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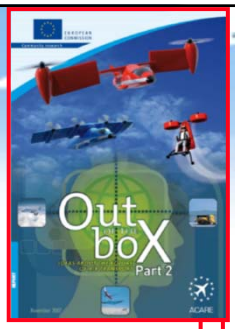
THE PERSONAL PLANE PROJECT

Le projet Européen PPlane: Une nouvelle dimension dans la mobilité ?

Le transport aérien de demain
Fondation Tuck – 9 Décembre 2013
Claude Le Tallec, Onera

PPLANE
The Personal Plane Project



Acronym: PPlane

- 7th Framework Programme, second call
- Work programme topics addressed:
  - **ACTIVITY 7.1.6. PIONEERING THE AIR TRANSPORT OF THE FUTURE**
    - **AREA 7.1.6.3. Promising pioneering ideas in air transport**
      - **AAT.2008.6.3.3. Personal air transport systems**
- Budget: 4.4 M€ (3.3 M€ from the European Commission)
- Duration: 30 + 6 months
- Start date: 1st of October, 2009

PPlane Partners

5 RC
4 Universities
3 SME
1 Industry

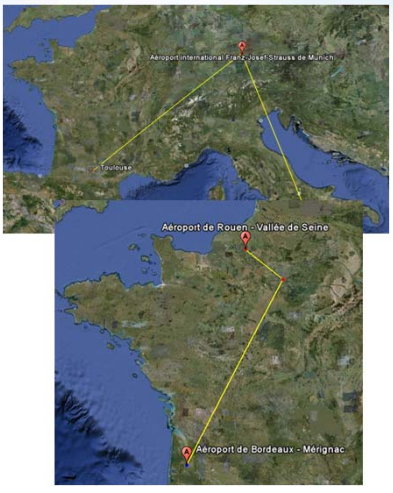
1.	**French Aerospace Lab**	**ONERA**	**France**
2.	Israel Aerospace Industries	IAI	Israel
3.	Airnet	AIR	Slovenia
4.	Bologna University	UNIBO	Italy
5.	Brno University	BUT	Czech Rep.
6.	CIRA	CIRA	Italy
7.	Intergam Communications Ltd.	ITG	Israel
8.	Warsaw University of Technology	WUT	Poland
9.	AT-One, German Aerospace Center	DLR	Germany
10.	Instituto Nacional de Técnica Aeroespacial	INTA	Spain
11.	AT-One, National Aerospace Laboratory	NLR	Netherlands
12.	University of Patras	PAT	Greece
13.	REA-TECH Engineering and Architect Ltd.	REA	Hungary

Project specific objectives

Developing system ideas to enable individual air transport

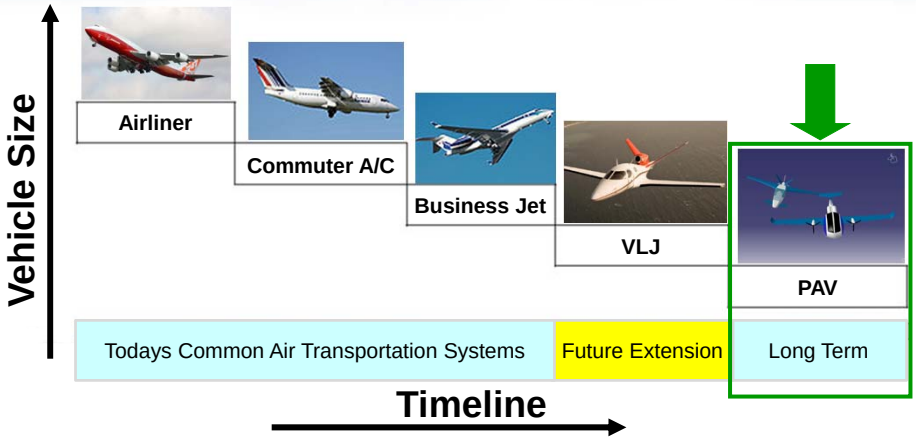
- To avoid the ever increasing congestion on European roads
- To complement the current transport system in European countries

- To achieve environmentally friendly multimodal trip, door to door, within 4 hours in Europe



Project specific objectives

- Where does PPlane fit in the Air Transport System?



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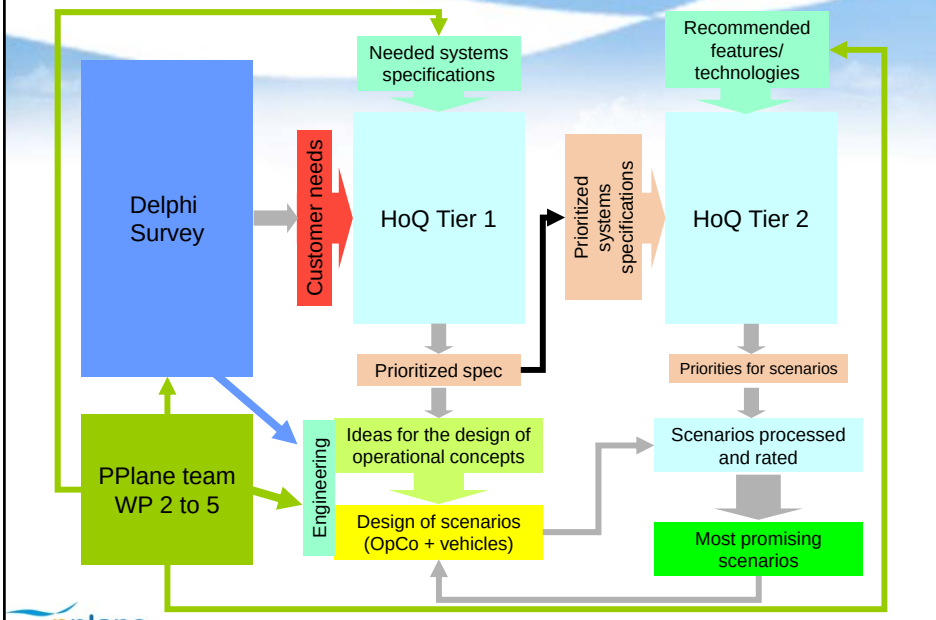
Project methodology – Ranking scenarios



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Human factors team findings

- PPlane transportation system should be used by a 'regular Joe': no specific competency nor training should be required from the PPlane occupants
  - Only passengers on board
  - Pilot on the ground
- PPlane passenger will have to be confident and more independent than passengers from current commercial flights
  - A pre flight briefing will be required (emergency procedures)
  - A short simulation trial (actual PPlane in a simulated mode) could be envisaged for familiarisation and acceptance checking before the actual flight

No pilot on board but Human factors issues are still there: on ground (pilot) and in the air (passengers)

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Human factors team findings

Only 1 sense?

- You ***can't hear*** the engine rpm fluctuating
- You ***can't feel*** vibrations, accelerations or motion
- You ***can't smell*** the fuel leak
- You ***can't taste*** the electrical fire
- AND, you ***lose vision*** in one eye, 30º FOV!
- WELCOME to UAS flying!

Mark Pestana
NASA Research Pilot

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Security team findings

Security

- ***Protecting the passengers and aircraft from attack***
  - Difficult to get the same protection as for conventional airlines using “secure” airports
  - PPlane less attractive than large airliners for any terrorism actions
    - Short range
    - Low number of passengers
- ***Protecting the aircraft from being used for unlawful acts***
  - Low mass and speed resulting in limited kinetic energy
  - Low fuel capacity
  - Limited payload capability

Command and control data link critical

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Safety team findings

Safety

- ***Flight*** and ***Flight Control System (FCS)*** –
  - Need to develop new type of highly reliable flight control system and autopilot
  - Design of FCS system could be based on existing designs for higher category aircraft
- ***Emergency management***
  - New systems and procedures have to be developed
- ***Navigation***
  - 4D contract managed at the PPlane system level
- ***Propulsion***
  - Multi engine recommended (or low failure rate for electric engines?)

On board human actions to be kept to a minimum

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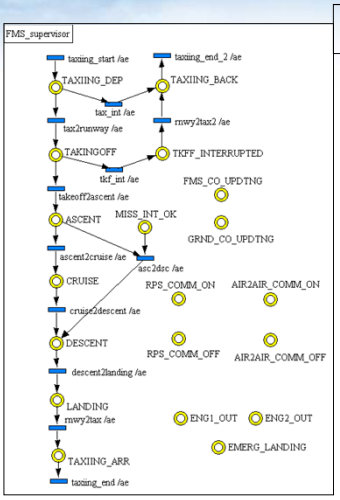
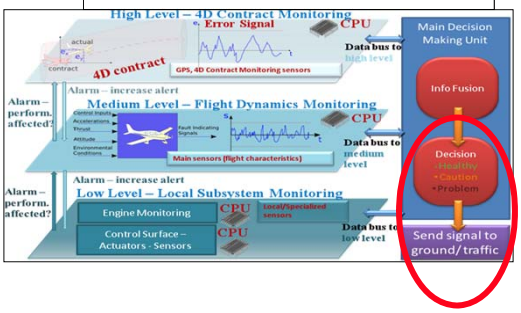
Automation and control team work and findings

PPlane supervision system (FMS)



Fault detection and identification

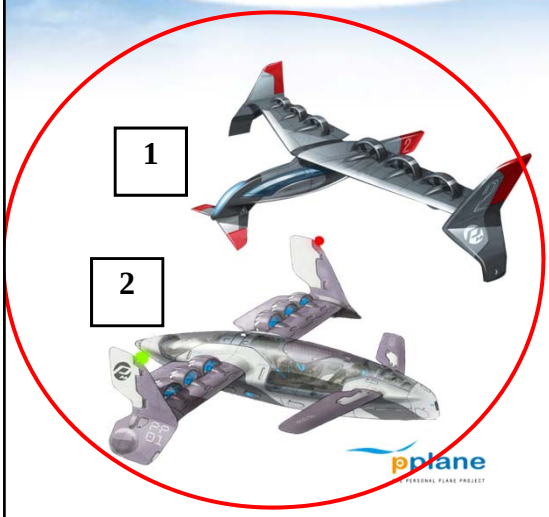


Environment team findings

- Emissions:
  - Emissions of NO_X, CO, CO_2 and H_2O with combustion engines
  - No direct emission with electric engines
- Noise
  - Engine: nearly no noise for electric engine, significant noise for combustion engines
  - Propeller: used with both types of engine
- Perceived nuisance by population
  - 4D contracts will enable optimized flight path
    - Noise
    - Global efficiency

PPlane may exist only if electric propulsion becomes viable for such air vehicles

Potential concepts of PPlane vehicles



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2010 – ILLUSTRATION
STEPHANE JANIN
ANTONY VILLAIN
SPEEDBIRDS TEAM

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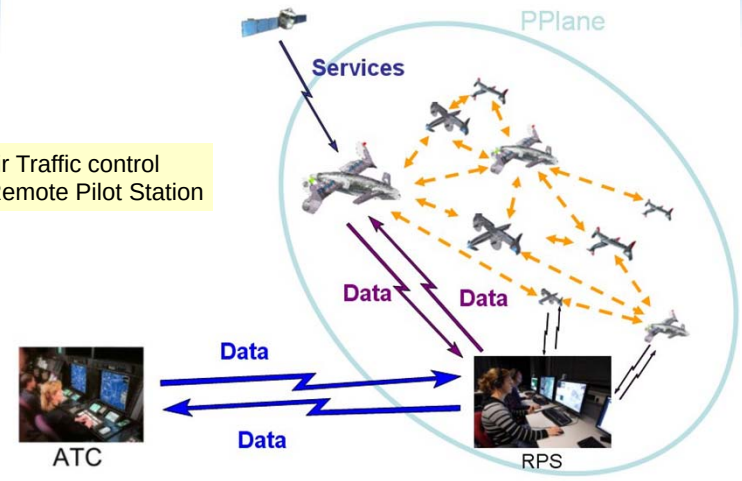
PPlane system architecture

ATC: Air Traffic control
RPS: Remote Pilot Station



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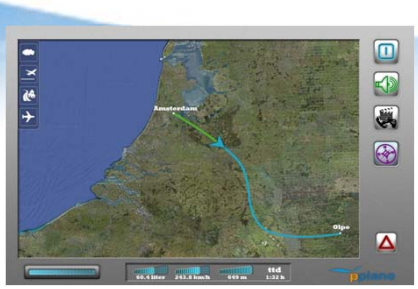
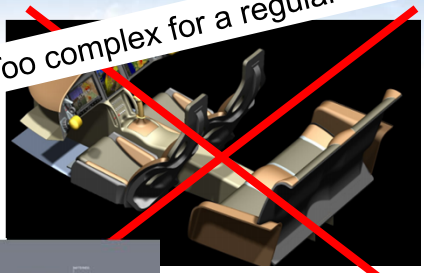
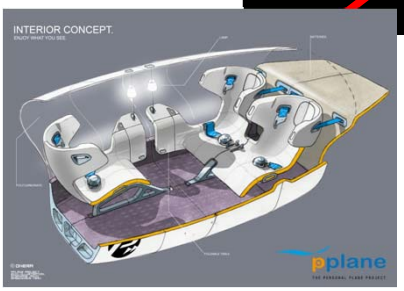
PPlane ground segment
PPlane air vehicle cabin/cockpit layout







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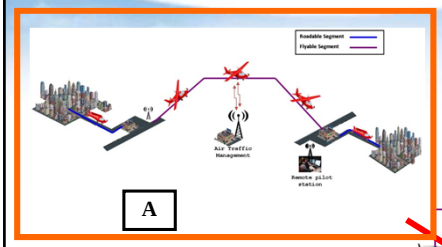
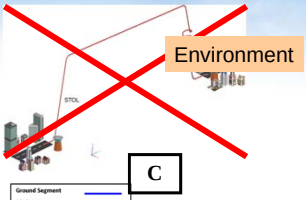
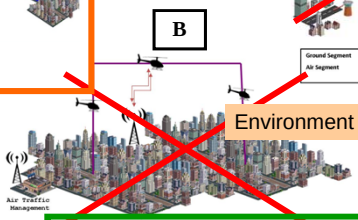
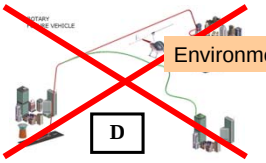
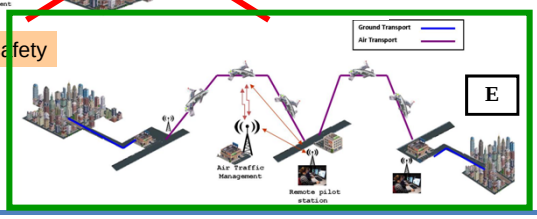
PPlane concepts of operation and scenarios











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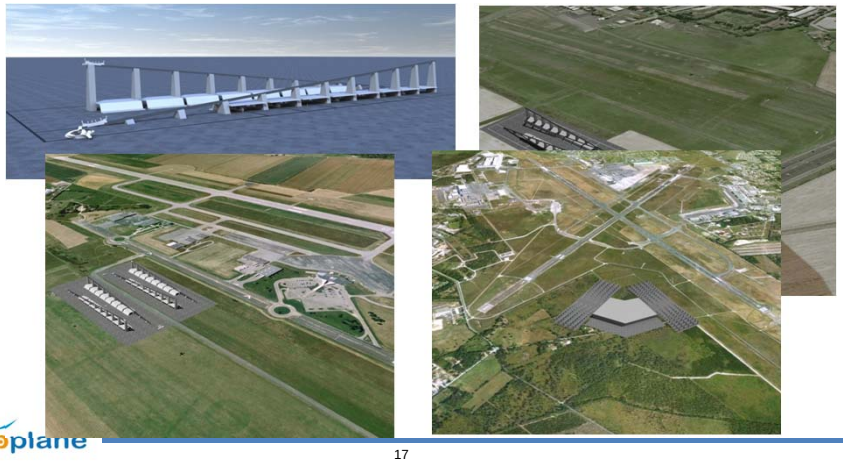
PPlane project results: Modes of operation

- Fully automated taxi, take-off and landing with a specific low footprint, safe and secure PPort modular infrastructure



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What type of ATM for PPlane?

- Conventional voice messages between Air Traffic Controllers and pilots are not an option any more
- ATC monitoring of aircraft compliance to planned 4D trajectory remains a problem for safety and efficiency
  - Conflict management
  - Uncertainty in aircraft future positioning
  - Latency in aircraft reaction to ATC instructions
- Self sense and avoid system not practicable: a 4D contract based, preplanned, Air Traffic Management is needed

→ ***Need for a 4D contract based ATM***

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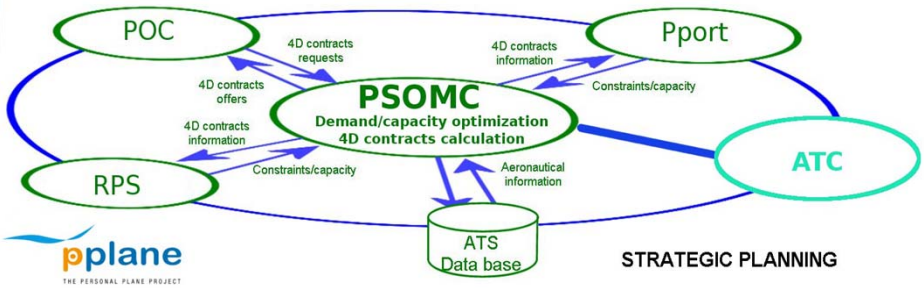
PPlane Network Centric Architecture



PSOMC: PPlane System Operation Management Centre
ATS: Air Transport System

POC: PPlane Operator Centre
Pport: PPlane airport
RPS: Remote Pilot Station

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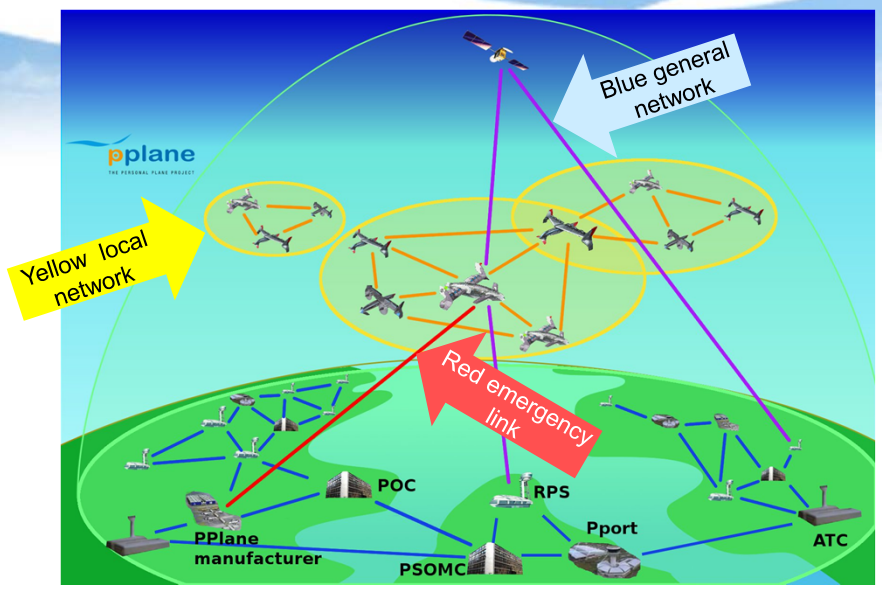
PPlane Network Centric Architecture



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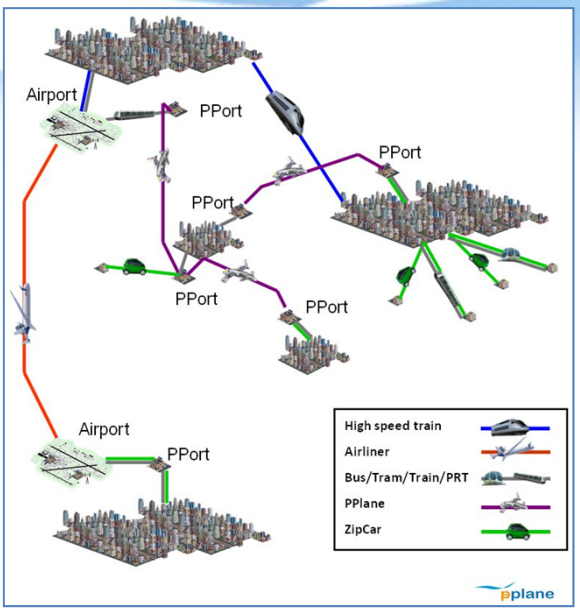
PPlane project results

PPlane is not a substitution to any transport means, it is one segment of a multi modal transport system

Personal Rapid Transport (PRT)



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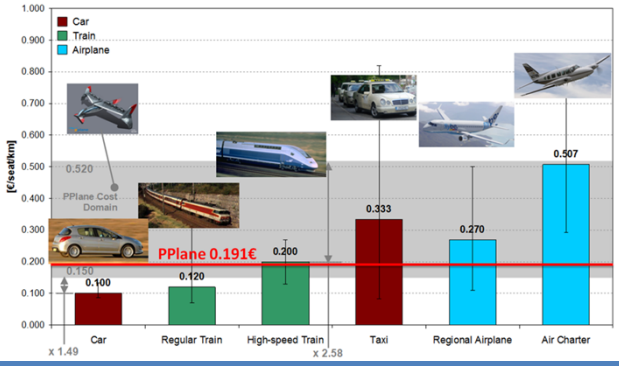
PPlane project results: automation and costs…

- This is a tricky issue…
  - Large investment to make the system feasible (to meet safety objectives)
  - Operation labor cost will depend on the number of people necessary to operate the system safely and securely
- Preliminary assessment
  - Cost of a high speed train trip



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PPlane project conclusions

- The PPlane system concept enables a variety of **fully-automated** (no pilot on-board – but humans still in the C2 loop!), **electrically-powered vehicles** to perform **on-demand personal** and ground supported flights
- Its ground support infrastructure is integrated into the global air transport system, providing efficient and conflict-free, highly-automated, flight service controlled by SESAR derived, 4D contract-based air traffic management (ATM)
- PPlane's vision is in-line with EC Roadmap: "***Automation has changed the roles of both the pilot and the air traffic controller. Their roles are now as strategic managers and hands-off supervisors, only intervening when necessary.***"

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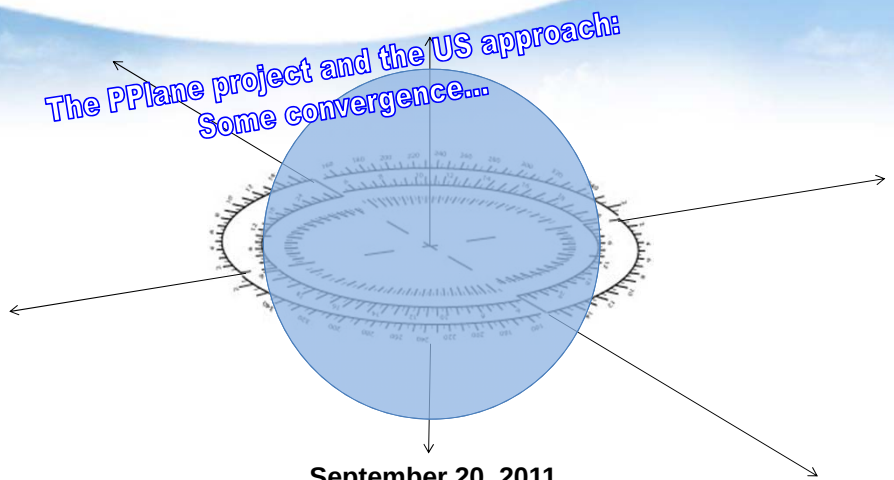
NASA aviation R&D tradespace analysis



September 20, 2011

Yuri Gawdiak
Manager of Strategic Analysis
Aeronautics Research Mission Directorate,
NASA Headquarters, Washington DC, 20546

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NASA aviation R&D tradespace analysis
Tradespace recalibration?

GDP
Fuel
Water/Food
Environment
Critical Resources
Scandium 21 Sc 44.95591
Constraints
Solution Architecture
Trends/Indicators
Behaviors
External Environment
Mechanisms
Infrastructure
Capabilities/Responsibilities
Technology Innovations
New Demand Drivers
Historic Evolution of Mobility
9
?
M&M & UAV Unmet Demand

NASA aviation R&D tradespace analysis
Needed changes

Irrational Daily Traffic Congestion
Zip Car
Large scale 80% Telepresence for work.
On demand, all electric, custom sized vehicles delivered door to door. Reduce world's significant (200%*) excess capacity of surface vehicles. Lead the World by helping Civilization sidestep unsustainable consumption and thereby preventing a possible Global Resource/Environmental Crisis
Yuneec e340 Electric Airplanes
Adv. GA Autopilots
Global Hawk/Adv Sensors
Autonomous Electric Zip GA
On demand, Electric, 1-4 passenger custom sized autonomous, sense & avoid aircraft. Meet historic trend of greater flexibility & shorter travel time at affordable costs. Use of parachutes for added safety.

Vision NASA

High-Speed Mobility through On-Demand Aviation *(Mark D. Moore & al, AIAA – August 2013)*

- Zip aircraft based on redundant electric propulsion systems that exhibit high reliability, high efficiency, very low noise, compactness, the ability to be distributed across the airframe, high specific power to weight ratios, and zero emissions
- Unique characteristic of Zip aircraft is the ability to autonomously redeploy from one airport to another as an UAS, although not necessarily at the same safety level

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Vision Européenne ?

Une nouvelle aviation générale, propre, silencieuse et sûre, à usages professionnels et de loisirs ?

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www.pplane-project.org

Merci pour votre attention !

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Automation

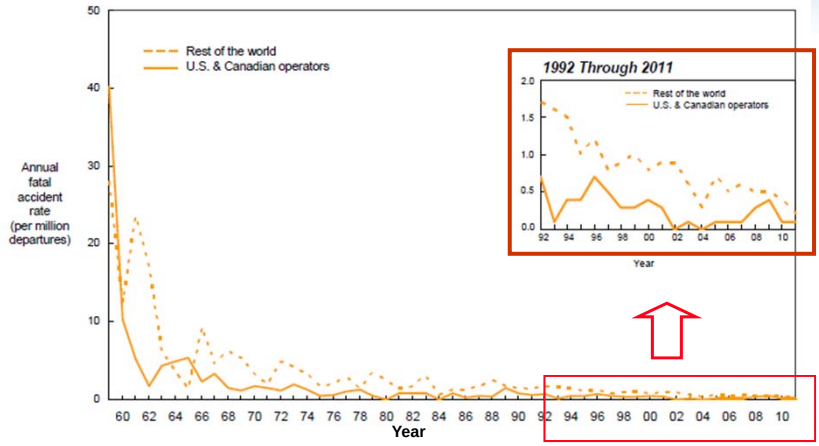
Unmanned aircraft systems current status (US congressional report, January 2012)

- Survey (*Aerospace America*, *March 2011)*: in 2011, there are 680 different UAS programs world wide, up from 195 in 2005
- USA unmanned aircraft inventory increased more than **40-fold from 2002 to 2010**
- **In 2011, almost 1 in 3 U.S. warplanes is a Robot**
- Global Hawk-class, Reaper and Predator-class UAS will grow from approximately 340 in FY 2012 to approximately 650 in FY 2021
- The Predator has only 7.5 accidents per 100,000 hours of flight (2009):
  - down from 20 accidents over that time in 2005
  - comparable to a (manned) F-16
  - **just under the 8.2 rate for small, single engine private airplanes flown in the U.S**

Automation

U.S. and Canadian Operators Accident Rates by Year

Fatal Accidents – Worldwide Commercial Jet Fleet – 1959 Through 2011



BOEING 2011 STATISTICAL SUMMARY, JULY 2012

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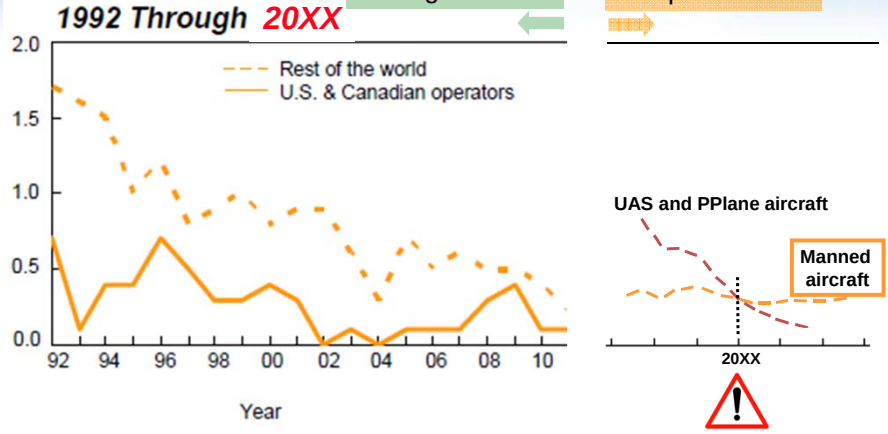
Automation

Boeing Statistics

Expectations



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