Architecture issues and challenges for the integration of RPAS in non-segregated airspace

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Outline

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Introduction

- Rapid evolution of unmanned aircraft allows the growth of an important economical sector.
- Currently case per case is studied to grant licenses to operate UAS in civil mission.

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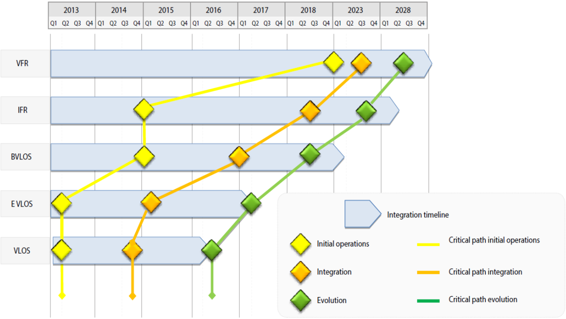
UAS Roadmap

- An important effort is been done from SESAR/NextGen initiatives.
- Progressive UAS integration in Europe.



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[1] Roadmap for the integration of RPAS into the European Aviation System

UAS integration in non-segregated airspace

Current airspace safety level should be maintained.

Seamless UAS integration for the current airspace users.

Keys for efficient integration.

1. The definition of a regulatory framework as light as possible.
2. The regulatory framework should cover all the UAS sizes and types.
3. The definition of a software framework for UAS development.

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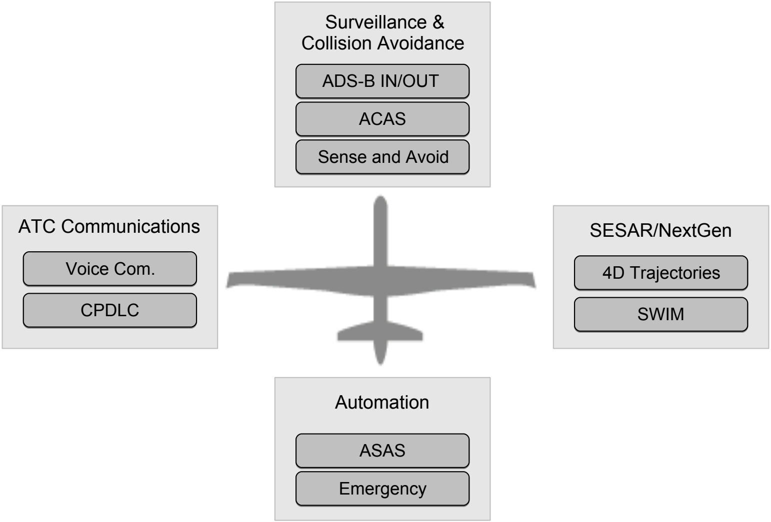
Approach of the systems for UAS ATM integration



Surveillance and collision avoidance constraints

The pilot is responsible for keeping the appropriate separation with other aircraft to avoid possible collision risk.

UAS could fly across several airspace classes in which the traffic could be managed by ATC.

UAS have to deal with both cooperative traffic and non-cooperative traffic.

Sense and Avoid

In general, UAS operator does not have the capacity to see the environment around the vehicle.

Sense and Avoid systems should detect:

1. Air traffic.
2. Terrain elevation.
3. Weather conditions.
4. Other obstacles.

Sense and Avoid systems should provide:

1. Self-separation.
2. Collision avoidance.

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Conventional surveillance

Is necessary to provide the same data to ATC as is provided in manned aviation.

Software architectures should support the integration of Mode S and Mode A/C transponders into UAS.

The integration of airborne collision avoidance system (ACAS) based in Mode S and Mode A/C transponders to reduce collision risk.

ADS-B in/out

Mode A/C sensors phased out due to RF inefficiencies.

ADS-B is an integral component of the SESAR/NextGen airspace strategy for upgrading aviation infrastructure.

Two different modes should be supported:

1. ADS-B out: Currently implemented in manned aviation.
2. ADS-B in: SESAR long term objective for airborne self separation..

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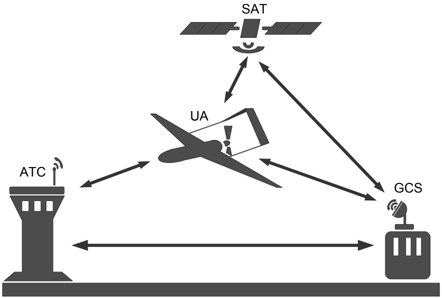
Voice communications

- UAS operator have to be in contact with ATC during the mission.
- Short range missions: Direct communication between ATC-Operator.
- Long range missions: UA as a relay of communications.



Digital communications

ATC-Pilot voice communication is not efficient enough.

New digital communications link has been developed called controller-pilot datalink communications (CPDLC)

Complements voice communication between pilots and ATCo.

Allowing the automation of some routine tasks.

Is currently being deployed and will become the main communication link.

SESAR/NextGen concepts: 4D Trajectories

Flight plan specification through 4D trajectories to optimize the flight routes and to increase the airspace capacity.

UAS architectures should support:

1. Flight management systems supporting 4D waypoints.
2. Mechanisms to share and synchronise airborne and ground trajectory.
3. Mechanisms to compute an accurate flight prediction.

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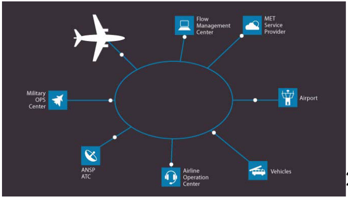
SESAR/NextGen concepts: SWIM

Infrastructure to share ATM data among regulatory authorities, airspace users, airport air navigation services providers, aeronautical industry and society,

The UAS should be able to consume information from network.

The UAS could be an active data generator node of network.



[2]

[2] ATN/IPS WG/4-IP/4 System wide information management (SWIM)

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Automation

Software architectures should support mechanisms to execute some autonomous maneuvers in some cases:

1. Emergency situation due to lost link or system failure.
2. Collision avoidance.
3. Self-separation.

Software standardization

UAS software standardization benefits:

1. Reduce UAS development cost.
2. Enable interoperation among subsystems.
3. Progressive UAS development in parallel to UAS regulatory process.

Two main UAS software standards: STANAG 4586 and Joint architecture for unmanned systems (JAUS).

STANAG 4586

A standard for communication between UAS and GCS

For military vehicles but could be used in UAS for civil applications.

Supports communication relay for subsystems required by current airspace rules.

Defines different levels of interoperability between UAS and GCS

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STANAG 4586

Provide support for:

1. Voice communication with ATC.
2. Relay of NavAid data.

New message should be defined:

1. Support DPDLC messages relay.
2. Support for data relay from UAS surveillance equipment such, ADS-B, to GCS.

Joint architecture for unmanned systems (JAUS)

Set of standards to define:

1. Communication protocols.
2. Internal unmanned vehicle components.
3. Component interaction.

Applicable to any kind of unmanned systems.

Defines low level components.

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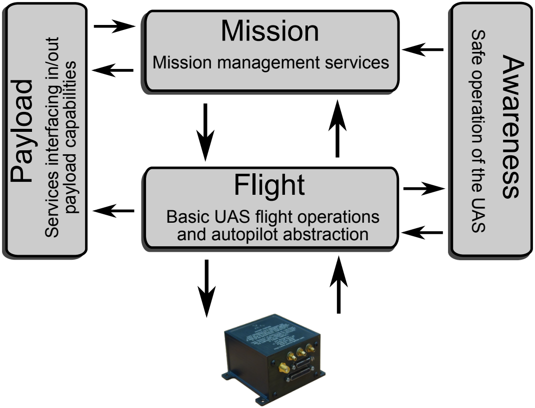
Joint architecture for unmanned systems (JAUS)

Some aspects to take in consideration in JAUS development:

1. Definition of a standard focused on UAS needs.
2. 4D waypoint navigation and trajectory prediction.
3. Components definitions to support systems such as SAA, ADS-B, etc.
4. Components definitions to execute commands autonomously.

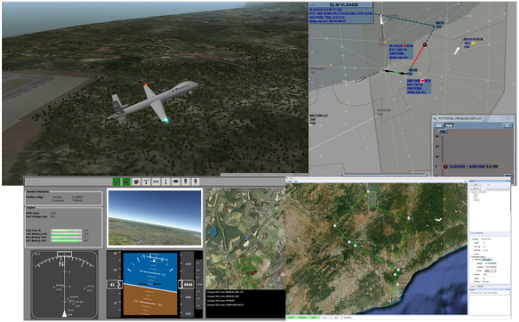
UAS Service Abstraction Layer (USAL)

Service oriented architecture to support the UAS development for different civil missions.



UAS Service Abstraction Layer (USAL)

Simulated and real scenario



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UAS Service Abstraction Layer (USAL)

Some gaps are identified:

1. Strategic reaction of awareness category are defined and implemented, but services for tactical reaction are not defined yet.
2. The USAL was designed for 3D flight plans. Flight Plan Manager System should be upgraded in order to support 4D navigation.
3. Services for data sharing in SWIM network should be defined.

Conclusions

The UAS developers will deal with the design of unmanned platforms taking into account the future regulatory process.

The definition of a software framework could allow an increasing development in vehicle design permitting fast adaptation to the progressively UAS integration.

Different standard has been published in the last years to permit interoperability between UAS subsystems.

These standards are designed to cover current necessities but some development will be required to meet future requirements.

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Thank you for your attention!

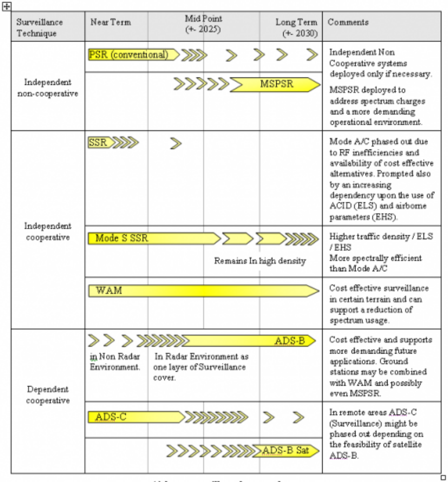
Questions ?

Evolution of the Surveillance Infrastructure
SESAR Project:Surveillance Infrastructure Rationalisation

Surveillance Technique	Near Term	Mid Point (+- 2025)	Long Term (+- 2030)	Comments
Independent non-cooperative	SMR/ASDE			
Independent cooperative	MLAT On main airports	On main and smaller airports		Could be combined with ADS-B receivers.
Dependent cooperative	Initial deployment	ADS-B General deployment		Requires appropriate ADS-B avionics to be deployed. Mandates required ensuring appropriate ADS-B equipage.

Airport Surface Surveillance

Evolution of the Surveillance Infrastructure
SESAR Project:Surveillance Infrastructure Rationalisation



Surveillance Technique	Near Term	Mid Point (+- 2025)	Long Term (+- 2030)	Comments
Independent non-cooperative	PSR (conventional)			Independent Non Cooperative systems deployed only if necessary.
			MSPSR	MSPSR deployed to address spectrum charges and a more demanding operational environment.
Independent cooperative	SSR			Mode A/C phased out due to RF inefficiencies and availability of cost effective alternatives. Prompted also by an increasing dependency upon the use of ACID (ELS) and airborne parameters (EHS).
	Mode S SSR	Remains In high density		Higher traffic density / ELS / EHS More spectrally efficient than Mode A/C
	WAM			Cost effective surveillance in certain terrain and can support a reduction of spectrum usage.
Dependent cooperative	in Non Radar Environment.	In Radar Environment as one layer of Surveillance cover.	ADS-B	Cost effective and supports more demanding future applications. Ground stations may be combined with WAM and possibly even MSPSR.
	ADS-C			In remote areas ADS-C (Surveillance) might be phased out depending on the feasibility of satellite ADS-B.
			ADS-B Sat	

Airborne surveillance by ground

Evolution of the Surveillance Infrastructure SESAR Project:Surveillance Infrastructure Rationalisation

Surveillance Application	Near Term	Mid Point (+- 2025)	Long Term (+- 2030)	comments
ACAS	SSR			Use Mode S and Mode A/C interrogations.
		Hybrid Surveillance New ACAS	Hybrid Surveillance	High reduction of RF contribution. Better knowledge of relative aircraft position.
Aircraft Applications	ATSA-AIRB[1] ATAS-VSA[2] ITP[3]	ADS-B In ATSA-SURF[4] IM[5]	ADS-B In Airborne self separation	Requires ADS-OUT and also ADS-B IN (which may be under voluntary equipage). Future applications may place more demanding requirements on ADS-B.

Air-Air surveillance

1 AIRB: Enhanced Traffic Situational Awareness during Flight Operations
2 VSA: Enhanced Visual Separation on Approach
3 ITP. In-trail-procedure
4 SURF: Enhanced traffic situational awareness on the airport surface
5 IM. Interval Management