



# Mission Systems for UAS:








improved Homeland Security  
by means of Unmanned Systems

**Michele Genisio**  
**Torino, Politecnico**  
**10 November 2011**



# Finmeccanica today & key data



AERONAUTICS	HELICOPTERS	SPACE	DEFENCE & SECURITY ELECTRONICS	DEFENCE SYSTEMS	ENERGY	TRANSPORTATION
						
€ 2,809 mln	€ 3,644 mln	€ 925 mln	€ 7,137 mln (38% of Group Revenues)	€ 1,210 mln	€ 1,413 mln	€ 1,962 mln
<b>Alenia Aeronautica</b> <b>Alenia Aermacchi</b> <b>Super Jet</b> <b>International</b> <b>ATR</b> <b>Eurofighter GmbH</b> <b>GMAS</b>	<b>AgustaWestland</b> <b>BAAC</b>	<b>Telespazio</b> <b>Thales Alenia Space</b>	<b>DRS Technologies</b> <b>SELEX Galileo</b> <b>SELEX Elsag</b> <b>SELEX Sistemi Integrati</b>	<b>Oto Melara</b> <b>WASS</b> <b>MBDA</b>	<b>Ansaldo Energia</b> <b>Ansaldo Fuel Cells</b> <b>Ansaldo Nucleare</b>	<b>AnsaldoBreda</b> <b>Ansaldo STS</b> <b>BredaMenarinibus</b>

 **Owned Companies**  
 **Joint Ventures**

**2010 Revenues: € 18,695 mln**

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**Delivering to our customers total awareness, total protection.  
Help them see, keep them safe.**

SELEX Galileo is committed to developing and sustaining, through continuous innovation, the most accurate and reliable systems to see, hear and understand the situation in which our users are operating and to enable them an effective and timely reaction to keep themselves and those they are protecting out of harm's way.

## SELEX GALILEO KEY DATA 2010

**Workforce 7125**

**Revenues 1,948 M€**

**Order intake 2,268  
M€**

**Backlog 4,255 M€**

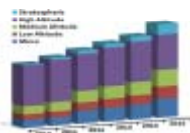
**HELP THEM SEE, KEEP THEM SAFE**



# Market Shares, Strategies, and Forecasts, Worldwide



Homeland security unmanned aircraft systems (UAS) markets grow as the governments worldwide realize these affordable airplanes can provide less expensive solution for dual-use: on the one hand they can provide control and defense of a nation's borders and deterrent to intruders; on the other hand they can be valuable for civilian applications in context of surveillance and monitoring of the environment



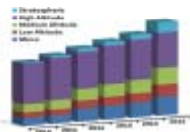
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# Market Shares, Strategies, and Forecasts, Worldwide

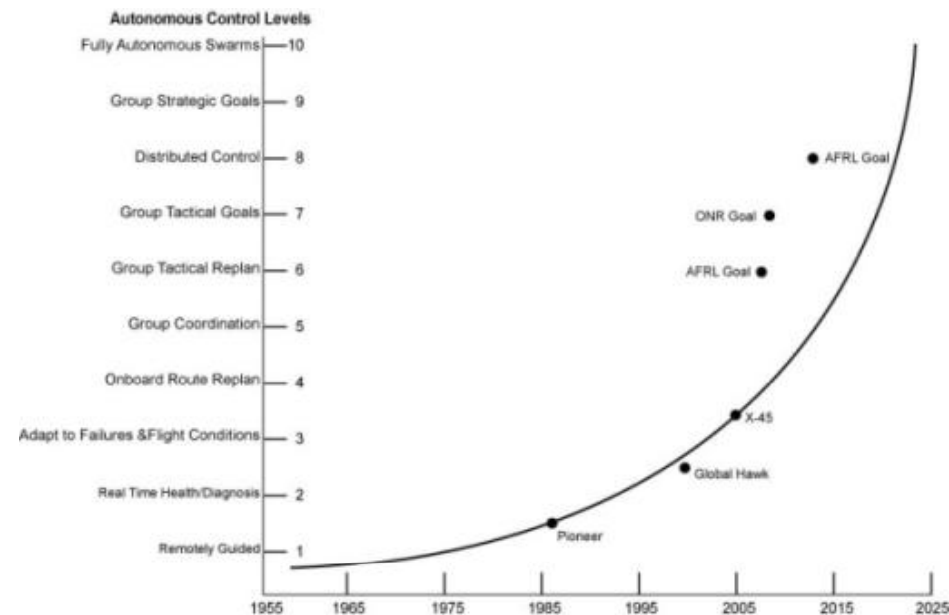


Key factors for the market of unmanned aircraft systems (UAS) are:

- Low cost
- Increased autonomy
- Ability to perform high-speed and long-endurance
- Ability to perform multi-mission ISR (intelligence, surveillance, and reconnaissance)
- Compact sensor packages
- Achieve better maneuverability
- Sense and avoid capability
- Insertion in the civil airspace



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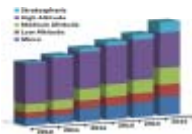
Autonomous Control Level Trend.jpg

# Market Shares, Strategies, and Forecasts, Worldwide

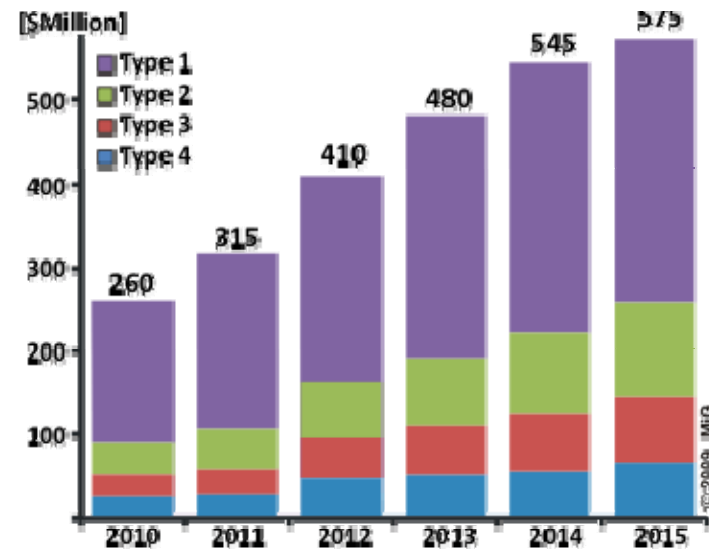


According to WinterGreen Research, “growth is spurred by increasing interest from homeland security planning departments. The governments worldwide are moving toward embracing UAS because of the increased intelligence capability and deterrent efficiency combined. The versatility of single aircraft, and the ability to use multiple inexpensive aircraft for different purposes is a formidable and compelling market driver.” (see Ref.1)

The global market for UAVs is evolving rapidly, creating a new set of business opportunities. These new markets are not always in the “traditional” sectors, both geographically and in terms of platforms or payloads. (see Ref.2)



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Global UAV for Border Protection  
Market Forecast by [\$Million] – 2010 – 2015

# UAS in EC Collaborative Research Projects



Relevant **EC funds** are towards Collaborative Projects for **multiple applications** of UAS integrated with conventional aviation, land and satellite observation systems

## Civil /Commercial Applications

Border management

Maritime patrol

Critical infrastructure protection

Fisheries and agricultural management

Pipeline / Powerline monitoring

Hydrogeological risks

Transportation security

Search and Rescue

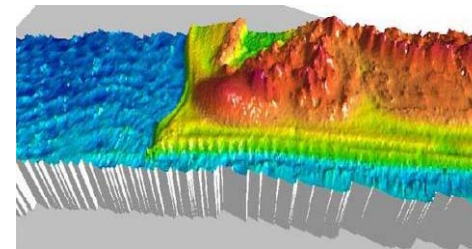
Earth observation

Crisis management

Forest fire monitoring

Private infrastructure surveillance/ security

Temporary telecommunications services





- BSUAV - Border Surveillance by UAV is funded by the PASR (Preparatory Action for Security Research) prior to 7th Frame Work Program of the European Union.
- BSUAV purpose is to present a complete analysis of the potential contribution of the UAV's (Unmanned Aerial Vehicles) to peacetime security on European borders, both green and blue.
- The project has been carried out by companies, universities and laboratories from many countries (Belgium, Italy, Netherlands, Slovenia, Spain, Sweden and United Kingdom), being led by France.





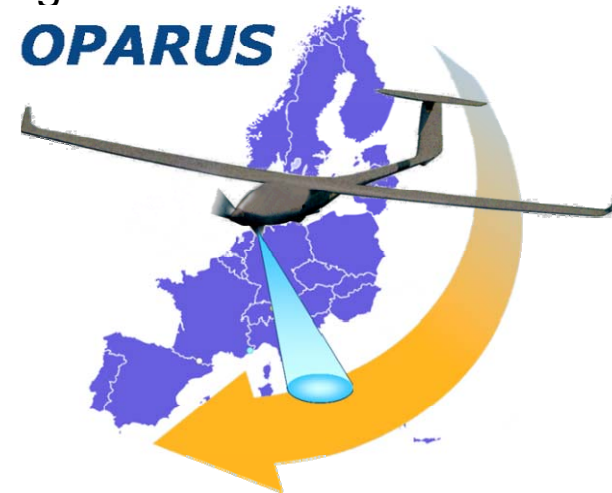
- Wide Maritime Area Airborne Surveillance (WiMAAS) is a capability project addressing the European Commission FP7 Security Research Call 1 topic “Surveillance in wide maritime areas through active and passive means”.
- WiMAAS is providing a key airborne building block (including UAVs) of a civil maritime surveillance System of Systems to be defined in Europe.
- Develop an original and innovative technological solution to increase airborne maritime surveillance efficiency while reducing costs.
- Fill the gap between Piloted Mission Aircraft and UAVs for maritime surveillance, and preparing concepts for using UAVs with remote control mission system operation and combining these with existing maritime surveillance systems.



## EC projects: OPARUS - Open Architecture for UAV-Based Surveillance System



- OPARUS - Open Architecture for UAV-Based Surveillance System is a Coordination Action (CA) financed by the EC, DG- ENTREPRISE under the FP7-SEC-2008-1 call.
- The overall objective of OPARUS project is to identify ways to develop an open architecture for the operation of unmanned air-to-ground wide area land and sea border surveillance platforms in the EU

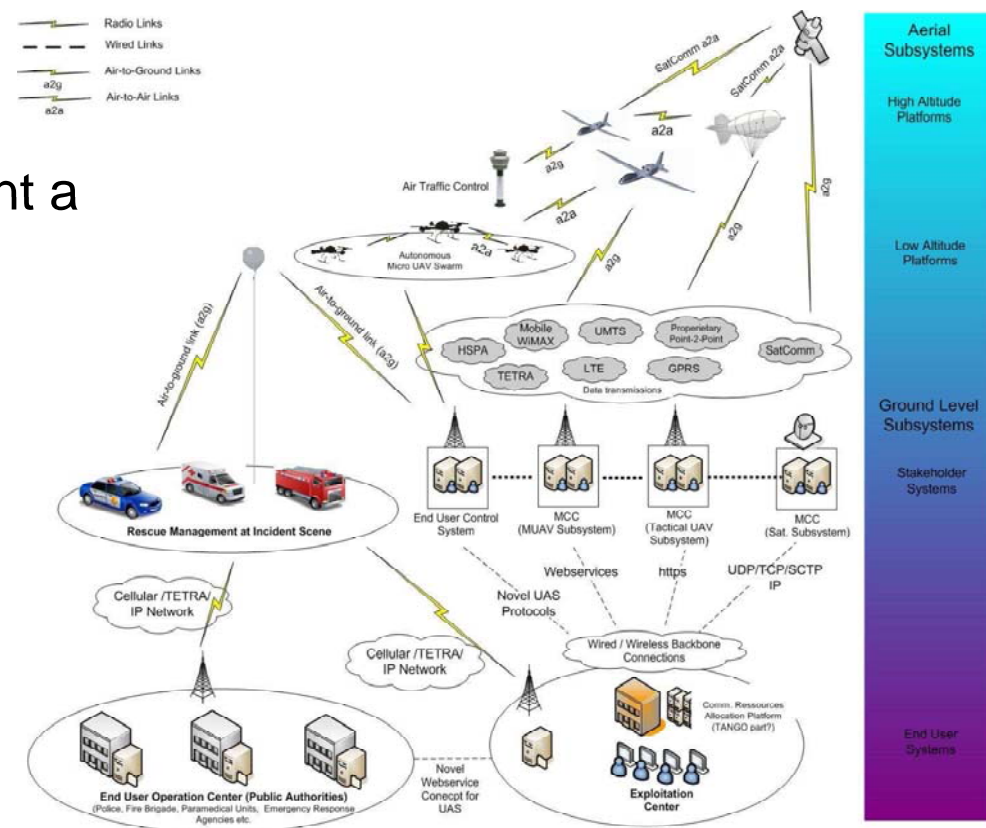


# EC projects: AIRBEAM - AIRBorne information for Emergency situation Awareness and Monitoring



The AIRBEAM project proposes a situation awareness toolbox for the management of crisis over wide area taking benefit of an optimised set of aerial (unmanned) platforms, including satellites.

The number of unmanned air- and space-borne platform available and their associated sensors present a new set of challenges to end users involved in the effective management of emergencies and actions of law enforcement.



# SMAT F1- Sistema di Monitoraggio Avanzato del Territorio



SMAT F1 (Sistema di Monitoraggio Avanzato del Territorio) is the 1<sup>st</sup> phase of the wider SMAT research project, which is organised in 4 phases.

SMAT F1 is funded by Regione Piemonte managed by Finpiemonte and promoted through the Comitato Promoter del Distretto Aerospaziale Piemontese.

The Civil Protection Dept. of Regione Piemonte shows its interest and availability to support the SMAT F1 project and identifies, among the many missions that SMAT will be able to perform,

the following three priority areas:

- Hydro-geological Risk
- Wood Fires
- Seismic Risk



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**MIDCAS** is a **strategic project** for allowing UAS flights in civil non segregated airspaces

It is acceptable by the manned aviation community:

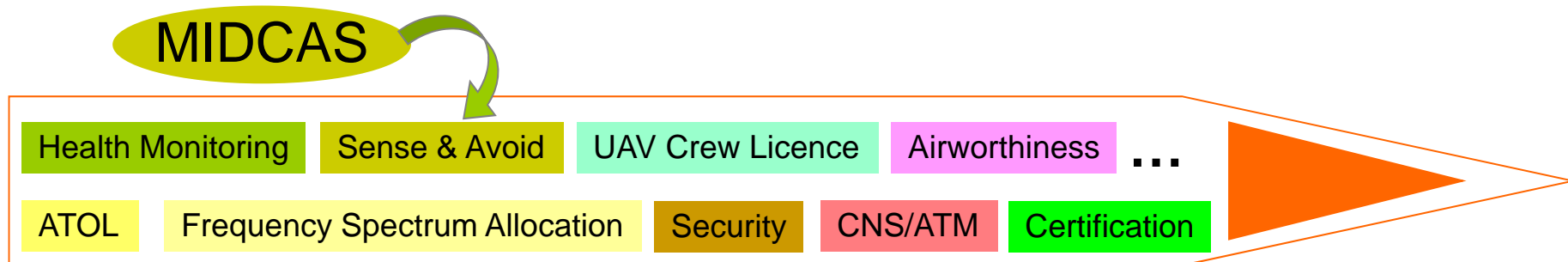
- Supported by a safety approach
- By proposing specifications & procedures



It is compatible with UAS operations in non-segregated airspace by 2015:

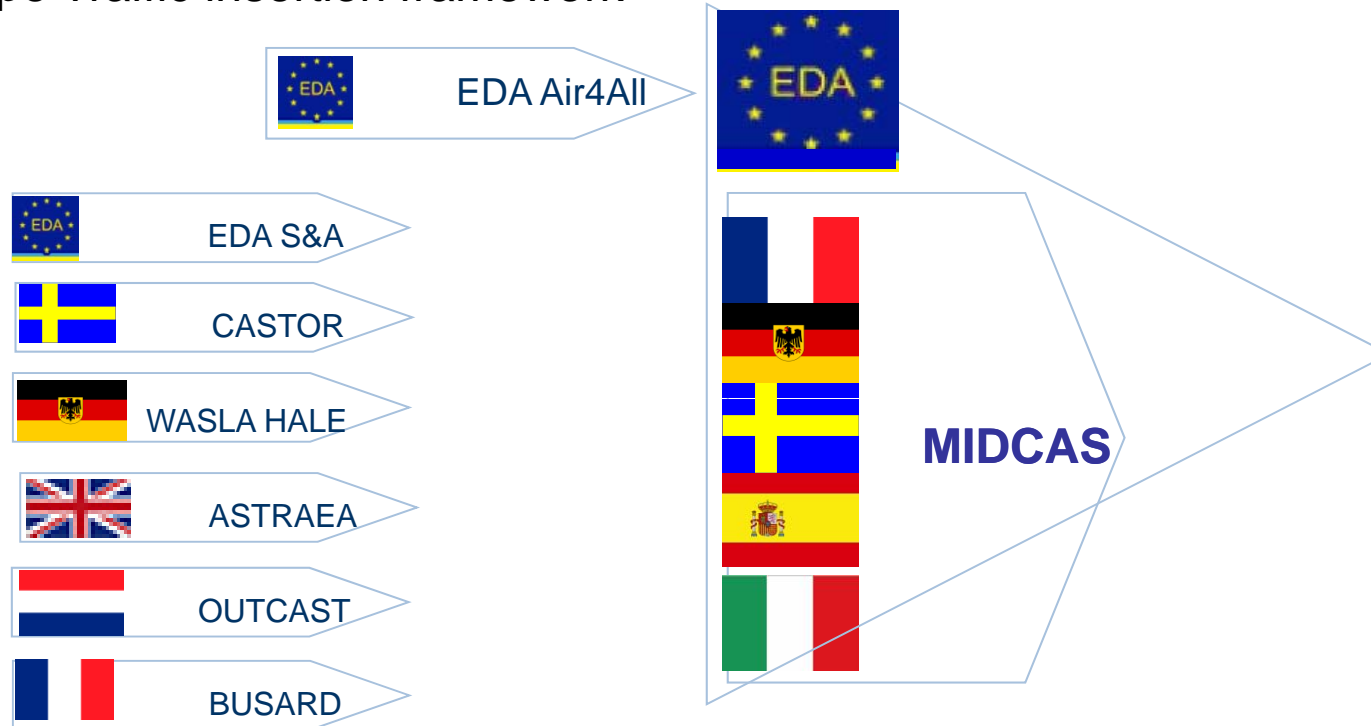
- By supporting standards definition
- Addressing the certification issue throughout the project

**MIDCAS**



« UAV insertion into General Air Traffic » roadmap

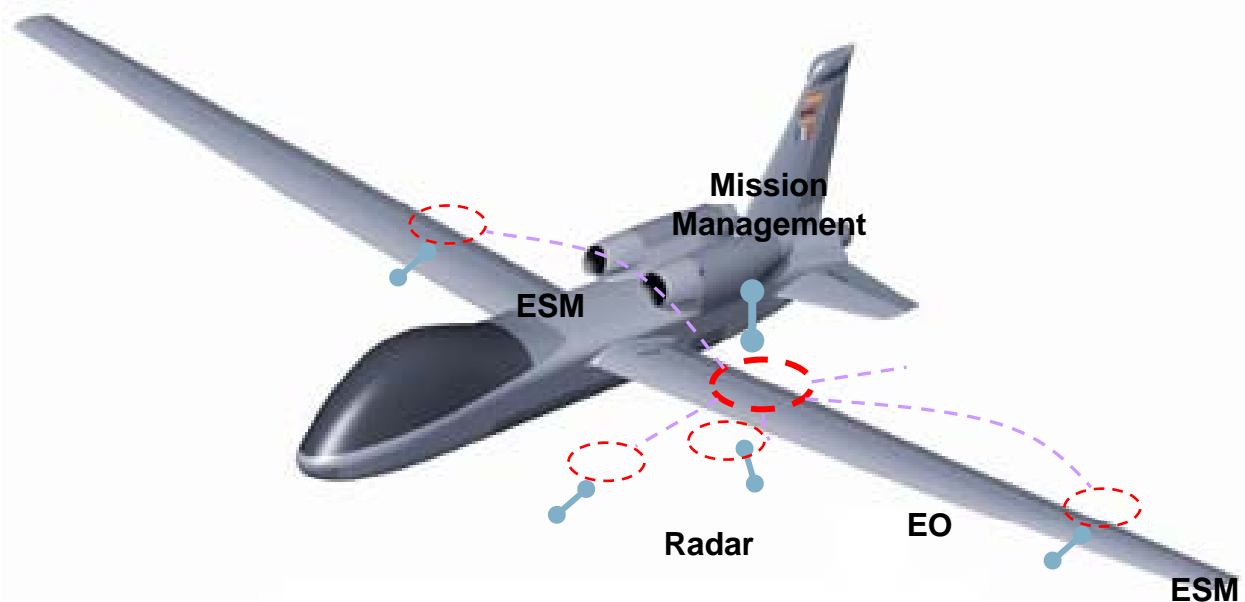
## Europe Traffic insertion framework



# SELEX GALILEO: APPROACH to UAS MISSION SYSTEMS



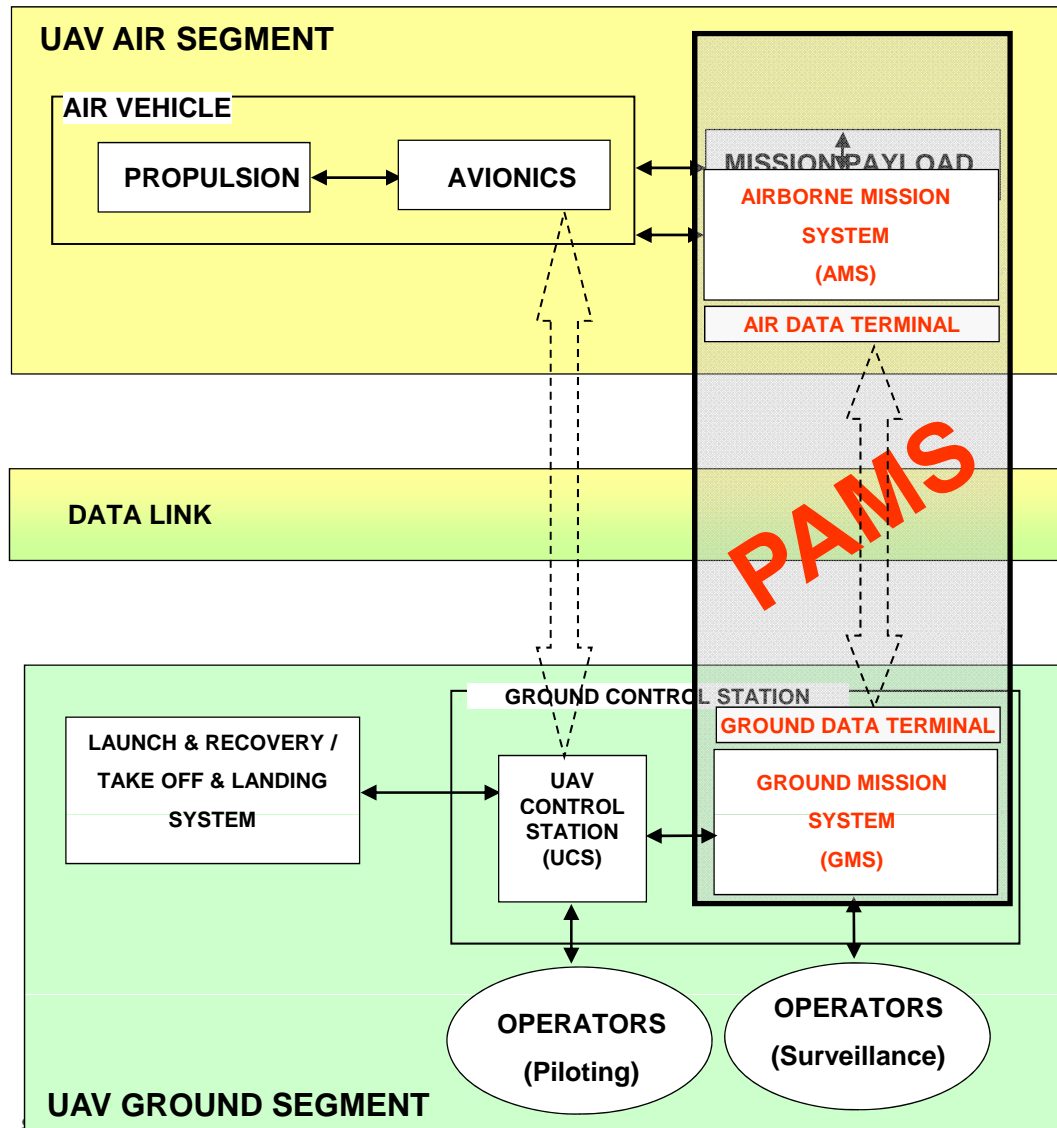
- Develop sky unmanned tactical ISTAR (Intelligent, Surveillance, Target Acquisition, Reconnaissance) architecture
- Leverage internal excellence in avionics and systems integration
- Develop Platform Agnostic Mission System (PAMS)





- Full ISTAR solution typically designed for MALE UAVs
- Multi-Platform/Sensor solution assuring PERSISTENT surveillance capability
- Platform Agnostic solution independent of AIRFRAME and PAYLOAD
- Full interoperable solution in support of NATO missions interfaced with C4I systems (fully compliant to applicable STANAG)

# Platform Agnostic Mission System (PAMS) – System Overview



Generic UAV System Elements  
(Described in STANAG 4586)

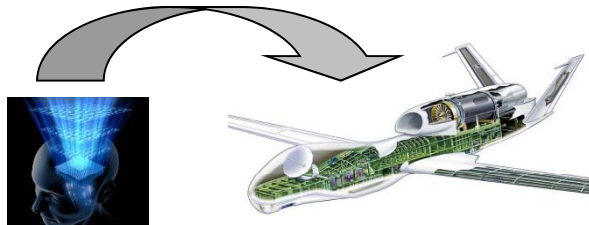
## PAMS main functionalities:

- On-board computing and sensor processing capabilities
- Ground Operator sensor control terminals and computational station for sensor data processing and fusion
- Data Exploitation and Mission Sensors Management typically interfaced for:
  - SAR/GMTI
  - EO/IR with multispectral capabilities
  - BIL
  - ESM

# Platform Agnostic Mission System (PAMS) – Innovative Key Features



## AN INNOVATIVE **ISTAR** APPROACH



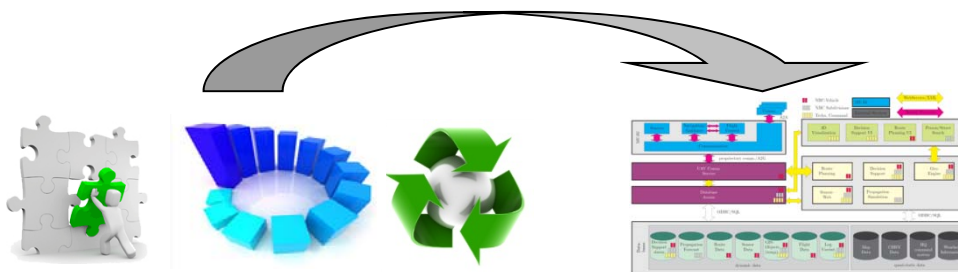
Moving toward **Autonomy & Intelligence** on board

It means:

- Ground operator workload shifted from “threats detection” to “**threats analysis**”.
- Data Link **throughput optimized**

*New concept of transforming the on board “acquired data” into “information” useful to maximize mission effectiveness*

## A **FLEXIBLE** SYSTEM ARCHITECTURE



Moving toward **SOA** (Services Oriented Architecture)

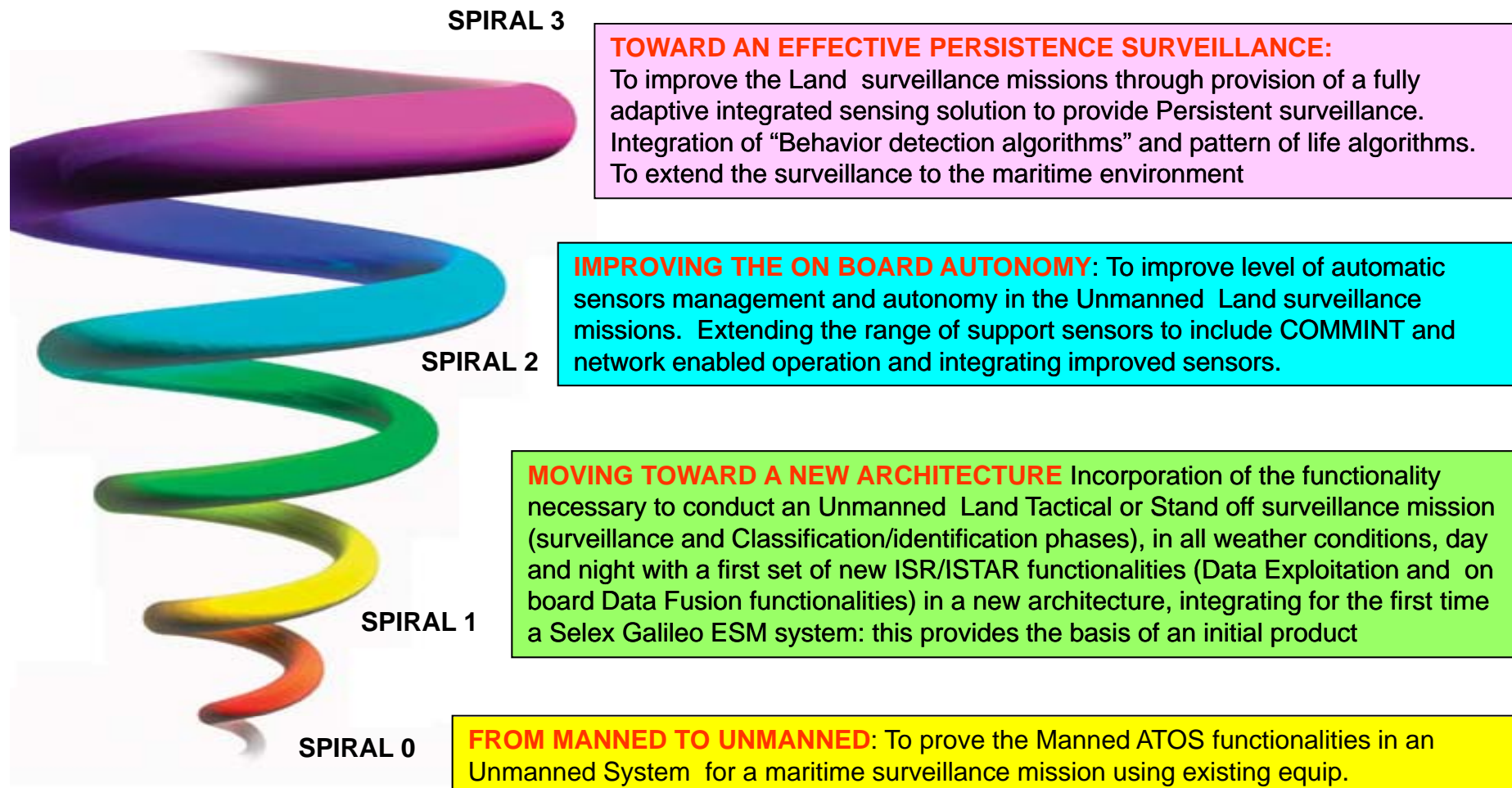
It means:

- **Interoperability** → easy to **transport**
- **Scalability** → easy to **upgrade**
- **Reusability** → easy to **customize**

# Platform Agnostic Mission System (PAMS) - Development Principles



The system development will be managed in a spiral approach, 4 spirals are now envisaged.



# Platform Agnostic Mission System (PAMS) — SPIRAL 1

## Mission Manager System (MMS) : Product Tree



### The Mission Manager System (MMS) is the CORE System of PAMS

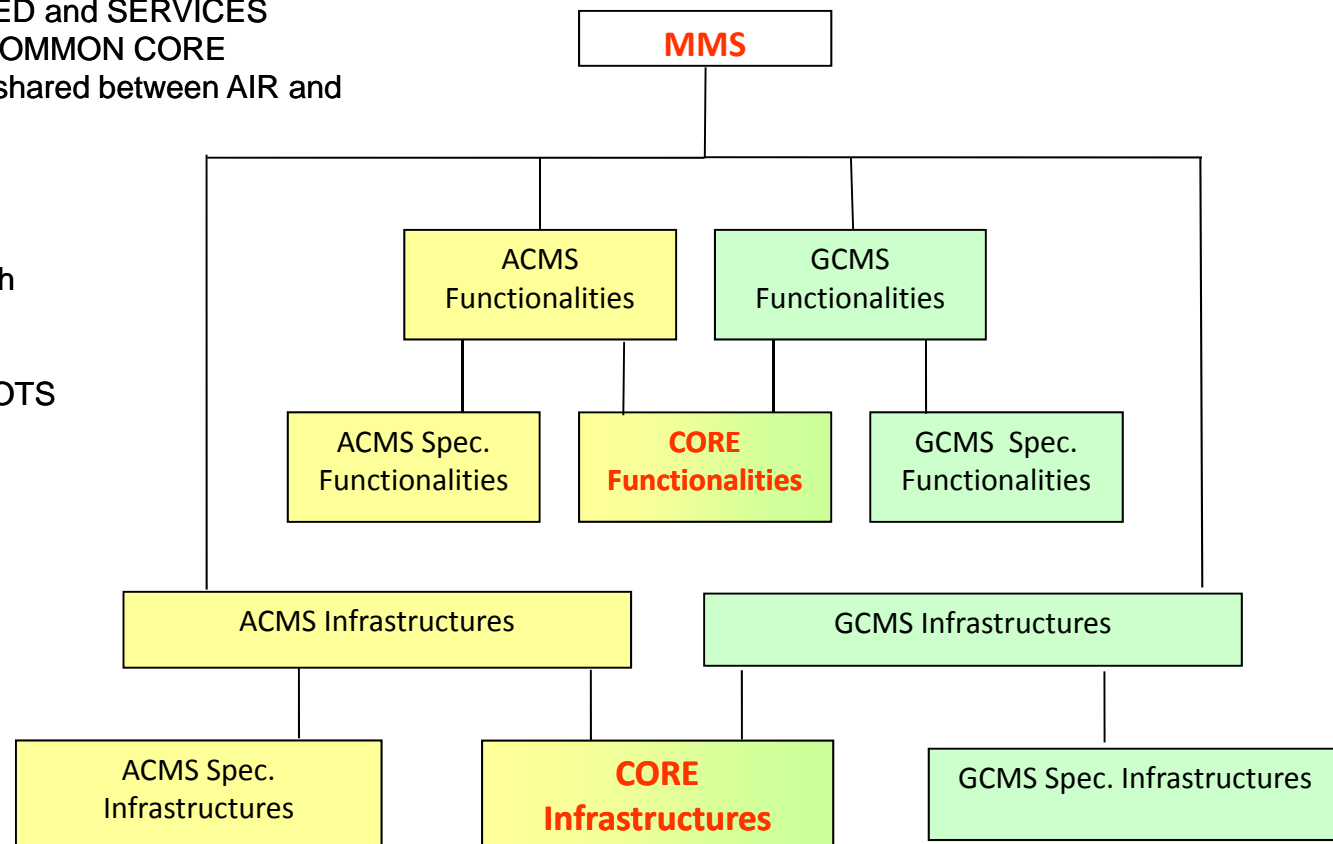
The software design, DISTRIBUTED and SERVICES ORIENTED, is characterized by COMMON CORE functionalities and infrastructures shared between AIR and GROUND segment.

#### Architectural Drivers :

- Network Centric Approach
- Modularity
- Reusability
- Use and Integration of COTS items

#### Technological Drivers :

- Interoperability
- Scalability
- Hard to Die and Resilience
- Graceful Degradation
- Re-Use of Legacy Capabilities
- Platform and Language Independence



## On Board Autonomy & Intelligence



Overcome the throughput constraints transforming the on board “acquired data” into “information” useful to maximize mission effectiveness and to shift the analysts workload from “threats detection” to “threats analysis”, thus reducing the required bandwidth of the communication link

## Platform Airframe and Payload Agnostic



- HW/SW technology independent
- Modular
- Scalable
- Reusable

## Full System Interoperability



### Net-Centric System driven by STANAG:

- 4586 Interface of the Unmanned Control System
- 7023 Air Reconnaissance Primary Imagery Data Standard
- 4607 NATO Ground Moving Target Indicator Format (GMTIF)
- 4609 NATO Digital Motion Imagery Format
- 7085 Interoperable Data Links for Imaging Systems
- 2525 Symbolology
- 3809 Digital Terrain Elevation Data (DTED) Exchange Format
- 7074 Digital Geographic Information Exchange Standard (DIGEST)

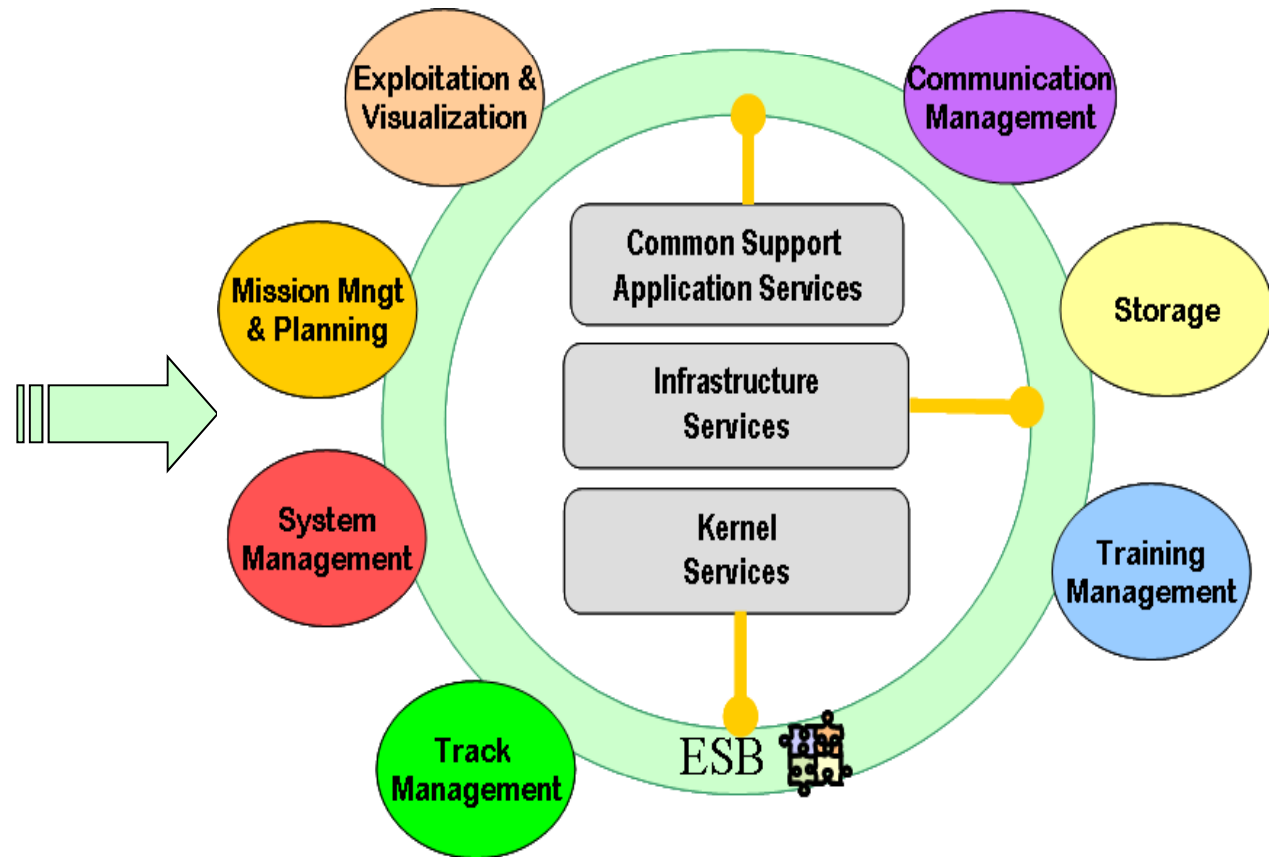
# SW Architecture : Main Concepts



Software will be a complete and modular distributed set of applications that will be designed according to a Service Oriented Architecture (SOA) approach

**Functional  
Requirements  
Analysis**

**Architecture &  
Technological  
Requirements**





# SELEX GALILEO UAS: FALCO



FALCO is tactical MALE UAS completely developed by Selex Galileo and at present in operations with 3 International Client



# UAS FALCO – OVERVIEW



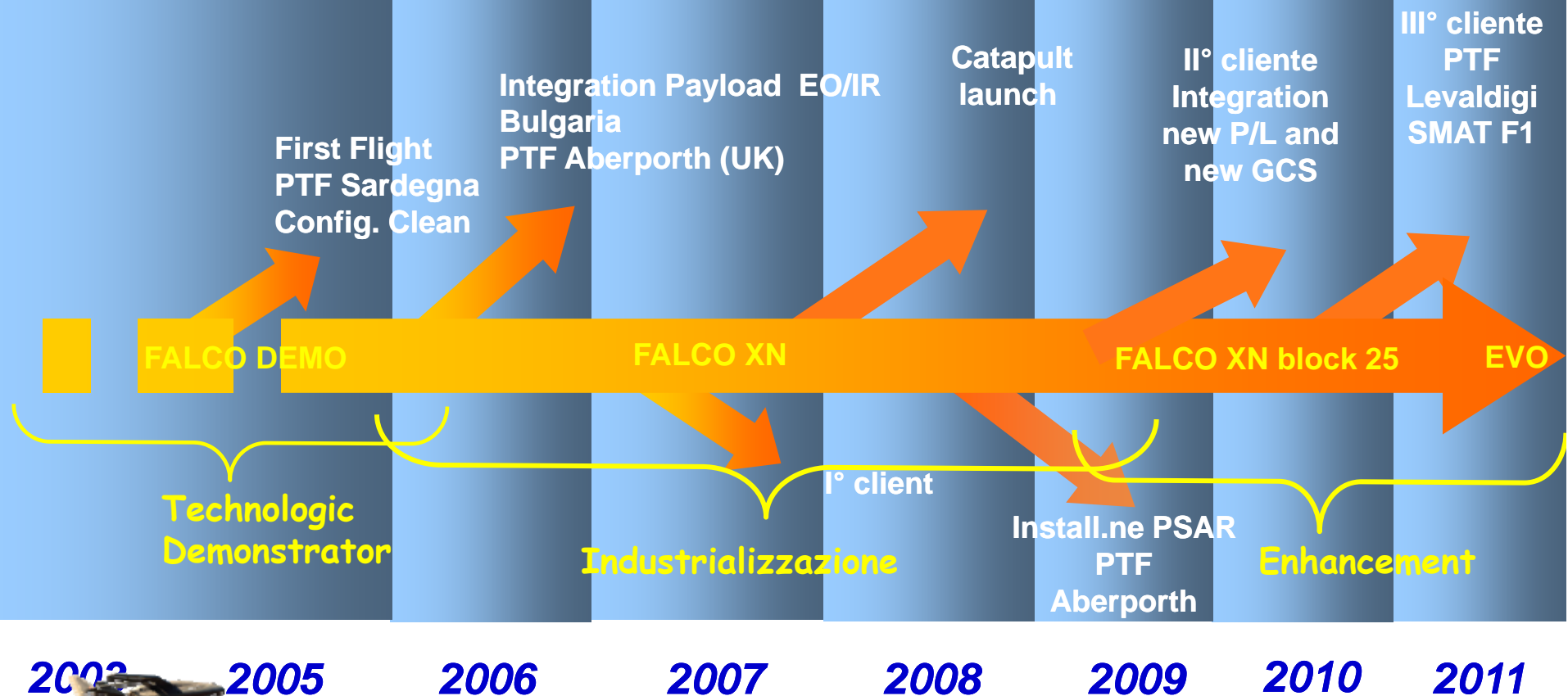
- ❑ **2005: first flight with the technological demonstrator, with PtF ENAC**
- ❑ **2007: in service. At present operative with 3 international clients**
- ❑ **Tested in different operative contexts with different climate conditions: in Bulgaria, Finland, north Africa**
- ❑ **Over 40 machines + 5 pre-serie (version XN)**
- ❑ **Missions up to 14 h distance from GCS > 200 Km**
- ❑ **from ENAC 4 PtF for R&D: Sardegna (2005), Park Aberporth (UK) (2006 / 2009) / Cuneo Levaldigi (2011)**



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# UAS FALCO – Development baseline



# UAS FALCO – Capabilities



- ☐ completely autonomous operations even from partially prepared airfield
- ☐ conventional take-off or from pneumatic catapult
- ☐ conventional landing, emergency parachute
- ☐ GPS navigation with inertial sensor and air data integrated for each Flight

## Control Computer

- ☐ Communication with ATC (radio, transponder)
- ☐ Mission planning with digital cartography
- ☐ Real-time download of sensor data
- ☐ Mission simulator



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Pilot and Payload console



Electrical RAC unit



# UAS FALCO – System Architecture



**Ground Data  
Terminal (GDT)**



**Velivolo**



**Datalink**



**Ground Control  
Station (GCS)**

**Payload  
PicoSAR**



**Payload EO/IR**



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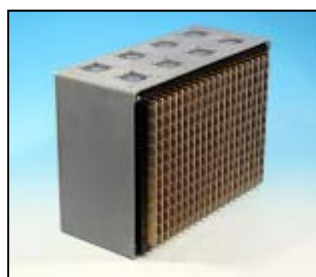




# UAS FALCO Mission System: Payload



- ❑ Falco can integrate multi payload
- ❑ Basic multi payload is: EO/IR + PicoSAR
- ❑ “plug and play” installation of 3 different sensors EO/IR (9”-16” and 16-40 Kg)



**PICOSAR**



**IPERSPETTRALE**



**EO/IR**



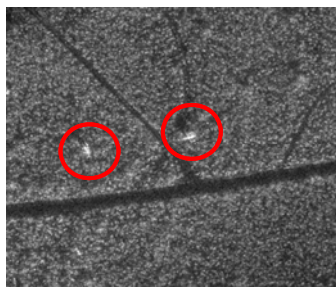
Color Video Camera



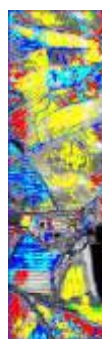
IR Camera



Spotter camera



Calcite  
Clorite  
Illite-Smectite  
Illite  
Smectite



Recent  
Eternit  
Altered  
Eternit



# Multispectral application



**Falco can offer multi sensor observation capability  
basic configuration: EO/IR + Pico SAR**



**PicoSAR**



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**EO/IR  
Stabilized Turret**

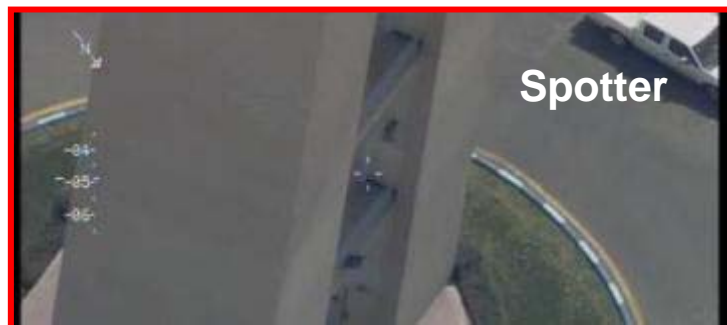




# FALCO Mission system: EO/IR payload



**EO/IR Switching and Zooming Capability:** UAV at 17,000 ft and 3.5 NM slant range



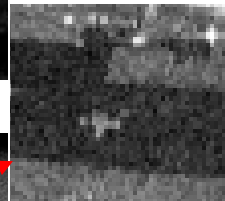
# FALCO Mission system: picoSAR payload



Medium  
resolution  
at 7 km  
range



High  
resolution  
at 7 km  
range



Low  
resolution  
at 20 km  
range



Overlay on  
optical imagery  
using NITF 2.1  
image format



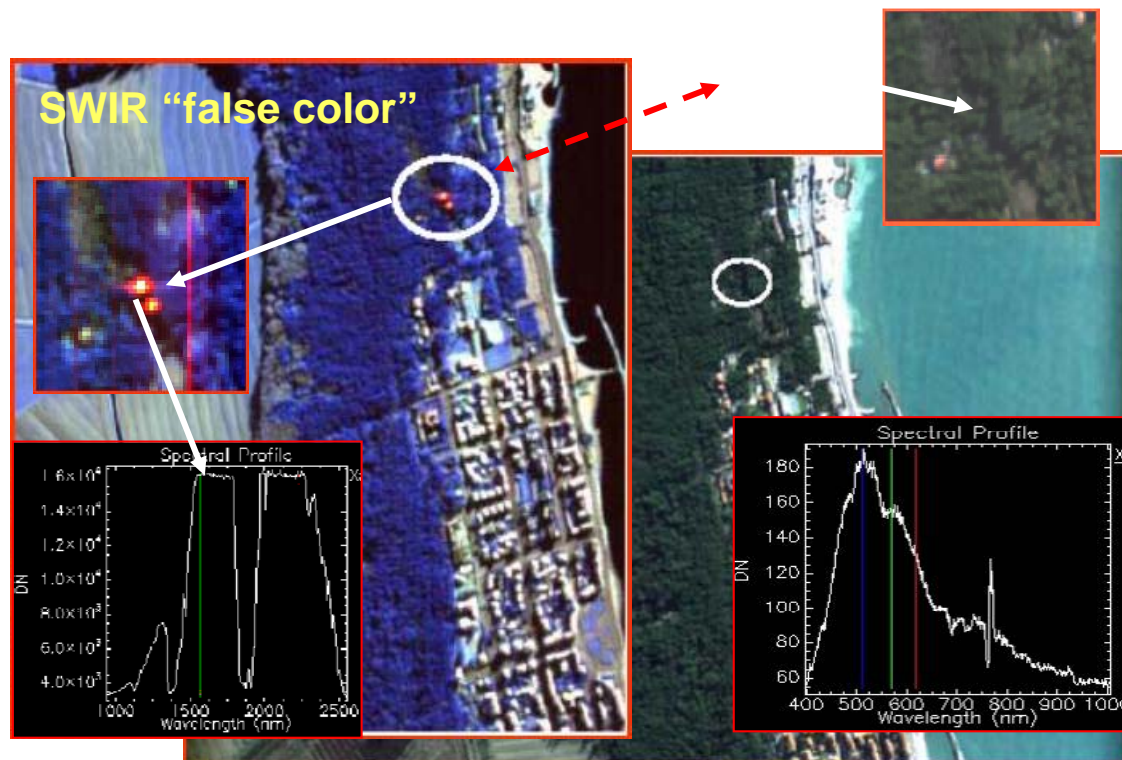
# FALCO Mission system: Hyperspectral payload

## Fires detection



Hot spots can be detected in low visibility conditions (smoke and vegetation)

### Marina di Pisa (Tuscany)



**Thermal Anomalies** can be detected in SWIR channels also under vegetation

**Hot-Spots** can be detected in visible channels without false alarms thanks to the Potassium (K) emission ( $\approx 760$  nm) where the “flaming” phase occur.



**K-emission** permits to discriminate between “flaming” and “smoldering” areas.



# FALCO Mission system: Hyperspectral payload

## Burned areas

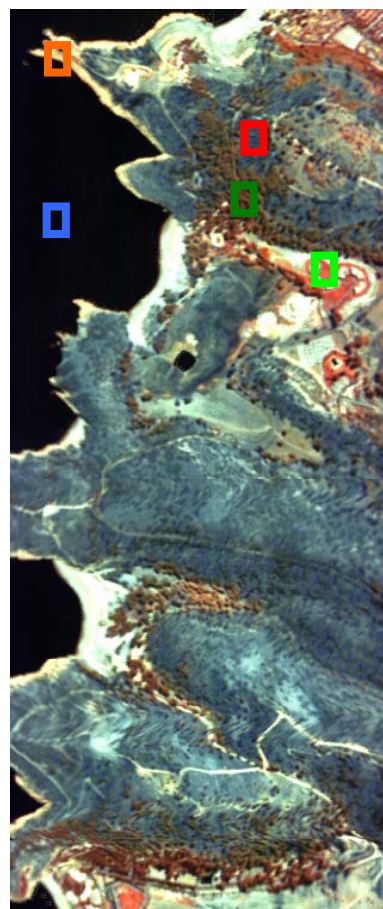


### SIM.GA - Telaer Campaign on Burned Areas - 2007

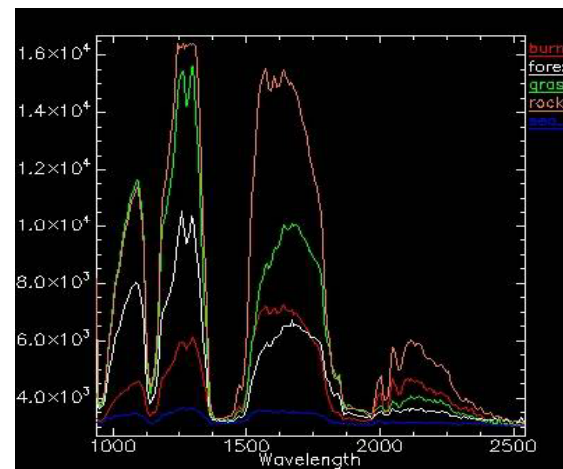
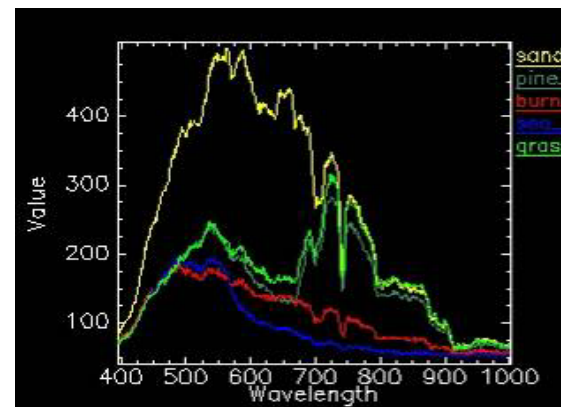


**VNIR\_rgb**

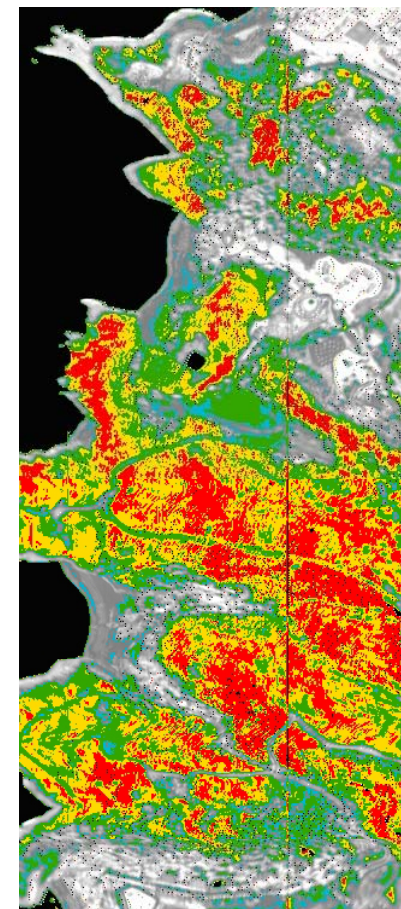
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**SWIR\_rgb**



**Spectral Signature (DN values)**



**Burned Index**

# FALCO Mission system: Hyperspectral payload

## Fires detection



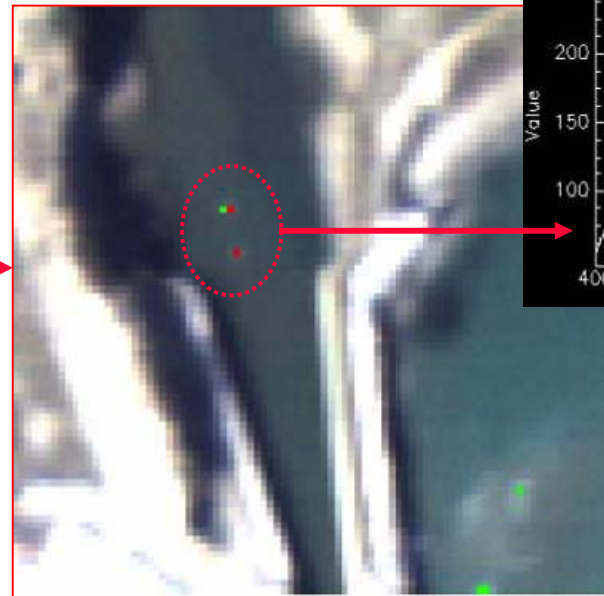
## Detection & identification of submerged targets

SIMGA Acquisition: Tuscany

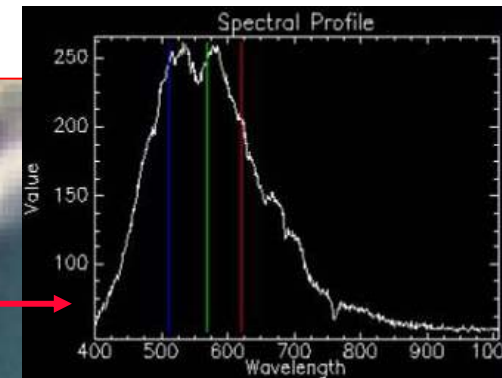
**True Color VNIR image**  
(From aircraft height of 3000m)



**Submerged Targets:**  
grey painted panels  
2x2m at 1.5m of depth



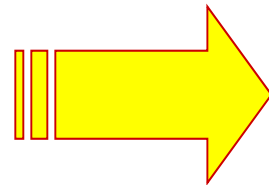
**Target identification Map**



**Target Spectrum**

# FALCO Mission system: Hyperspectral payload

## Coast Erosion, Bathymetry



Equalization



- Arno River estuary

- Coastal Erosion
- Underwater dune mapping

- Underwater dune structure may be easily determined
- Darker water means the zone is under erosion



# FALCO Mission system: Hyperspectral payload

## Sea vegetation Identification



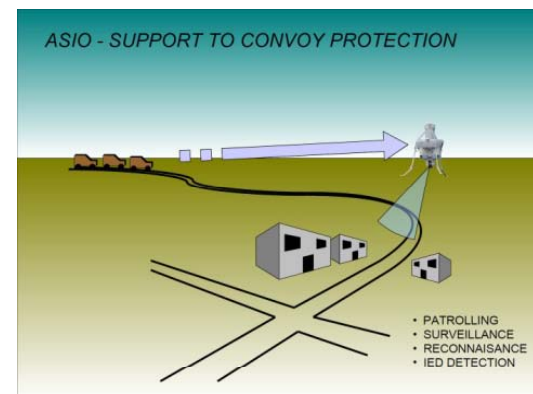
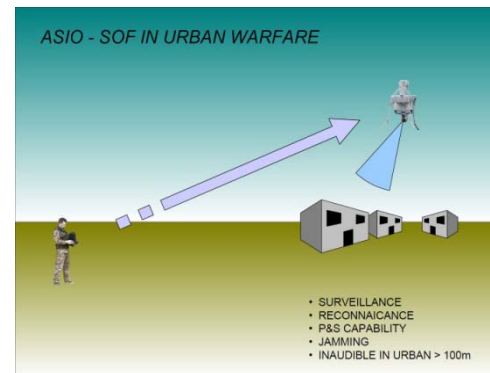
*Posidonia oceanica* meadow - San Vincenzo / Parco di Rimigliano (Tuscany)



**MICRO UAS are transportable systems , of great mobility, easily deployed and controlled:**

- **surveillance**
- **protection of responders**
- **monitoring**

dual-use operations



# Selex Galileo: Micro UAS



**DRAKO**



**SPYBALL**



**CREX-B**



**ASIO**



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**Thank you for your attention!**



# Bibliography



Ref.1	Homeland Security and Commercial Unmanned Aircraft Systems (UAS) Market Shares, Strategies, and Forecasts, Worldwide, 2011 to 2017 - Publisher : WinterGreen Research
Ref.2	"Unmanned Aerial Vehicles (UAVs) for Border Security – Global Market & Technologies Outlook – 2010-2015". Publisher: Market Intel Group LLC.