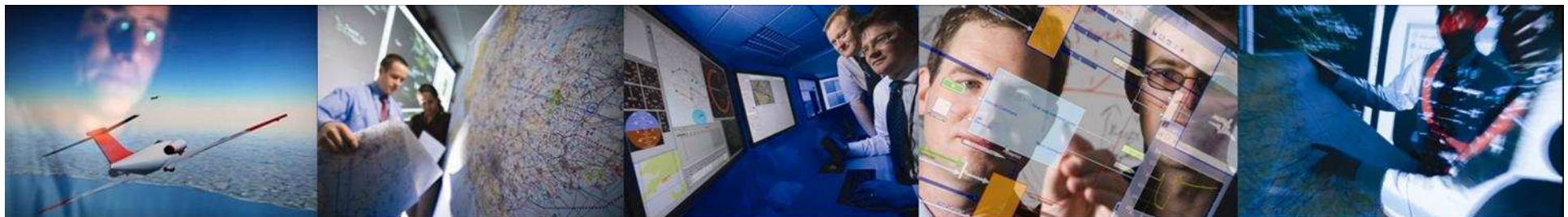




Opening the Airspace for UAS

Lambert Dopping-Hepenstal

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Contents

- **What are the aims of ASTRAEA?**
- **Why is it important?**
- **Who is involved?**
- **What is the challenge?**
- **How are we approaching it?**

Introduction

ASTRAEA is a unique programme which aims to open up a new aerospace market.

The aim is to:

- **Enable the routine use of Unmanned Aircraft Systems (UAS) in all classes of airspace without the need for restrictive or special conditions of operation.**
- **Develop and demonstrate key technologies and operating procedures required to open up the airspace.**
- **Support the development of the regulatory framework for this new class of operation.**

UAS in the UK Aerospace Industry

- The UK has 17% share of the global aerospace market
- The annual value to the UK economy is £22.6 billion with UK companies directly employing 124,000 people across the UK economy
- The Aerospace Industry is technology centric and will be the early adopters of autonomy
- UAS create new market opportunities for the industry and will lead to technology and application spin-offs in other sectors
- Many of these applications in military and civil markets fall into the category of “Dull, Dirty and Dangerous” operations

Civil UAS applications



Homeland Security

Paramilitary

- Drug Traffic Monitoring
- Law Enforcement
- Border & Coastal Patrol

Emergency Services

- Disaster Assessment
- Search & Rescue
- Firefighting



Land Management

Agriculture & Forestry

Environmental Research & Monitoring

- Oil Slicks
- Landslide & Avalanche Prediction
- Earthquakes
- Forest Fires
- Floods
- Nuclear, Biological & Chemical



Earth Sciences

Atmospheric Research

Digital Mapping & Planning

Meteorology

Oceanic Observation

Geological Survey



Commercial & Civil

Powerline / Pipeline Monitoring

Road Traffic Monitoring & Control

Maritime Traffic Control

Autonomous Transport

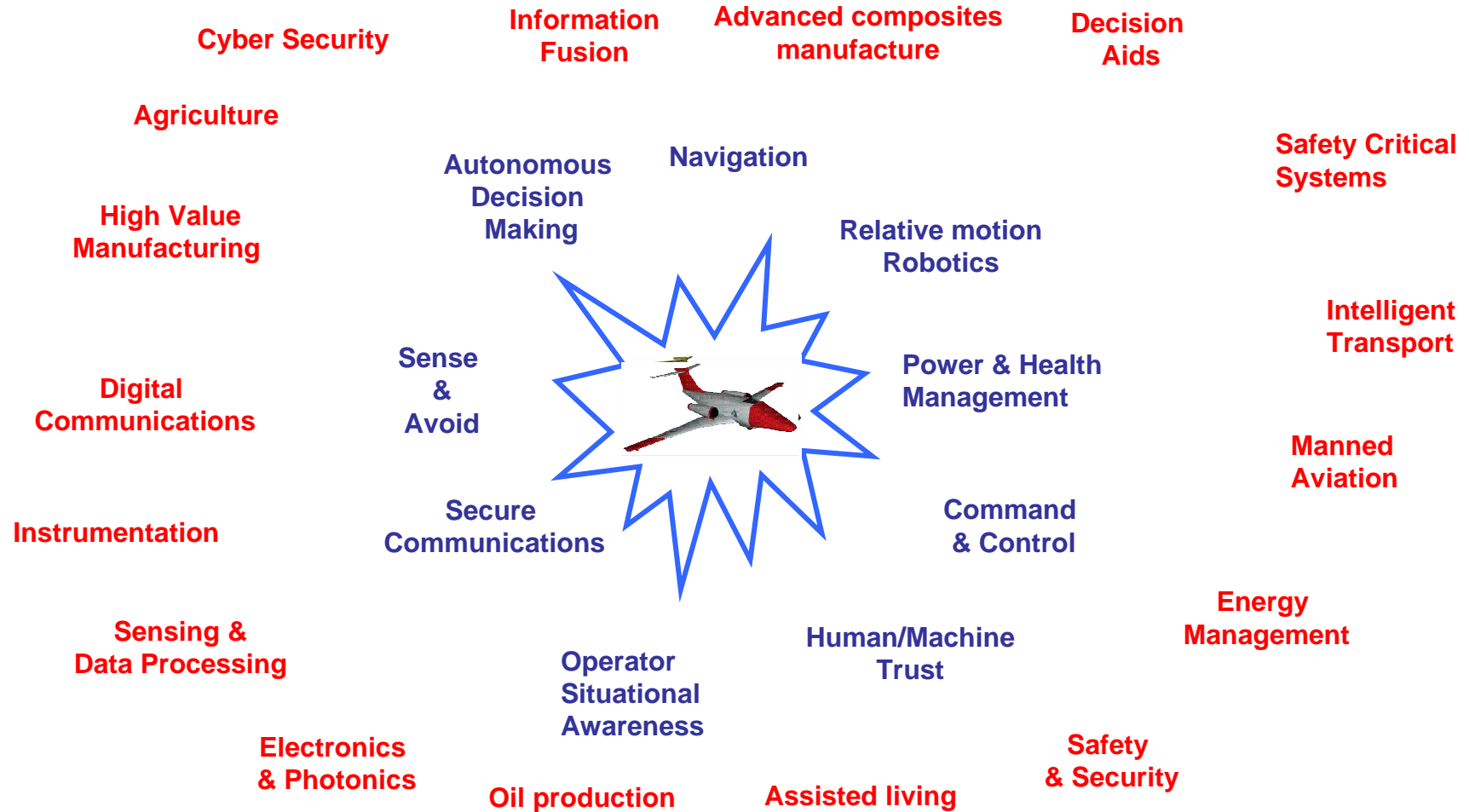
- Freight
- Passenger

Satellite Complement

- Communication Relay
- Broadcast Services

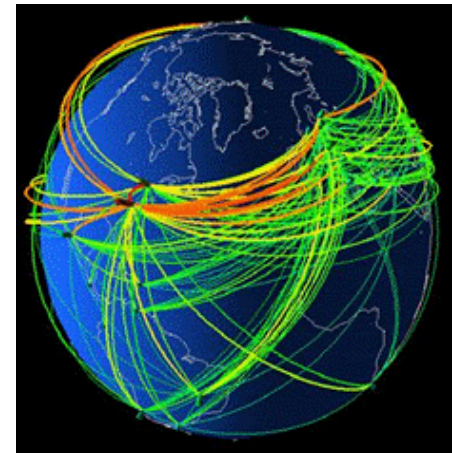


UAS Technology & Application spin-offs



The Airspace Integration Challenge

- Regulations for manned flight have matured over the past 100 years
- Implicit assumption that pilot is on-board
- No agreed interpretation on standards and regulations for unmanned systems
- Regulatory authorities have provided guidance
 - Transparency
 - Equivalence
 - As safe as manned aviation
- Catch 22 situation
 - Regulators require example system to certify
 - Industry require regulations to specify requirements
- Public perception
 - Pilots and airspace users
 - General public

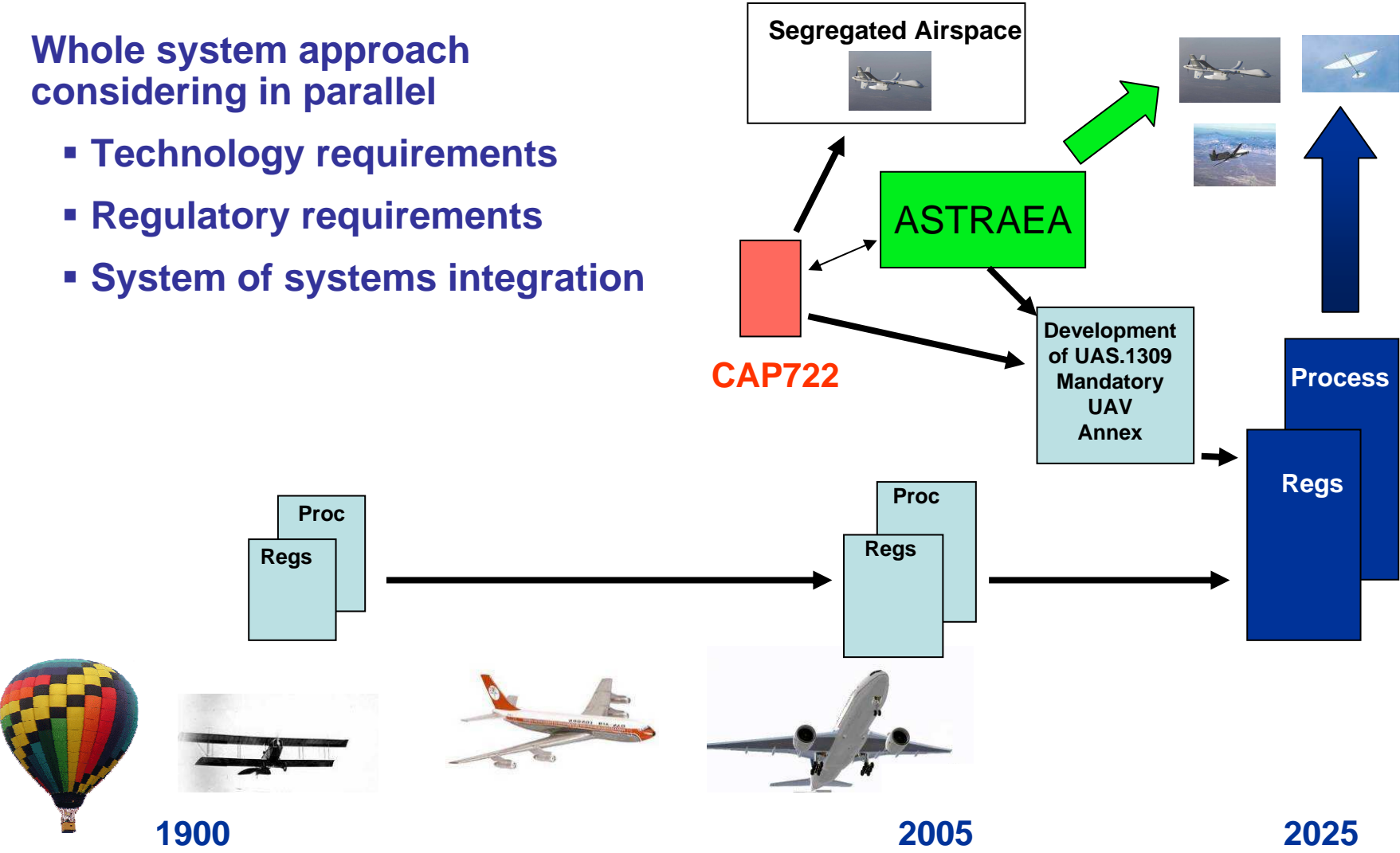


Approach



Whole system approach considering in parallel

- Technology requirements
- Regulatory requirements
- System of systems integration



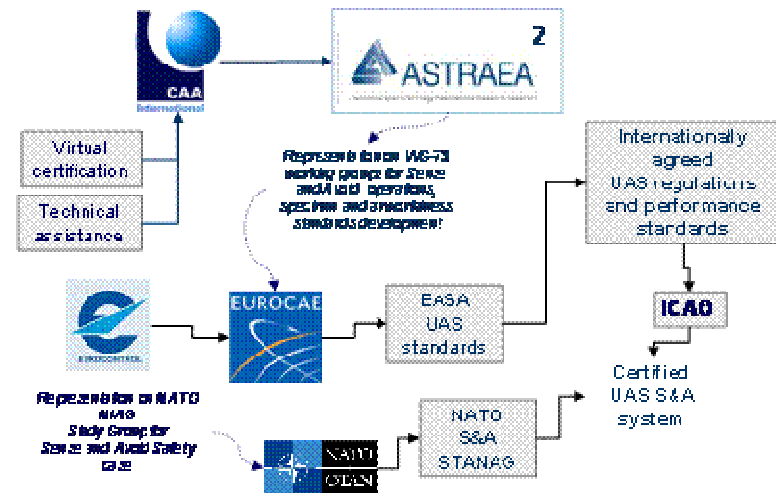
Regulatory Agreement



- Interaction with UK CAA through a “Virtual Certification” and technical assistance process to understand the route to certification and operational integration of UAS in non-segregated airspace.
- To prepare the National (and contribute to the International) Regulatory framework to enable routine UAS flight outside Segregated Airspace.

- The key areas of activity are:
 - Sense and Avoid
 - Autonomy
 - Airspace Integration
 - Airworthiness
 - Spectrum and Command and Control
 - Human Factors
 - Security

ASTRAEA 2 – the route to UK, European and International certification



Partners and Associates

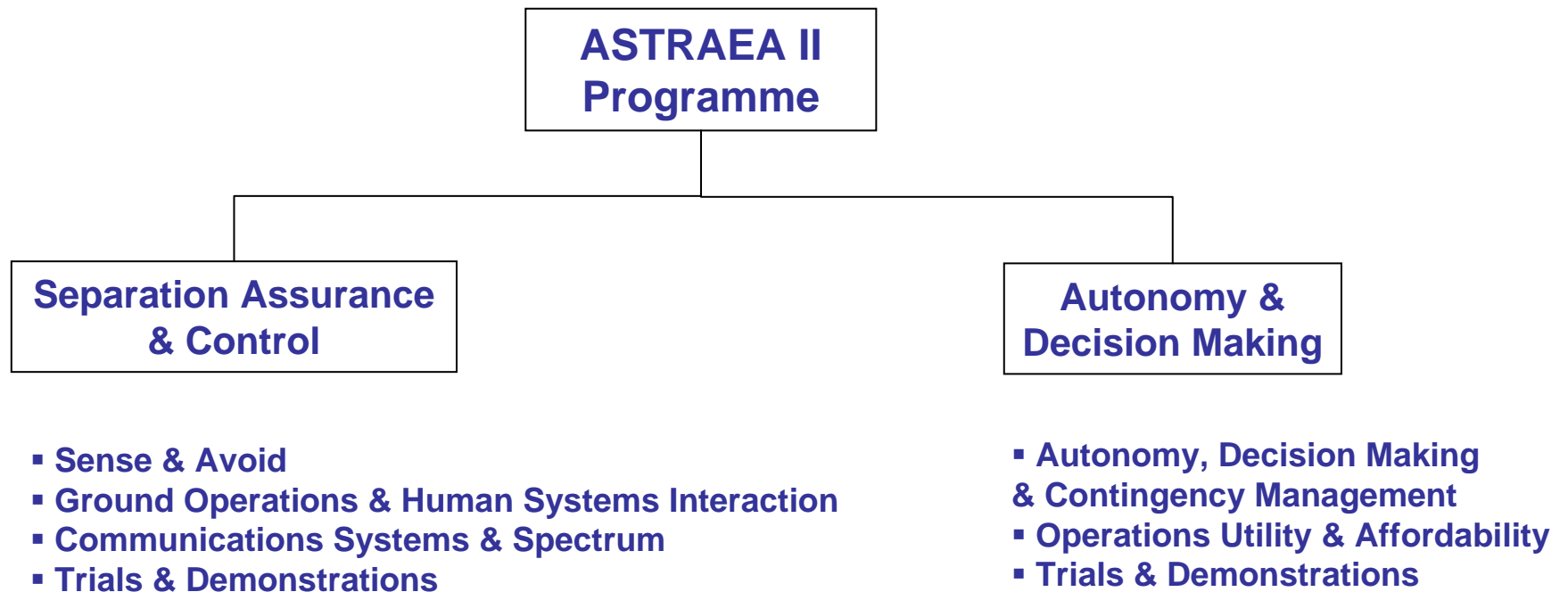
A National Aerospace Technology Strategy programme jointly funded by industry and the public sector.

- **TSB**
- **Regions**
 - Welsh Government
 - Scottish Enterprise
 - SEEDA
 - SWRDA
 - NWDA
- **Industrial partners**
 - Agent Oriented Software
 - BAE Systems
 - Cassidian
 - Cobham
 - QinetiQ
 - Rolls-Royce
 - Thales
- **Universities**
 - Bristol
 - Cranfield
 - Sheffield
 - Strathclyde
- **UK Civil Aviation Authority**
- **Other subcontract SMEs and Universities**

Programme Construct



January 2009 – March 2013



Autonomy & Decision Making

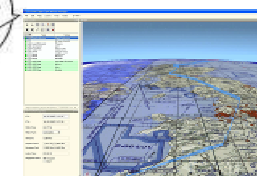
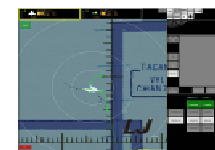
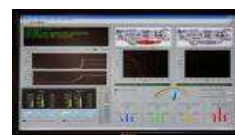
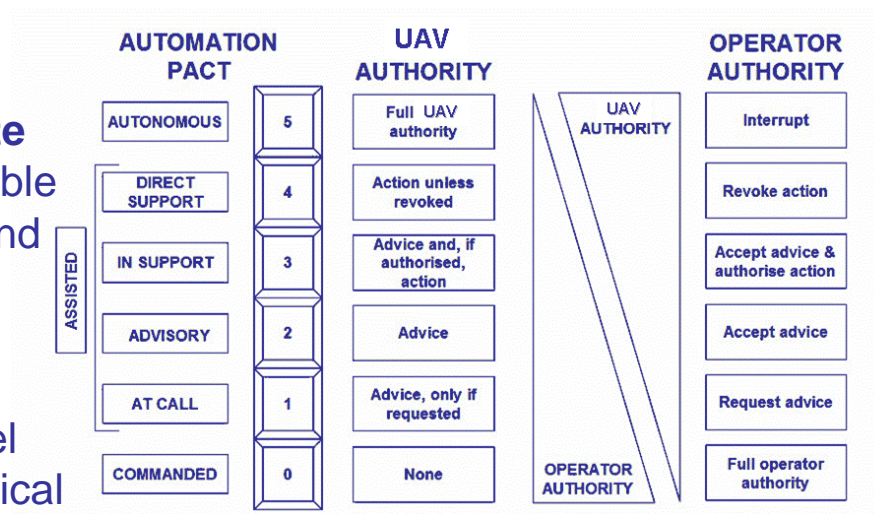


- Determine how the **decision making system** allows safe autonomous operations

- To **augment the capabilities of the remote operator** so that the UAS behaves in a sensible and safe fashion in the presence of normal and exceptional circumstances.

- To **reduce the workload of the remote operator** so he/she can focus on the top level mission goals while the UAS perform the tactical tasks.

- To enable a **higher UAS to operator ratio** so that the full potential economic benefit can be realised.

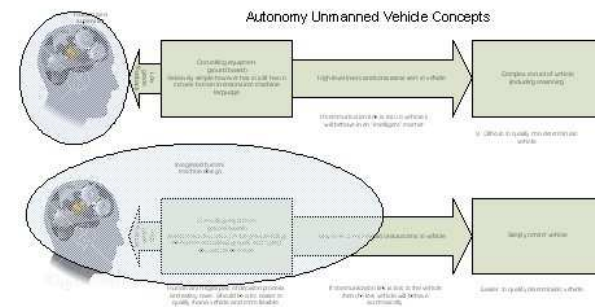
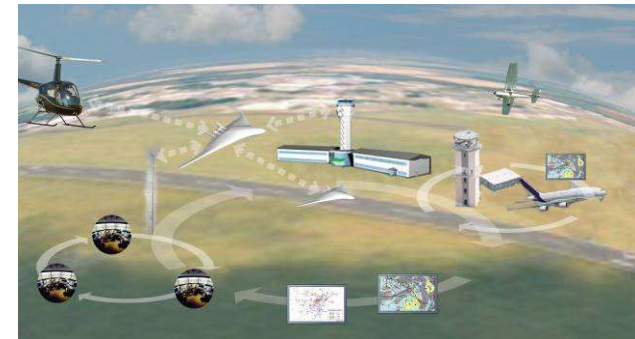


Ground Operation & Human Systems Interaction



- Identify the **ground operational environment** required for a UAS, including:
 - Tools required by the **operator** and the information that needs to be provided to allow **informed decisions** to be made
 - The required **interaction with ATC** and other authorities
 - The restrictions placed on the **ground operating environment by the regulatory authorities**, eg safety, security and certification requirements

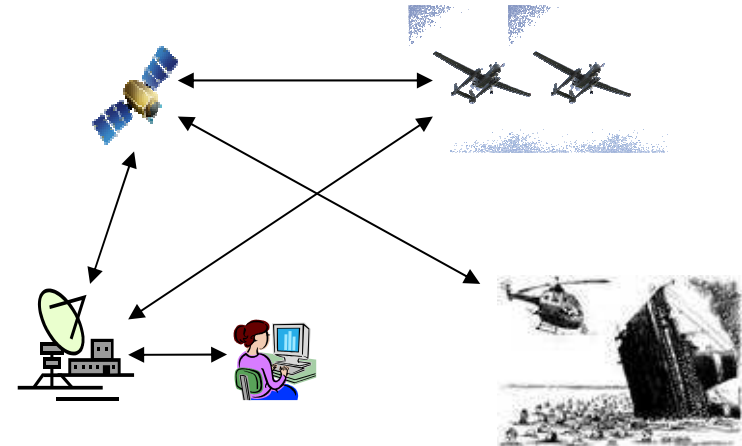
- Identify how to fully **integrate the human into the autonomous system**, including:
 - Issues of **system trust** and maintaining operator awareness
 - Innovative HSI solutions
 - Numbers of operators, their **roles and skill levels**
 - Novel solutions to meet **training** needs



Communications Systems & Spectrum



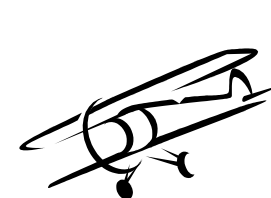
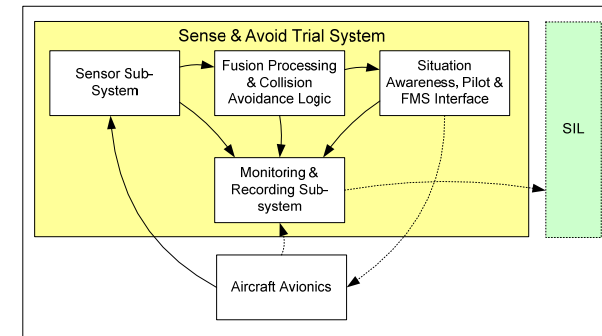
- Determine how the future systems will **communicate both with the ground and other airborne assets** to provide safe flight and human in the loop capabilities in a civil environment.
- Develop and demonstrate the **architecture** that allows the Human in the loop to maintain communications with the UAS both Line of Sight (LOS) and a Beyond Line of Sight (BLOS) situations.
- To augment the capabilities of the UAS in its ability to **cooperate with other air assets** in normal and exceptional circumstances.
- To ensure that the **Operator has the ability to intervene**, make decisions and take control if necessary thus maintaining public confidence.
- To make the case for UAS spectrum allocation at the **World Radio Conference 2012**
- To enable **higher UAS density** through cooperation and mutual understanding of individual air vehicle intentions.



Sense & Avoid



- To enable UAS to **sense** (using visual, radar, co-operative transponder or other advanced technologies) **all other air traffic in the airspace or ground based obstacles**
- To determine whether **any air traffic poses a potential conflict**
- To provide the UAS pilot with **data to determine any course or altitude change to avoid intruders or to autonomously manoeuvre the UAS to eliminate the conflict**
- Develop **technology** that enables UAS to avoid collision with other aircraft in situations where a loss of separation occurs
- Develop a clear **path to certification** through comprehensive regulatory engagement
- **Demonstrate** and explore technology solutions and operating standards to the stakeholder community in both synthetic and real world environments
- **Build public confidence** and develop a complete and robust safety case leading to an increased demand for UAS solutions in the civil domain



Demonstrations

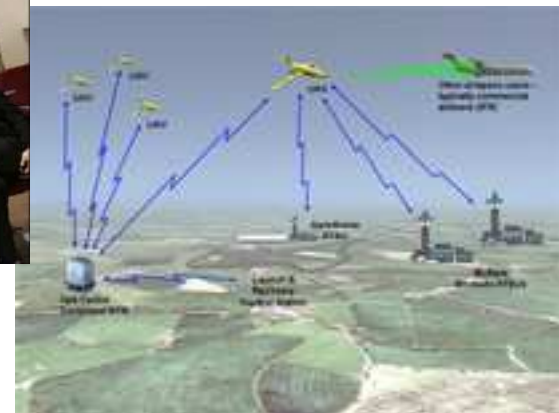


- Synthetic Environments
- Hardware in the Loop
- Surrogate Aircraft



User Engagement

- To seek end user guidance for the ASTRAEA scenario work, which drives solution development, taking into account people and process as well as technology.
- End user engagement will ensure
 - Full consideration is given to all lines of development and the impact of these on the technical solutions
 - Risks and barriers to market entry and solutions / mitigation actions jointly identified
 - Opportunities for early market entry jointly identified
 - The societal, economic and environmental benefits of UAS and associated technologies established
- Participants
 - Potential customers
 - Pilots
 - Operators
 - Infrastructure
 - Service providers
 - Manufacturers



ASTRAEA End Goal

- **At the culmination of the ASTRAEA programme we intend:**
 - **To understand and agree with the CAA the route to system certification.**
 - **To have captured the lessons learnt and to be in the forefront of contributing to UK and world regulatory development.**
 - **To be able to (individually or collectively) develop and sell products and services suitable for the new market.**
 - **To have conveyed to the wider community the benefits of the new market.**
 - **To have identified spin off opportunities and potential routes to exploitation.**



Summary

ASTRAEA is a unique programme which will enable a new branch to the aerospace industry.

ASTRAEA will enable new services to meet the requirements of a wide range of end users.

ASTRAEA will create opportunities for UK manufacturing and service industries in the emerging UAS market and related intelligent technology applications.

ASTRAEA will give industry the knowledge and confidence to develop certifiable products and services to address these markets.

The technologies developed in ASTRAEA are potentially capable of broad application in other sectors and provide the confidence for further investment in UAS product development.

AOS Autonomous
Decision-Making
Software

BAE SYSTEMS

COBHAM

 **CASSIDIAN**
AN EADS COMPANY

QinetiQ

 **Rolls-Royce**

THALES

www.ASTRAEA.aero

