Harvis

Human Aircraft Roadmap for Virtual Intelligent System

This project has received funding from the Clean Sky 2 Joint Undertaking (JU) under grant agreement No 831884. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Clean Sky 2 JU members other than the Union

Presentation of HARVIS Project

Presenter: Antonio Leopoldo Rodríguez Vázquez

Company: Skylife Engineering

Date: 12Th February 2019

Place: Clean Sky JU, White Atrium, Avenue de la Toison d'Or 56-60, 1060 Brussels

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Project Overview

- Partners:

ENAC

CVBLAB

Harvis

Deepblue

skylife

Clean Sky

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Project Overview

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- Context:
  - The growth of air traffic.
  - For 2019, the growth of IFR movements is expected to be 2.6% to reach 11.2 million. (Expected + 2% per year)
  - Mobility Changes:
    - Integration of unmanned aircrafts into the European air space.
    - Tasks' automation.
    - Role of the humans in complex systems.

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Project Overview

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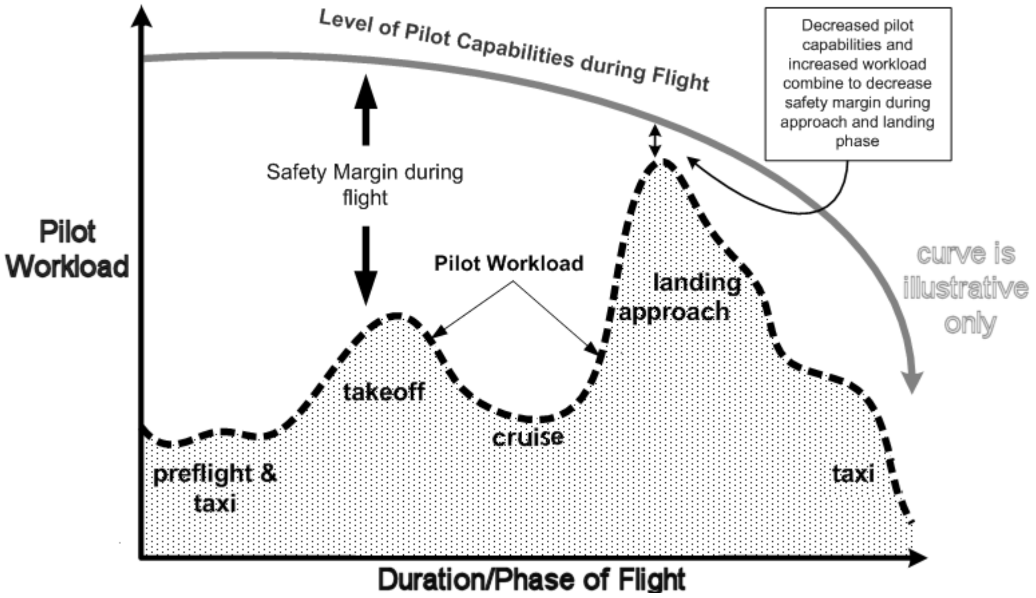
- Context:
  - Peak workload conditions:
    - Unpredictable situations.
    - Difficult meteorological conditions
    - Multiple system failures or cockpit crew incapacitation, etc.
  - Pilot to have more and more information related to the flight conditions in lockstep with tighter restrictions to consider in their flight trajectories.



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Project Overview

- The overall objective of HARVIS

Identify how cognitive computing algorithms implemented in a digital assistant could support the decision making of a single pilot in complex situation.

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Project Overview

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- Relation to the CS2JU Work Plan:
  - Topic: JTI-CS2-2018-CFP08-THT-02 Cognitive Computing potential for cockpit operations.

    Objectives → Low TRL research activities focused on identifying a roadmap for a digital assistant that will enable single pilot operations of Large Passenger Aircrafts

- HARVIS project will address these objectives:
  - Improving EU competitiveness:
    - 3 EU member are involved
    - Involve Universities by proposing PhD programs.
  - Improving mobility:
    - HARVIS will support the ambition of the **LPA Platform 3 IADP**, and it is a key enabler to deal with the increasing complexity of the aircraft and its systems, the ATM and the increasing heterogeneity of crew population and of their operational involvement.
    - HARVIS project will provide a **path to single pilot operations** (a necessary step before autonomous operations) to be reached within the next 15 or 20 years
    - **HARVIS will provide a roadmap identifying how Cognitive computing and AI can be integrated in aerospace sector and the key points** for which the European community should bet within the next. As well as the current technological limitations and the options that must be avoided.

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Concept and Approach

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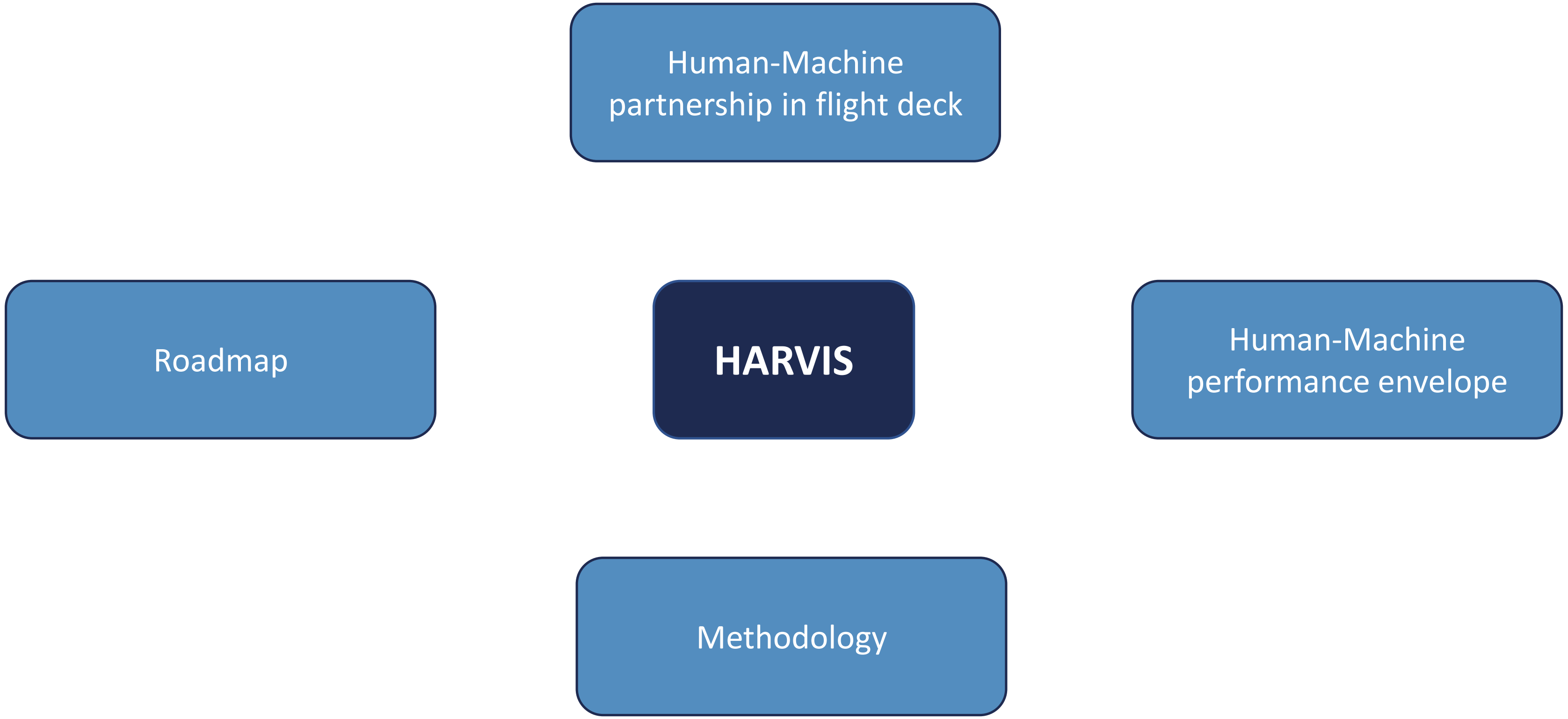
- Main objetives:



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Concept and Approach

Harvis

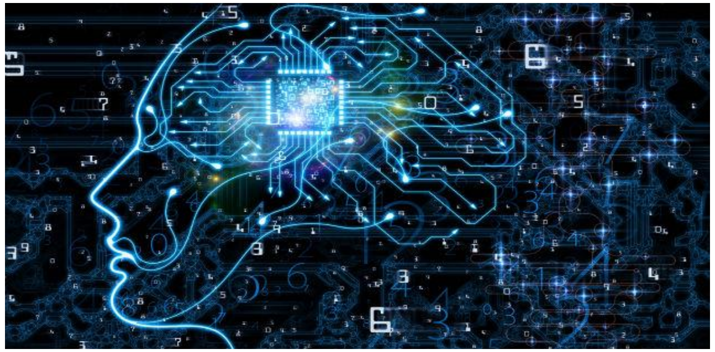
Human-Machine partnership in flight deck

Roadmap

HARVIS

Human-Machine performance envelope

Methodology



Roadmap

- Analyse the **impact of the use of cognitive computation in cockpit** operations, studying the its benefits and losses.
- Define which are the scenarios where a **"digital assistant"** will produce the greatest benefits.
- To **identify the technologies and the shortcomings** (legal, technological, etc.) that prevent these technologies to be applied successfully in real life.
- Define the technologies that should be supported as well as those to be avoided.
- Evaluate the integration of this assistance technology into the **realistic working process**.
- Identify **collateral risks** how to avoid them.
- Analyse how the impact of **cognitive computing will transform the actual working conditions**. As well as, propose effective solutions and how pilots should be trained in this context so that the solution is solid and effective (machine learning approach).
- Analyse how equipment that uses this technology can be certified or even **licensed**.

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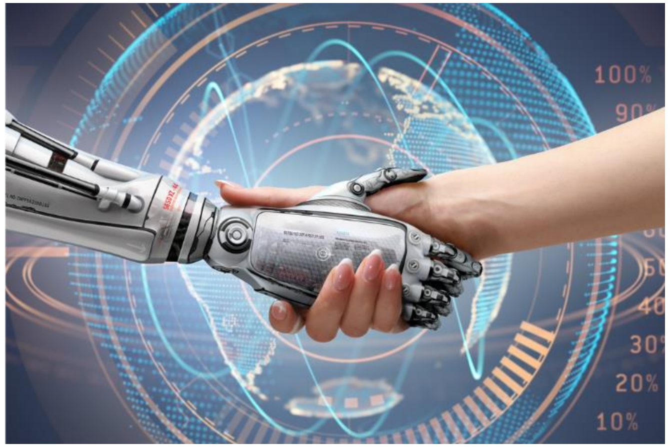
Concept and Approach

Harvis

- Human-Machine partnership in flight deck
- Roadmap
- HARVIS
- Human-Machine performance envelope
- Methodology

Human-Machine partnership in flight deck

- Exploring the opportunity for cognitive computing and AI technologies to assist pilot(s) during flight operations, in both nominal and abnormal conditions.
- Define a way to leverage abilities of both (Human and machines).
- Provide a reference frame for Human Machine interactions
- How pilot will learn to team up with AI technologies to help manage their tasks improving performance



2 Pilots

Present

1 Pilot + IA

Future

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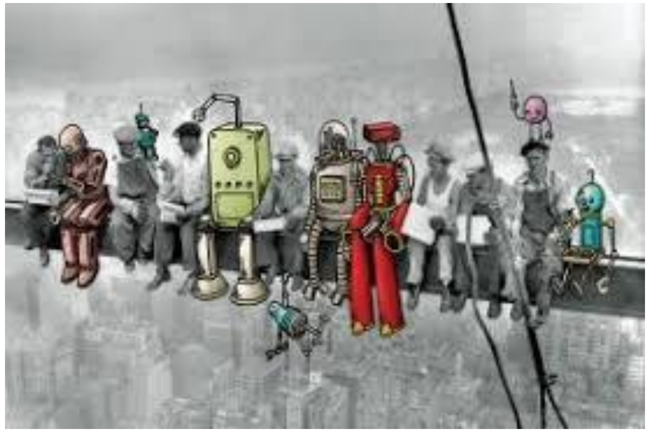
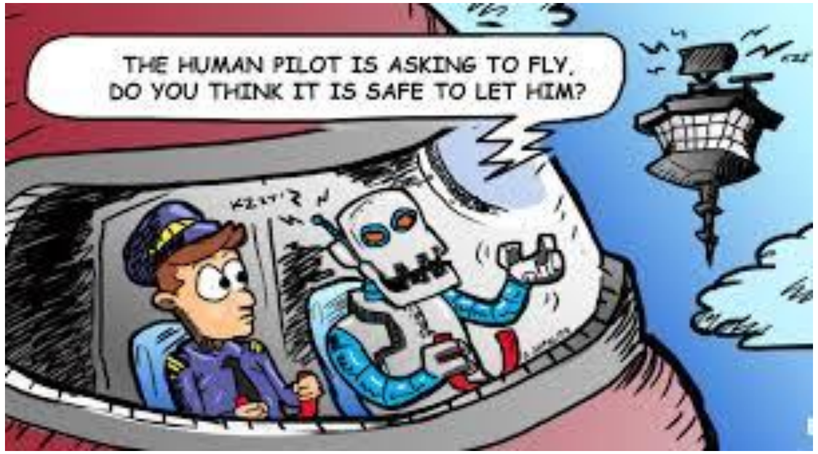
Concept and Approach

Harvis

- Human-Machine partnership in flight deck
- Roadmap
- HARVIS
- Human-Machine performance envelope
- Methodology

Human-Machine performance envelope
• Explore how the human machine partnership framework impacts the performance envelope. • Aligning cognitive computing and artificial intelligence in the future flight deck. • How cognitive computing could bring more efficient support to the pilot in the light of existing limitations • Define envelope considerations such as pilot training, AI training, AI certification, etc





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Concept and Approach

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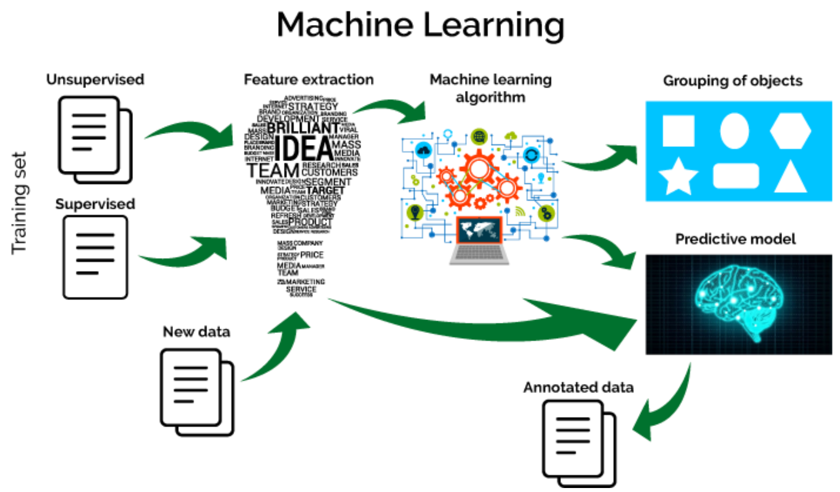
Human-Machine partnership in flight deck

Roadmap

HARVIS

Human-Machine performance envelope

Methodology



Methodology:

- State of the Art review.
- AI training:
  - ➢ Design a “feature extraction” algorithm.
  - ➢ Database generation (Real or simulated).
  - ➢ Propose a Human-Machine communication
- Use case definition:
  - ➢ Realistic and feasible.
  - ➢ Advisory board
- Simulation and validation.

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Concept and Approach

- Main objetives:

1. Detailed **State of Art** about **cognitive computing algorithms**.
2. Analyze the scenarios where a “digital assistant” will produce the **greatest benefits to the pilot.**
3. To **identify the technologies and the shortcomings** that prevent these technologies to be applied successfully in real life
4. Study **the benefits of a potential decision making** with enhanced information which might not be available on – board.
5. Benefits of the **insertion of these technologies into the realistic working practices**.
6. To **identify collateral risks**.

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Concept and Approach

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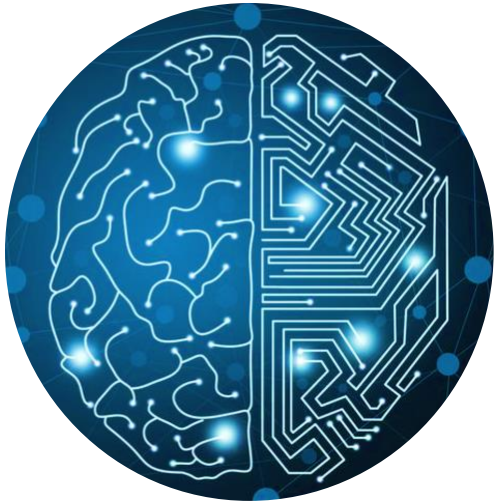
- Ambition:

Inputs

- Monitor Pilot state and actions.
- Pattern Recognition:
  - Flight data
  - Aircraft data
  - Environmental data
- Interaction between pilots and flight deck.
- Pilot feedback through controls.



To provide

- Information requested by the pilots.
- Advisory alert if unsuitable decision are taken
- Automatic data interpretation.
- Anticipate pilots' needs.
  - Suggest new flight plans
  - Calculate optimal descent profiles.
- Record the obtained data.

The experience of hundreds pilots

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Implementation

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- Working Packages

- **WP1 State of The Art Review and Case studies**
  - T1.1 SoA in aerospace Applications
  - T1.2 SoA in other Areas
- **WP2 Human-Machine Partnership**
  - T2.1 Task Analysis, Concept and Use cases
  - T2.2 Human-Machine Performance Envelope
  - T2.3 Training and Future Workforce
- **WP3 Use case implementation**
  - T3.1 Cognitive algorithm design
  - T3.2 1st Use Case Implementation
  - T3.3 2nd Use Case Implementation
- **WP4 Validation and Roadmap**
  - T4.1 Validation Plan
  - T4.2 Simulation and Demonstration
  - T4.3 Multi-Criteria analysis
  - T4.4 Technology Roadmap Validation
- **WP5 Management**
  - T5.1 Project coordination and administration
- **WP6 Dissemination**
  - T6.1 Development of the project communication materials
  - T6.2 Participation in European Events, Seminars and Publications
  - T6.3 Advisory Board

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Implementation

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- Gantt agreement

		Y1				Y2				Y3				
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	***OUTPUT***
WP 1	**State of The Art Review and Case studies**													
T1.1	SoA in aerospace Applications													D1.1 State Of The Art
T1.2	SoA in other Areas													
WP2	**Human- Machine Partnership**													
T2.1	Task Analysis, Concept and Use cases													D2.1 Task Analysis
T2.2	Human-Machine Performance Envelope													D2.2 Human Machine Envelope
T2.3	Training and Future Workforce													D2.3 Training
WP3	**Use case implementation**													
T3.1	Cognitive algorithm design													D3.1 1st Demonstrator
T3.2	1st Use Case Implementation													D3.2 2nd Demonstrator
T3.3	2nd Use Case Implementation													
WP4	**Validation and Roadmap**													
T4.1	Validation Plan													D4.1 Validation Plan
T4.2	Simulation and Demonstration													
T4.3	Multi-Criteria analysis													D4.2 Analysis report
T4.4	Technology Roadmap Validation													D4.3 Technologies Roadmap
WP5	**Management**													
T5.1	Project coordination and administration													D5.1 Periodic Rport D5.2 Final Report
WP6	**Dissemination**													
T6.1	Communication, Dissemintaion and Exploitation													
T6.2	Participation in European Events, Seminars and Publications													D6.1 Dissemination report
T6.3	Advisory Board													
				ML1		ML2				ML3				ML4

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Implementation

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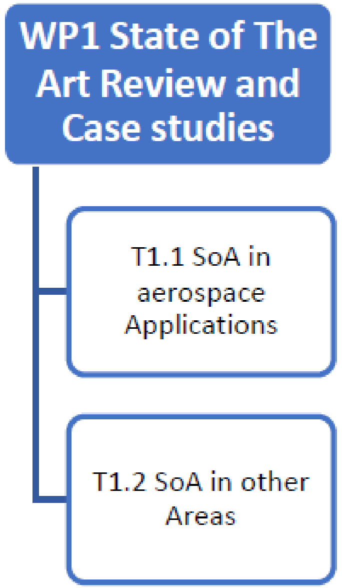
- Tasks Analysis



<table>
<tr><td>WP :</td><td colspan="6">1. “State of the Art in aerospace Applications”</td></tr>
<tr><td>Leader:</td><td colspan="6">UPV</td></tr>
<tr><td>Objectives:</td><td colspan="6">Define the state of the art in cognitive computing, and to define what are the more relevant case studies.</td></tr>
<tr><td rowspan="2">Tasks:</td><td colspan="2">❑ Task 1.1 “State of the Art in aerospace Applications”</td><td rowspan="2">Start:</td><td>T0+10</td><td rowspan="2">End:</td><td>T0+10</td></tr>
<tr><td colspan="2">❑ Task 1.2 “State of the Art in other Areas”</td><td>T0+10</td><td>T0+10</td></tr>
<tr><td rowspan="2">Risks:</td><td colspan="6">• Proposed Use Cases seems not relevant according to the State of the Art Study
• Literature is not available due to copyright or IP protections.</td></tr>
<tr><td>Estimated risk:</td><td colspan="5">Low/Medium</td></tr>
<tr><td>Start:</td><td colspan="2">T0</td><td>End:</td><td colspan="3">T0+6</td></tr>
<tr><td>Deliverables:</td><td colspan="2">D1.1: “State of the Art of CC algorithms”</td><td>Lead Part.:</td><td>UPV</td><td>Due Date:</td><td>T0+6</td></tr>
</table>

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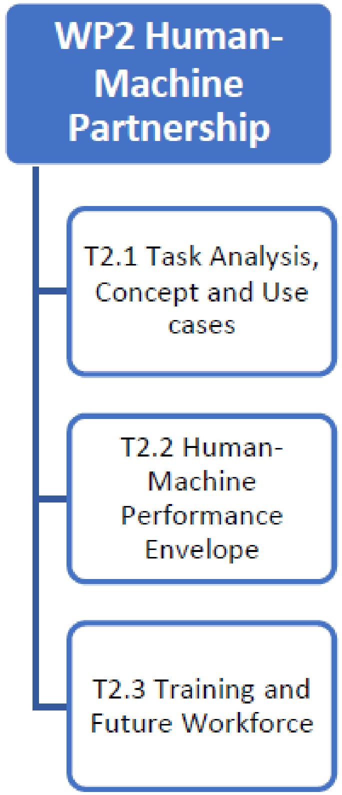
Implementation

- Tasks Analysis



WP :	2. “Human-Machine Partnership”				
Leader:	DBL				
Objectives:	Define a new human machine partnership framework, and the consequent performance envelope.				
Tasks:	❑ Task 2.1 “Task Analysis, Concept and Use cases”:	**Start:**	T0	**End:**	T0+12
	❑ Task 2.2 “Human-machine performance envelope”		T0		T0+24
	❑ Task 2.3 “Training and future workforce”		T0+30		T0+36
Risks:	• Use Cases rejected by stakeholders or advisory board				
	Estimated risk:	Medium			
Start:	T0	**End:**	T0+36		
Deliverables:	D2.1 Analysis of potential CC aided tasks	**Lead Part.:**	ENAC	**Due Date:**	T0+12
	D2.2 Human machine interface and envelope		DBL		T0+24
	D2.3 Pilot training considerations for CC		DBL		T0+36

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Implementation

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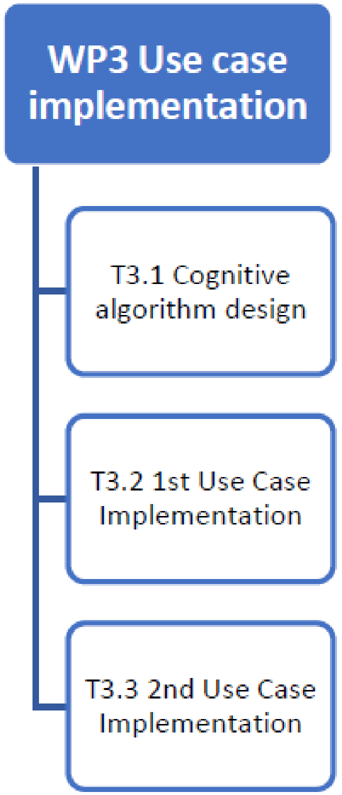
- Tasks Analysis



WP :	3. “Use case implementation”				
Leader:	SKLE				
Objectives:	The development of a proof of concept of cognitive computing assistant				
Tasks:	❑ Task 3.1 “Cognitive Algorithm Design”	**Start:**	T0+6	**End:**	T0+18
	❑ Task 3.2 “First Use Case Implementation”		T0+10		T0+24
	❑ Task 3.3 “Second Use Case Implementation”		T0+10		T0+24
Risks:	• Data gathered is not enough to have significant information and develop a model with the required accuracy. • The Use Cases will face some lack of technological solution that prevents the demonstration objective.				
	Estimated risk:	Medium			
Start:	T0+6	**End:**	T0+24		
Deliverables:	D3.1 1st Demonstrator:	**Lead Part.:**	SKYLIFE	**Due Date:**	T0+24
	D3.2 2nd Demonstrator:		ENAC		T0+24

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Implementation

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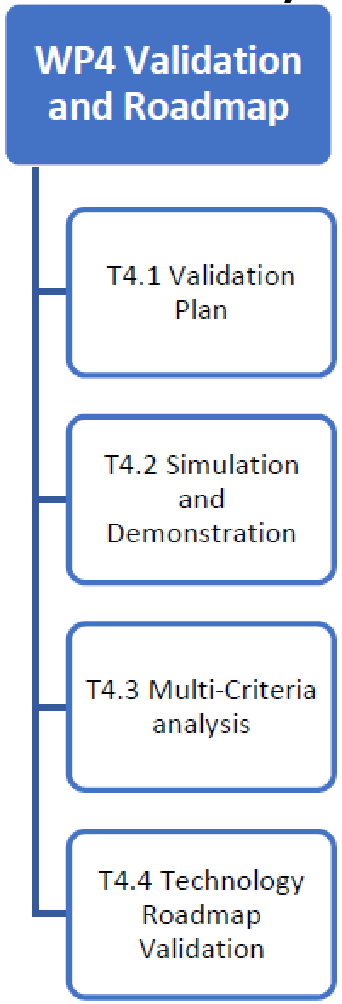
- Tasks Analysis



WP :	4. Validation and Roadmap				
Leader:	ENAC				
Objectives:	Run the simulation activities in order to validate the digital assistant behaviour. Investigate the impact of the digital assistant on pilot. Provide a multi-criteria analysis and a technology roadmap validation.				
Tasks:	❑ Task 4.1 "Validation Plan"	**Start:**	T0+19	**End:**	T0+24
	❑ Task 4.2 "Simulation and Demonstration"		T0+25		T0+36
	❑ Task 4.3 "Multi-Criteria Analysis"		T0+31		T0+36
	❑ Task 4.4 "Technology Roadmap Validation"		T0+31		T0+36
Risks:	• Simulators are unavailable (work, busy,…) • Difficulties in finding subjects for the experiment				
	Estimated risk:	Medium/High			
Start:	T0+19	**End:**	T0+36		
Deliverables:	D4.1 Validation Plan	**Lead Part.:**	DBL	**Due Date:**	T0+24
	D4.2 Analysis Report.		DBL		T0+36
	D4.3 Technologies Roadmap		SKL		T0+36

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- Deriverables

Number	Deliverable name	WPn	Leader	Type	Diss. level	Delivery date
D1.1	State of the art Of CC algorithms	WP1	UPV	R	Public	T0+6
D2.1	Analysis of Potential CC aided Tasks	WP2	ENAC	R	Public	T0+12
D2.2	Human Machine Interface and Envelope	WP2	DBL	R	Public	T0+24
D2.3	Pilot training consideration for the implementation of a digital assistant.	WP2	DBL	R	Public	T0+36
D3.1	1st Demonstrator	WP3	SKLE	DEM	Public	T0+24
D3.2	2nd Demonstrator	WP3	ENAC	DEM	Public	T0+24
D4.1	Validation Plan	WP4	DBL	R	Public	T0+24
D4.2	Analysis Report	WP4	DBL	R	Public	T0+36
D4.3	Technologies Roadmap	WP4	SKLE	R	Public	T0+36
D5.1	Consortium agreement	WP5	SKLE	R	Confidential	T0+1
D5.2	Final Report	WP5	SKLE	R	Confidential	T0+36
D6.1	PEDR	WP6	DBL	R	Confidential	T0+6
D6.2	DMP	WP6	DBL	R	Confidential	T0+6
D7.1	Ethics	N/A	SKLE	ETHICS	Confidential	T0+1

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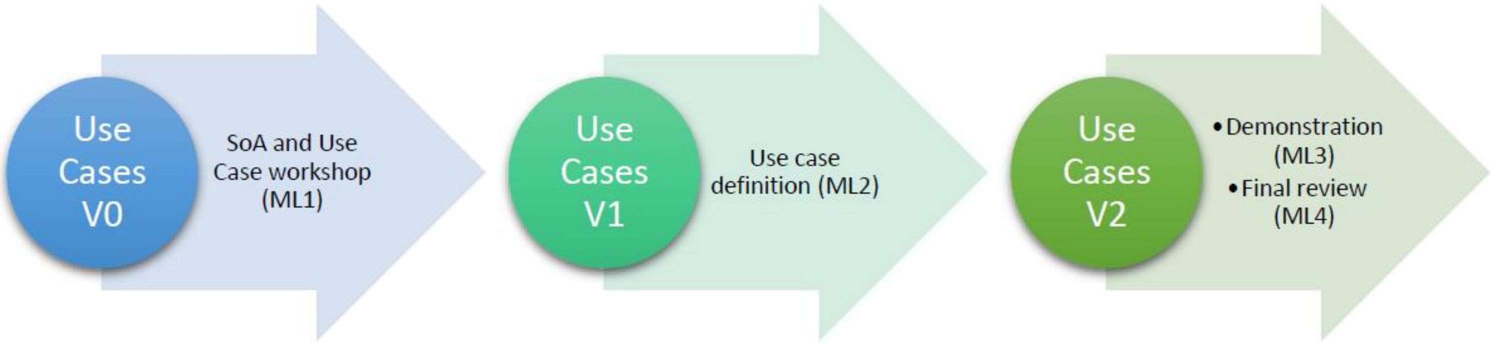
- Milestones

Number	Name	Leader	WP	Due date	Description
ML 1	SoA and Use cases workshop	SKLE	WP1	T0+6	Present SoA and the proposed use cases.
ML 2	Use cases definition	DBL	WP2	T0+12	Detailed presentation of the use cases to be demonstrated
ML 3	**Progress Assessment**	**SKLE**	**WP1 & WP2**	**T0+12**	**Asset the progress and confirm continuation of work (CSJU PO)**
ML 4	Demonstration implementation	ENAC	WP3	T0+24	Public demonstration of use cases.
ML 5	Final Review	SKLE	WP4	T0+36	Final review of the results of the projecct



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Advisory Board

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Roles

- Industry (interest expressed by THALES AVIONICS, SAAB, HONEYWELL, ZODIAC, DASSAULT AVIATION)
- Users (Pilots and associations)
- Liability experts (e.g. ALIAS network)
- Automation experts
- Regulators (e.g. EASA)

Steps

JUN 2019	DEC 2019	DEC 2020	DEC 2021
USE CASES V0	**USE CASES V1**	**DIGITAL ASSISTANT**	**RESULTS**
State-of-the-Art & Use cases workshop	Use cases definition	Public demonstration	Validation & Way forward

Expected support

- STATE OF THE ART + ROADMAP
- USE CASES: Are the use cases relevant and realistic for the involved stakeholders?
  - They are aligned with expectations on future aviation scenarios
  - They are feasible in the 2035+ timeframe
  - They add value for the different stakeholders
- HUMAN-MACHINE PARTNERSHIP FRAMEWORK & ENVELOPE
- RESULTS: Participate to the final demonstration and provide feedback

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Thank you very much for your attention

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