum 25 meters
Pods' capacity	minimum of 88 passengers with their luggage. can be also configured for cargo transport
Pod mission profile (EPC)	Pod has to be a lifting body following a fully controlled descent trajectory after air release.
Pod's environmental system (EPC)	independent system per pod
Pod's Survivorship (EPC)	parachute and life boats system are included.
Connection to the carrier	Easy connection/ Release mechanism

The main part of the pod is essentially a fuselage structure that defines the passenger cabin. The "cabin module" is the part that is transferred between the rail vehicle and the aircraft. In the case of the IPC it is directly loaded inside the aircraft. A conveyor and restrain rail system similar to the one used in military transport aircraft is considered to allow for the easy loading and securing of the pods inside the aircraft. The "floor" of the rail carriage can have the same configuration in order to accept the cabin module.

Figure 3: Restrain system on the floor of a cargo aircraft

In the case of the EPC, the cabin module needs to be assembled with a "flight module" before it is attached on the special pylons underneath the aircraft. The flight module consists of a base structure that incorporates the lift and control surfaces and all the systems needed for the flight mission of the pod.

An important part of the study dealt with the seating arrangement in respect to the dimensions of the pod. Various alternative configurations (different seating pitch and row arrangements) were considered and the one that provided a solution close to the target for the seating capacity within the dimension limits was selected.

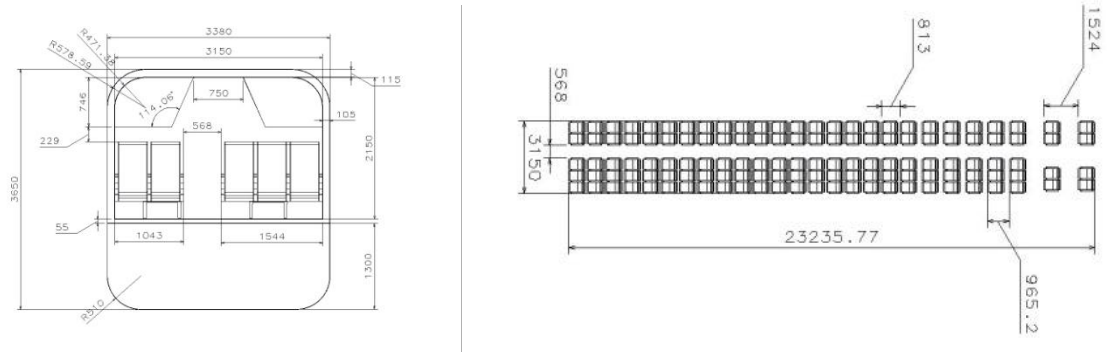

Figure 4: Selected seating layout

Sizing of the flight module, lift and control surfaces was performed based on preliminary aircraft design procedures and simple calculations. The result of the study was the preliminary design of the pod for the two carrier configurations: IPC-cabin pod and EPC-cabin pod+flight module.

These are shown in the images below.

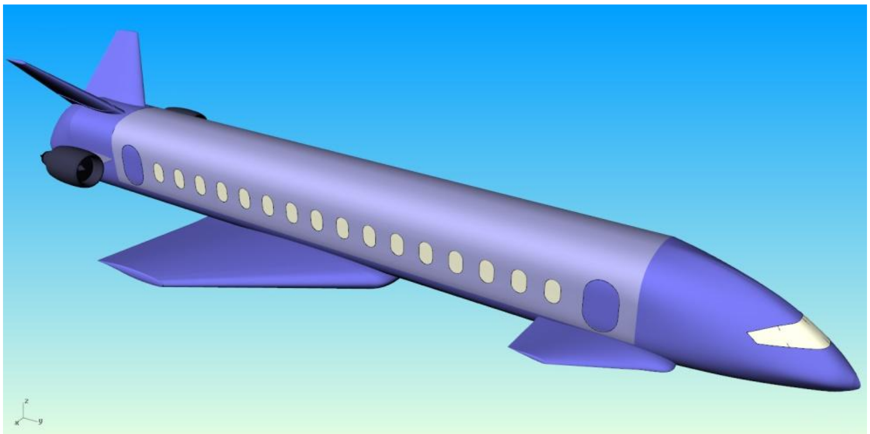

Figure 5: The EPC cabin pod (light blue) assembled on the flight module (blue)

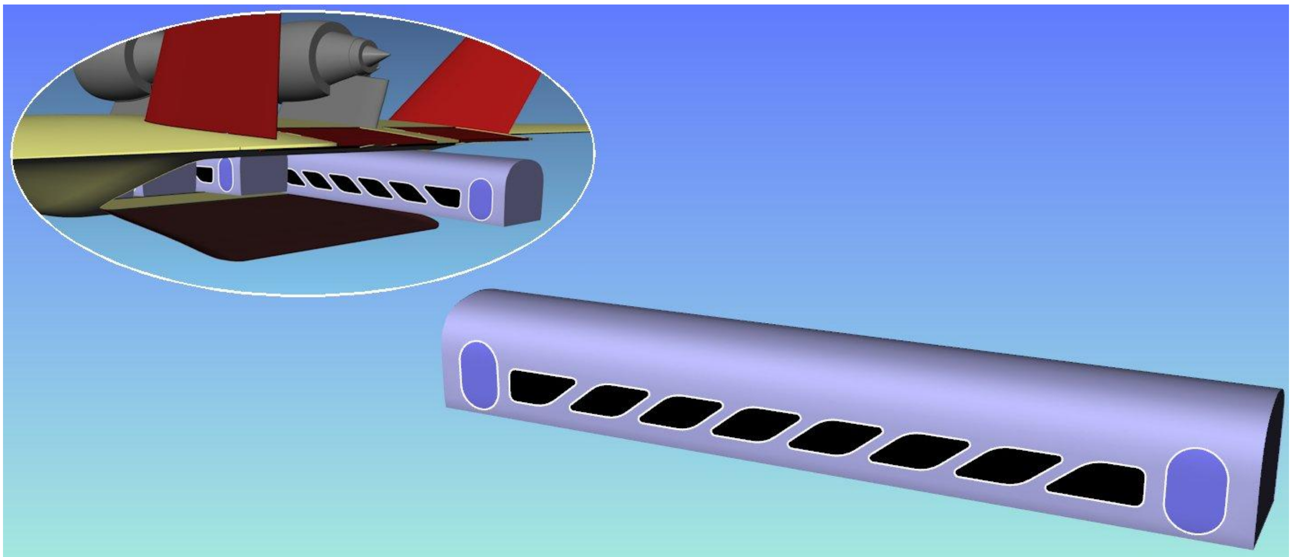

Figure 6: The IPC pod. In the image detail, view of the pod loading inside the IPC carrier.

<u>Carrier aircraft preliminary design</u>

The EPC configuration was proposed and studied by UoP. This concept was focused on safety as the externally attached pods allow their use as "escape capsules" in case of extreme emergency as a last resort that increase the passengers' chances of survival. The attachment of the pods on the carrier is considered to follow practices encountered in space vehicles such as the attachment of the Space Shuttle on a Boeing 747. To further support the scenario for an air evacuation of the aircraft through the release of the pods, an airborne platform with lift and control surfaces was designed. A simpler pod configuration where the pods are assumed to safely land by means of parachutes was also considered.

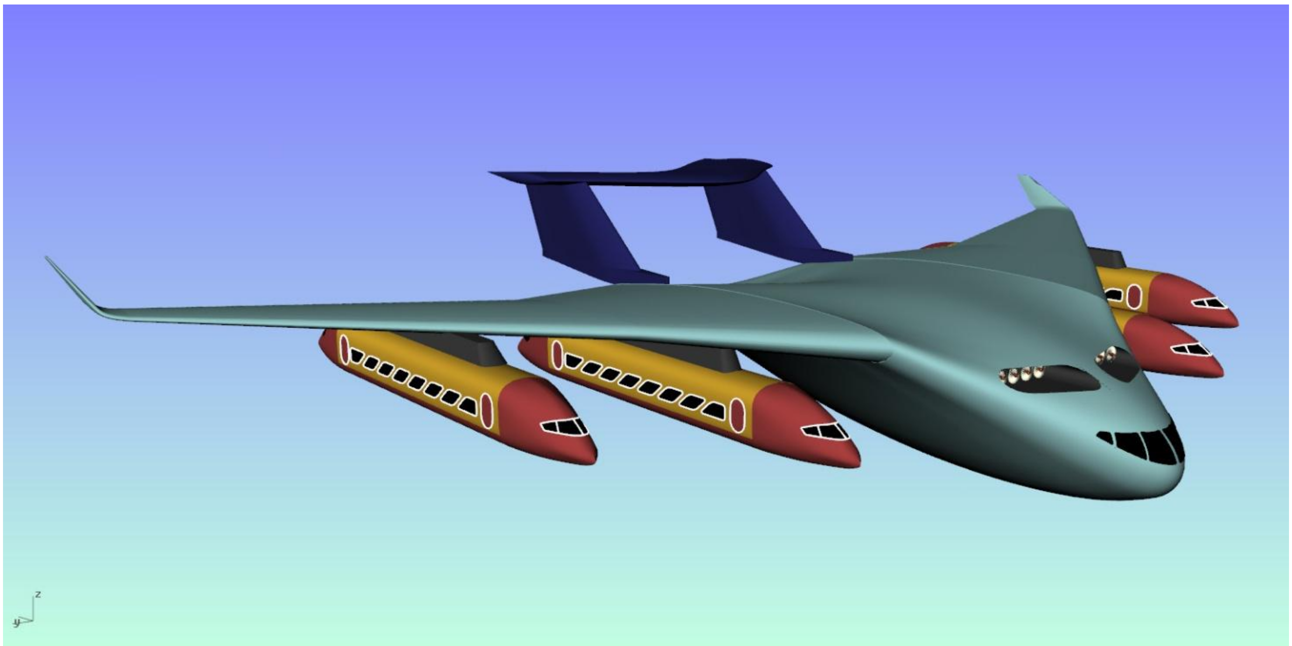

Figure 7: EPC with simple pods

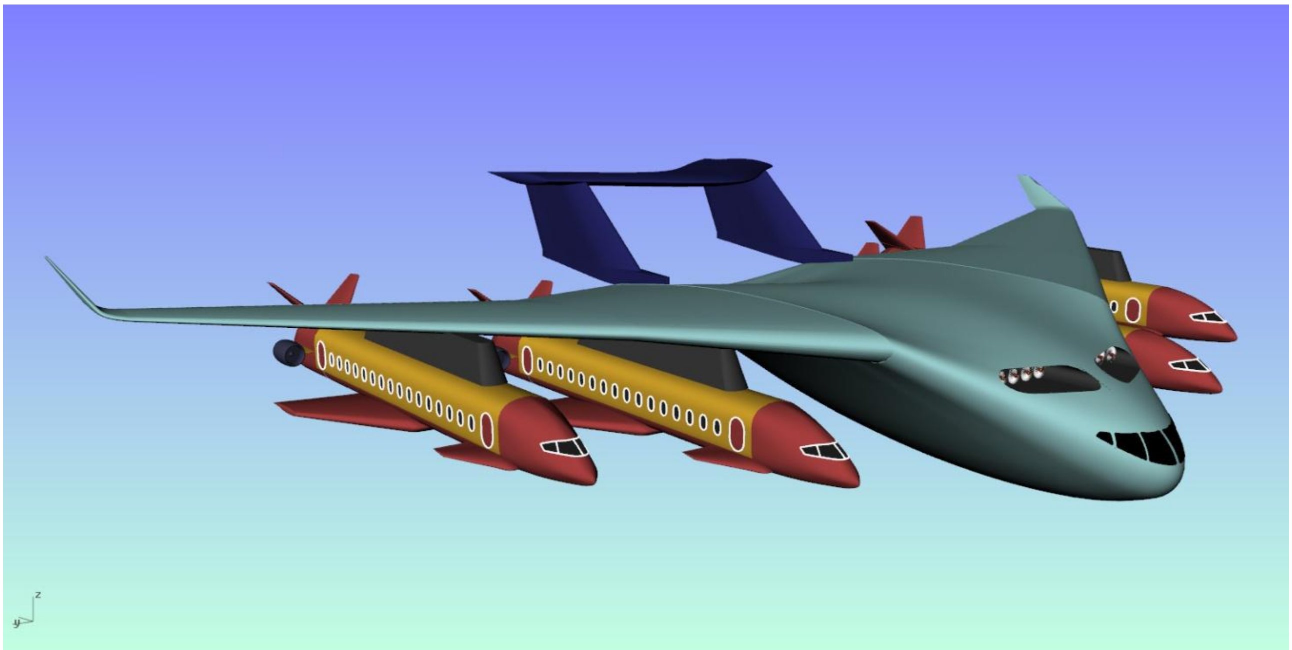

Figure 8: EPC with "flying" pods

The IPC configuration is focused on efficiency and ease of operation. The aircraft follows the Blended Wing Body (BWB) format to create a large interior space that is used to facilitate the pods. The pods are loaded through a rear ramp door (see detail in Figure 6) and secured inside the fuselage by means of a "rail" system similar to the one used in military transport aircrafts for the loading of cargo pallets.

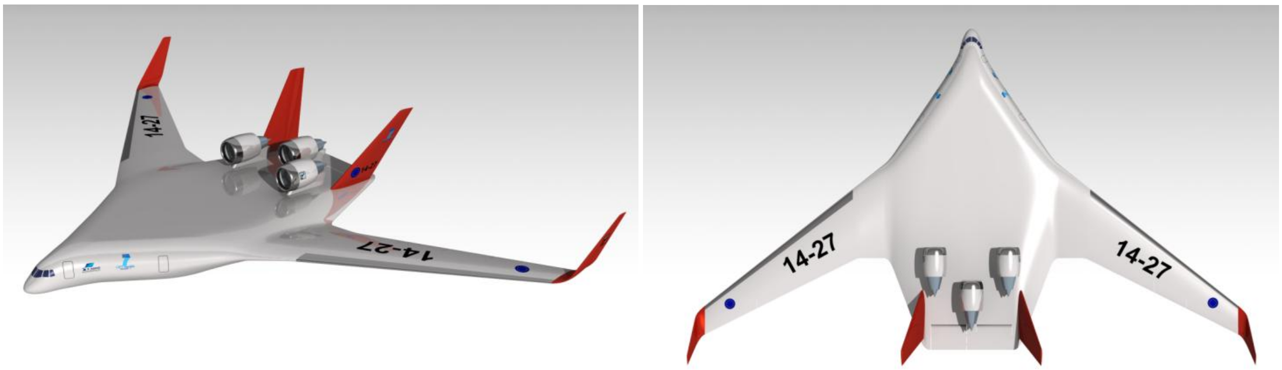

Figure 9: The IPC carrier aircraft

Both concepts were studied following preliminary aircraft design practices and simple calculations. Aspects like Preliminary Weight Estimation, mission profile and carpet plot analysis, aerodynamics, airfoil selection, preliminary structural analysis of the wing, dynamic stability, power consumption etc were covered. Summarizing the results of the study, an assessment matrix was prepared in order to rank the two concepts according to pre-defined criteria.

Envisaged transport system

The last work package of the project dealt with the conceptual development of a "holistic" transport system for Europe that would incorporate both air and rail transport in a seamless fashion. The goal of such a system would be to accomplish the EU goals for a door to door passenger transportation within 4 hours. The relevant study showed that to achieve this goal the most effective measure is to reduce the turn-around time of the aircraft thus minimizing waiting time for the passenger but most importantly increase the aircraft/passenger throughput of the airport. This goal is well served by the pod system. As pods can be loaded in a convenient time before the in-bound aircraft is ready for take-off, the whole process is not sequential and thus less prone to delays.

The issue of seamless intermodal travel was also studied. The main finding was that the most effective way to accomplish that is to develop dedicated automated lines to carry the pods between the airport and city center terminals where crossing to local transport can be easier. This option facilitates both security and operational requirements.

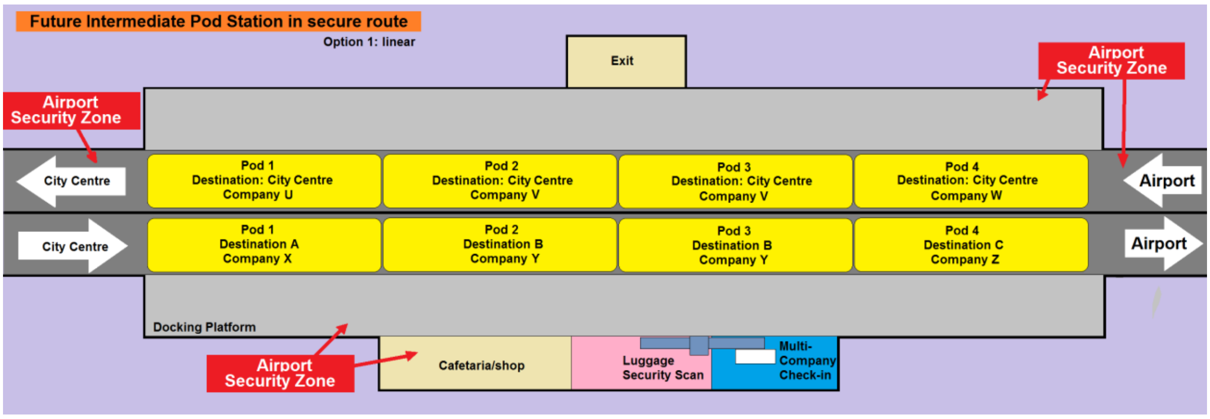

Figure 10: Intermediate pod station built like a train station.

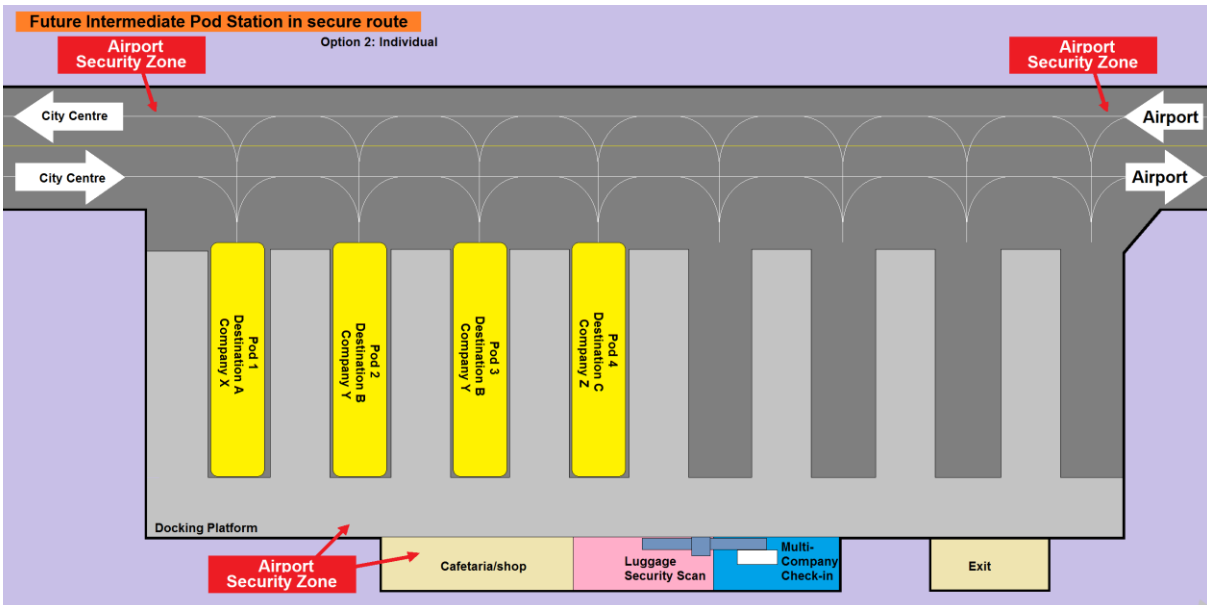

Figure 11: Intermediate pod station with a 'pier' bus station setup.

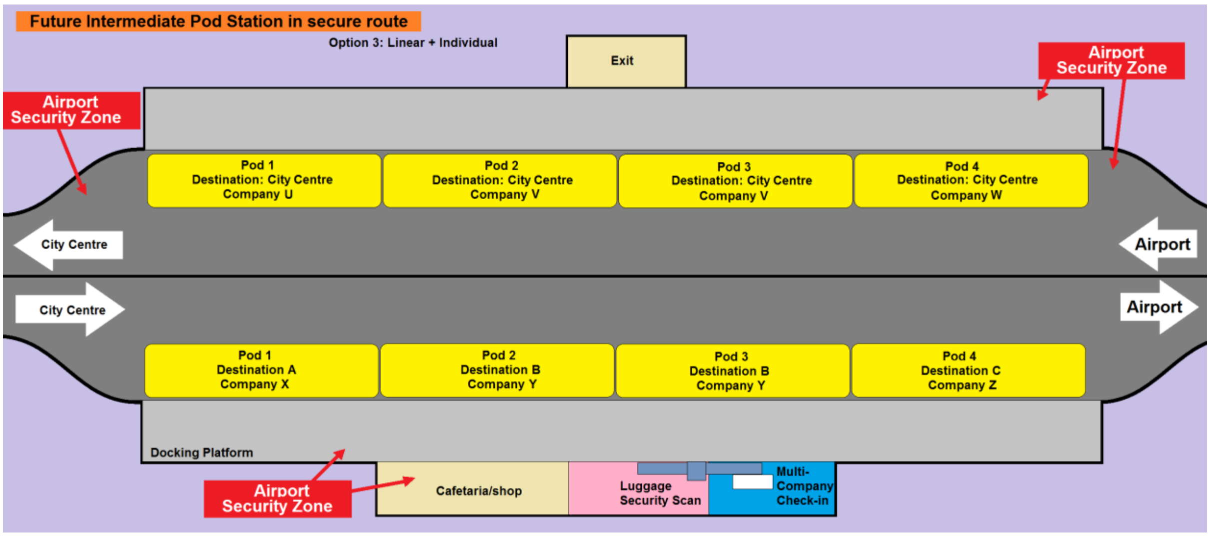

Figure 12: Intermediate pod station with a bus station setup.

Potential impact and main dissemination activities and exploitation results

The envisaged benefits from the Carrier-Pod concept are multiple:

- Inter-modal passenger transport. The passenger/cargo modules will be engineered in order to be compatible with both rail and air transport modes. For every traveler, change of transportation mode is often associated with nuisance. By using a common "pod" the result will be seamless mobility through rail and air transport where the passengers will feel comfortable, safe and secure.

- Increased flexibility in aircraft configuration and fleet management. Airlines would keep a series of passenger pods with different seating configurations and decide on the final arrangement of the pods according to demand. Cargo pods could be used in passenger flights with low seat occupancy in order to increase turnover. As the loaded modules will be carried to the aircraft by a rail system, aircraft taxing will be minimized.

- Passengers will be able to take advantage of distributed airport facilities away from the runway. By utilizing the inter-modal pods, passenger may enter the pod in a railway station and then get transported directly to the "carrier" aircraft by using the railway system. In each flight, several pods may be loaded, each of them may originate from a different location (rail station).

- Faster and easier passenger loading. The "cabin pod" could have multiple or large side doors for easy access and quick seating of the passengers. Luggage will be placed in special compartments possibly assisted by personnel. In this way, congestion of large airports due to the expected increase of air traffic could be avoided.

- Evacuation of the aircraft in case of an emergency that threatens the survival of the craft and its passengers. The "pods" could be released and safely landed using various measures (lift surfaces, parachutes, air-bags etc).

- Increased flexibility in maintenance as the carrier and pod may enter scheduled or un-scheduled maintenance independently leading to a smoother operation of the overall system. The carrier-pod system is also expected to minimize risks from handling and passenger boarding as loading will be performed in a single automated step (according to statistics 20-25% of maintenance and repair comes from accidents during aircraft handling operations).

Regarding dissemination the following activities were performed:

1. Presentation of the project in a Workshop on "Enabling and promising technologies for achieving the goals of Europe's Vision Flightpath 2050"

2. Article on European Energy Innovation magazine (issue with focus on aviation. Available on-line, also distributed during Farnborough AirShow)

3. A MSc thesis on the subject of "Conceptual design of a carrier-pod aircraft configuration" under the supervision of NLR

4. Dissemination Event, Workshop on "Next generation aircraft concepts and related Breakthrough and Emerging Technologies in Aeronautics and Aviation" (to be held on 26th of January 2015)

5. Presentation of the project results in the upcoming AeroDays 2015 event (October 2015)

Exploitation of the project results is sought through setting up of a follow-up or relevant research project that would further investigate the concepts and develop in detail crucial design features and system components.