



Bird Strike Risk Reduction for Civil Aviation

Overview of Opportunities presented by New Technologies





Agenda

- Rationale
- Presentation Objectives
- Established Techniques used to Mitigate Bird Strikes
- Identification of New Technologies and Opportunities given
 - Detection Methods
 - Direct Detection Methods
 - Indirect Detection Methods
 - Visualization and Communication methods and tools
- Integrated Systems/Services approach



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Rationale

- **Bird strikes are a major problem for Aviation:**
 - **Estimated conservative cost** due to damage and delays of commercial aircraft worldwide are estimated between **1 and 2 billion Euros per year**
 - Present **major problems in taking-off and landing**
 - **Few things can be done when airport areas are located in major migratory routes**
 - Existing **countermeasures** are of **limited effectiveness**



Rationale

- **Available and everyday growing technologies such as space-based assets are almost unexplored.**
- These may bring invaluable insights:
 - Take advantage of **space-based satellite systems** such as earth observation, telecommunication and navigation tools **with non-space assets** such as radar
 - Develop and improve bird location / movement prediction models and provide these as automated services to the civil air community **to reduce the risk of bird-aircraft collisions at and near airports**



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Presentation objectives

- Identification of new technologies
- General assessment of opportunities provided by new technologies
- High level overview of an Integrated Technologies System-Service



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Established Techniques used to Mitigate Bird Strikes

- **Aircraft and components design for minimization of impacts**
- **Bird Management**
 - Sounds, Lights, Pyrotechnics, Radio-Controlled Airplanes, Decoy Animals/Corpses, Birds of Prey, Lasers, Dogs, Falcons, Egg addling, nest removal, trapping, shooting, electrified mats, among others
 - **Drawbacks:** In most cases birds get used to the repellent techniques.
- **Land Planning and Management at and near airports**
 - Vegetation control, garbage removal, non-food Recycle Centers, controlled construction and demolition of debris facilities, avoidance of fly ash disposal
- **Avoidance of Birds' Migratory Routes**

There are three approaches to reduce the effect of bird strikes. The aircraft can be designed to be more *bird resistant*, the birds can be moved out of the way of the aircraft, or the aircraft can be moved out of the way of the birds.



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Identification of Technologies and Opportunities given

■ Detection Methods

■ Direct detection

- **Direct detection** concerns the actual **detection of the presence of birds**, either on an individual basis or of bird density.
- There are several technologies for direct bird detection

■ Indirect detection

Identification of Technologies and Opportunities given

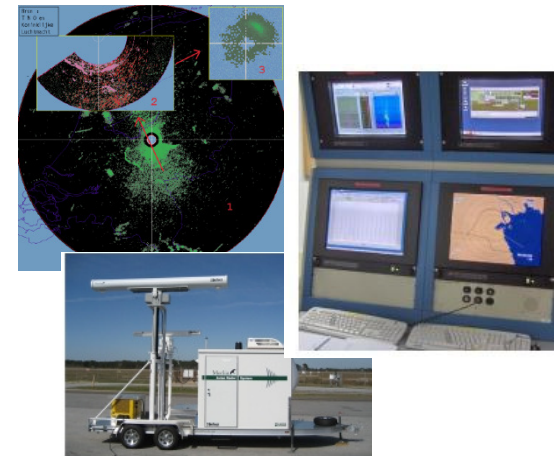
Direct Detection Methods

- **New build Radars used to Detect Birds in the vicinity of Airports:**

- Current implementation in civil aviation is very limited
- Some need expertise operator; other gives a user friendly interface
- Limited Range of action
- Real-Time detection

- **Examples:**

- MERLIN
- Bird Radar Data Interface (BIRDI)
- **R**adar **O**bservation of **B**ird **I**ntensity (ROBIN)
- Mobile Avian Radar System (MARS)
- eBirdRad



Identification of Technologies and Opportunities given

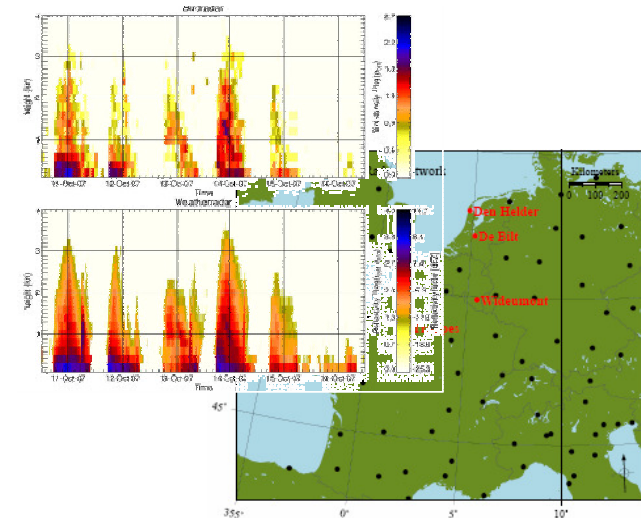
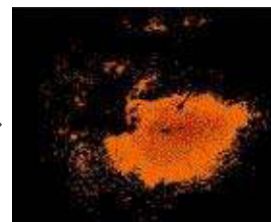
Direct Detection Methods

■ Meteorological radars used for Bird Detection

- Systems that use meteorological radar data and complex algorithms to present near real-time images of birds
- Constraints (e.g. False alarms – omission and commission errors)
- Can also provide valuable information for scientific research on bird migration
- Dokter et al. 2009 successfully extracted quantitative bird migration information from operational weather Doppler radars
- Continent-Wide Networks of weather radars used for bird detection:
 - **OPERA** (over 180 radars) - Europe
 - **NEXRAD** (over 150 radars) - US



Weather Removal

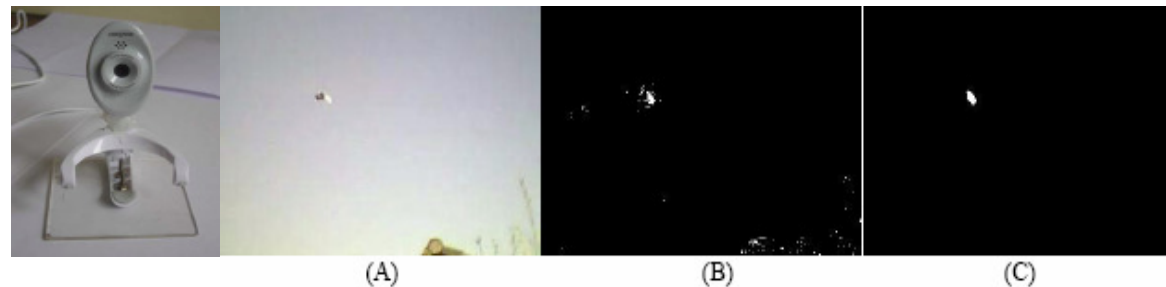


Identification of Technologies and Opportunities given

Direct Detection Methods

■ CCTV (Closed-Circuit Television)

- Real-time detection without user intervention
- Video Storage for historical purposes
- Low budget technology
- Each camera has limited area coverage
- Verstraeten *et al.* 2010 used Webcams for Bird Detection and Monitoring in a demonstration study
- Zhang *et al.* 2008 used cameras pointing upwards and making the image against the sky. Birds are detected and tracked after applying filters over the images

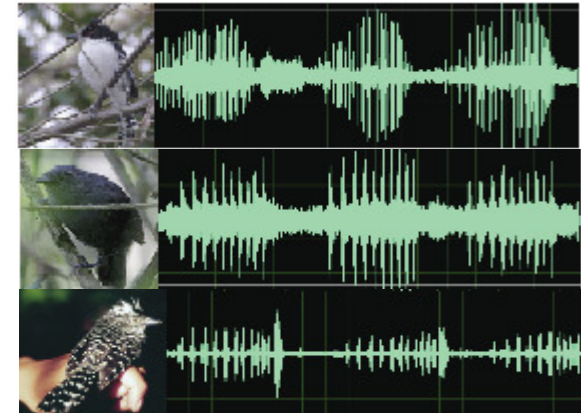


Identification of Technologies and Opportunities given

Direct Detection Methods

■ Acoustic Methods

- Acoustic signals of birds are detected
- Birds species/types can be distinguished
- **Example:**
 - EchoTrack™ Airborne Wildlife Surveillance System - uses acoustic sensing and leading edge waveform (sound) analysis that identifies and locates species, and their direction of travel



■ Thermal Imaging

- The long wave Infra Red (IR) radiation emitted by the body of a bird is detected by Thermal Imaging cameras

■ Night Vision Equipment

- Used for making survey of birds at night
- Obtains information through a Infra Red light with a range of detection around 500 feet, depending on the bird's size

Identification of Technologies and Opportunities given

Direct Detection Methods

■ Tagging Technologies

■ Radio

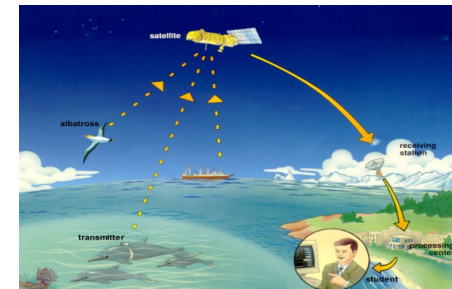
- Localisation of a animal, tagged with a electronic device which sends pulsed electronic radio signals to a radio receiving device

■ GSM

- Localisation of a animal equipped with a GSM unit that communicates with the worldwide infrastructure for mobile communications
- The GSM unit can be coupled with sensors and GPS modules and thus can send coordinates and other data through the GSM system directly to a mobile phone

■ SatNAV/SatCOM

- Localisation of a animal equipped with different sensors that communicates with the satellite infrastructure available



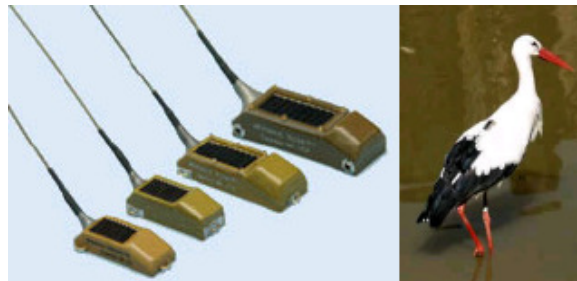
Identification of Technologies and Opportunities given

Direct Detection Methods

- **Tagging Technologies**
 - **SatNAV/SatCOM**

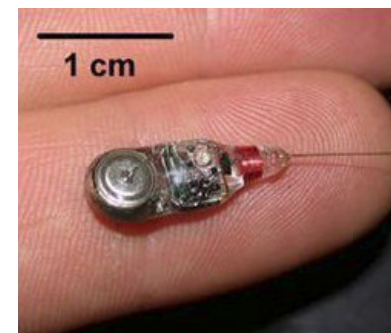
ARGOS

- Global satellite-based location and data collection system dedicated to studying and protecting our planet's environment
- Remote detection of mobile objects (e.g. Birds) equipped with a compatible transmitter offering the possibility of collecting data from measurement sensors connected to this transmitter



ICARUS

- Remote sensing platform for scientists world-wide that can track small organisms globally, enabling observations and experiments over large spatial scales
- Smaller Transmitters Tags, compared with ARGOS System's Equipment, enabling locate birds of any size





Identification of Technologies and Opportunities given

- **Detection Methods**

- Direct detection

- **Indirect detection**

- **Indirect detection methods** concerns the **use of systems to provide information on factors which can be used to determine or predict the presence of birds**
 - **Space-based data is particularly well suited** for the characterisation of such factors



Identification of Technologies and Opportunities given

Indirect Detection Methods

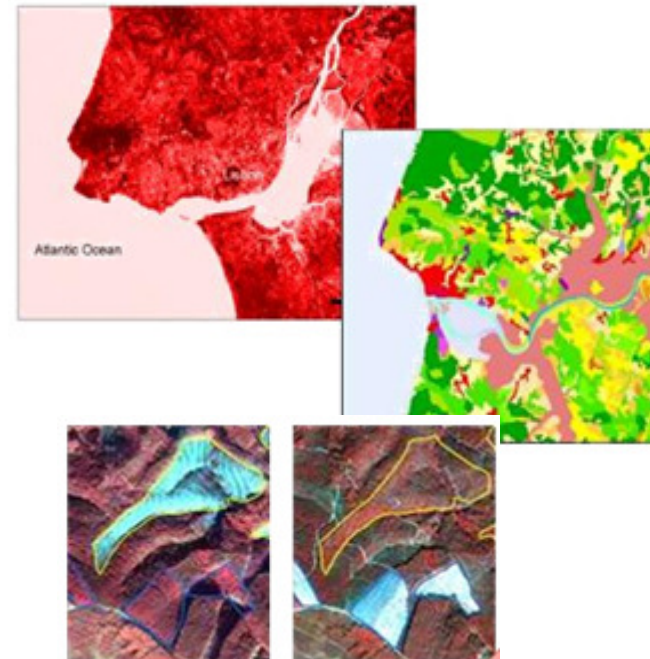
- Bird movements depend on a wealth of environmental factors including landscape and land use conditions, presence of snow, weather conditions, etc. **This set of dynamic information can be provided by Earth Observation satellites.**
- **Local movements of birds** are overlaid by wider and global bird migration phenomena, which **can be monitored and modeled by means of global space based tools**
- In the last years a new discipline called **Space Ornithology** has evolved and a number of steps are being taken towards the **utilization of space assets to track the movement of birds**

Identification of Technologies and Opportunities given

Indirect Detection Methods

■ Earth Observation

- Huge availability of Space-based and airborne Sensors to be explored with different technical specifications:
 - **OPTICAL**
 - **RADAR**
 - **LIDAR**
- Large area coverage
- Numerous environmental variables can be characterised
- Data is easily accessible
- Reliable
- Cost-effective

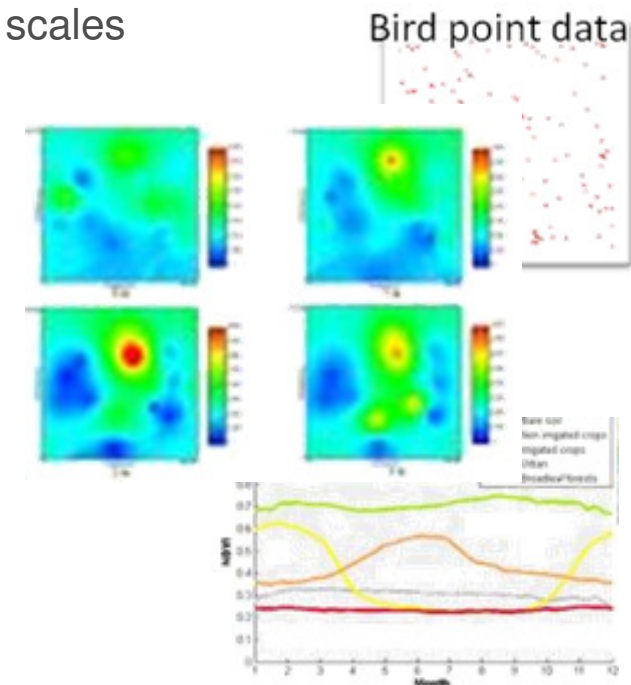


Identification of Technologies and Opportunities given

Indirect Detection Methods

■ Earth Observation

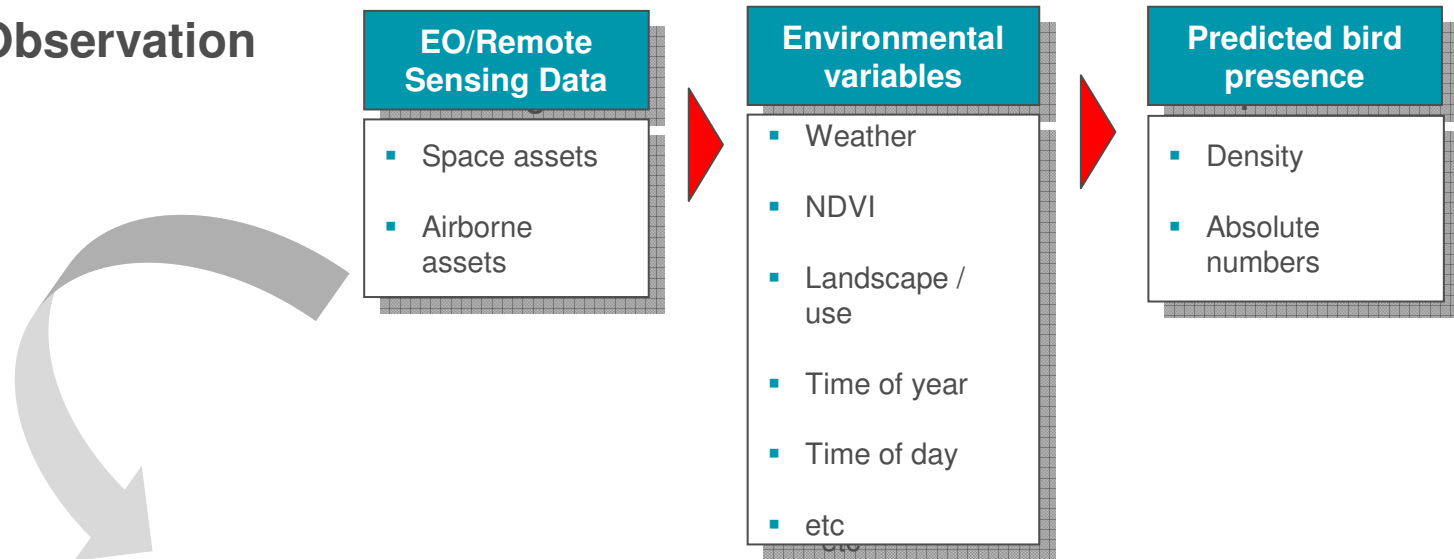
- Modelling relationships between **Birds and Environmental variables, measured by Earth Observation Technologies** (space-based and airborne Optical, RADAR and LIDAR) can provide insights' in:
 - Bird presence and movements at local scales
 - Bird migratory routes
 - Managing of bird habitats
- Recent and future EO satellite systems can provide more and better information for models:
 - Better model reliability
 - Better prediction
 - Accurate variable estimations
 - Local/Regional/Global scales



Identification of Technologies and Opportunities given

Indirect Detection Methods

- **Earth Observation**



- Buchanan et al (2005) used satellite data to characterize and identify upland vegetation in bird abundance-habitat models;
- St-Louis et al (2006) used linear regression models to evaluate the correlation between high spatial resolution satellite image texture and bird point count data;
- Bellis et al (2008) assessed the relationship between greater *Rhea Americana* group size NDVI and texture measurements from satellite imagery;
- Abdi (2010) used Landsat 7 ETM+ data to create a predictive distribution map of the species based on habitat preference;



Identification of Technologies and Opportunities given

Indirect Detection Methods

- **Tagging technologies: Radio, GSM, SatNAV/SatCOM**

Bird tracking data combined with environmental data can be used with success for modeling spatial patterns, temporal dynamics, behavior, and ecology of birds

- The use of data for track and trace of tagged birds (e.g. ARGOS / ICARUS services) can help answering the following questions:
 - what proportion of their time do birds fly and how does this vary between species?
 - what is the seasonal and daily fluctuation in time spent flying?
 - what are the factors that make birds fly?
 - at what altitudes do birds generally fly?
 - what are the conditions and circumstances that determine their flight altitude?
 - do birds have preferred flight routes during local movements which can be predicted?



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Identification of Technologies and Opportunities given

Visualization and Communication methods and tools

- Enhanced **Visualization** and Communication tools for the end-users:
- SATCOM can provide broader and reliable communication
- GIS's can be used to disseminate bird strikes data:
 - GIS systems can provide an easy understanding of complex data visualization through the use of several available imaging tools and imaging analysis
 - GIS systems can be used to publish several layers from and to external services through the use of open standards, for example, of WMS (Web Mapping Services) and WFS (Web Feature Services)
- Birds' now casts and forecasts data can be integrated with air traffic control displays.



Identification of Technologies and Opportunities given

Visualization and Communication methods and tools

- Enhanced **Visualization** and Communication tools for the end-users:
- Spatial analysis services can enable end users to perform analysis based on several criteria's:
 - Apply buffers of analysis around airport areas;
 - Define custom areas of analysis;
 - Analyze complex data based on time variables, i.e. query data based on time intervals, on a specific date, compare data in different time tables, etc;
 - Combine different types of layers of information;
 - Birds' positioning data can be correlated with acoustic data to identify the species detected;



Identification of Technologies and Opportunities given

Visualization and Communication methods and tools

- Enhanced Visualization and **Communication tools** for the end-users
- Intranet or even Internet channels can be used to publish information for end-users
- DVB communication technologies can be used for improved digital images/video transmission
- Interchange ability and Interoperability among various components and systems
- Optical Fiber can be used in replacement of Cooper cables, allowing gather several high bandwidth channels of communication of Traffic Control Systems into only one single fibber channel, and providing Electromagnetic compatibility, improved electrical safety and security.

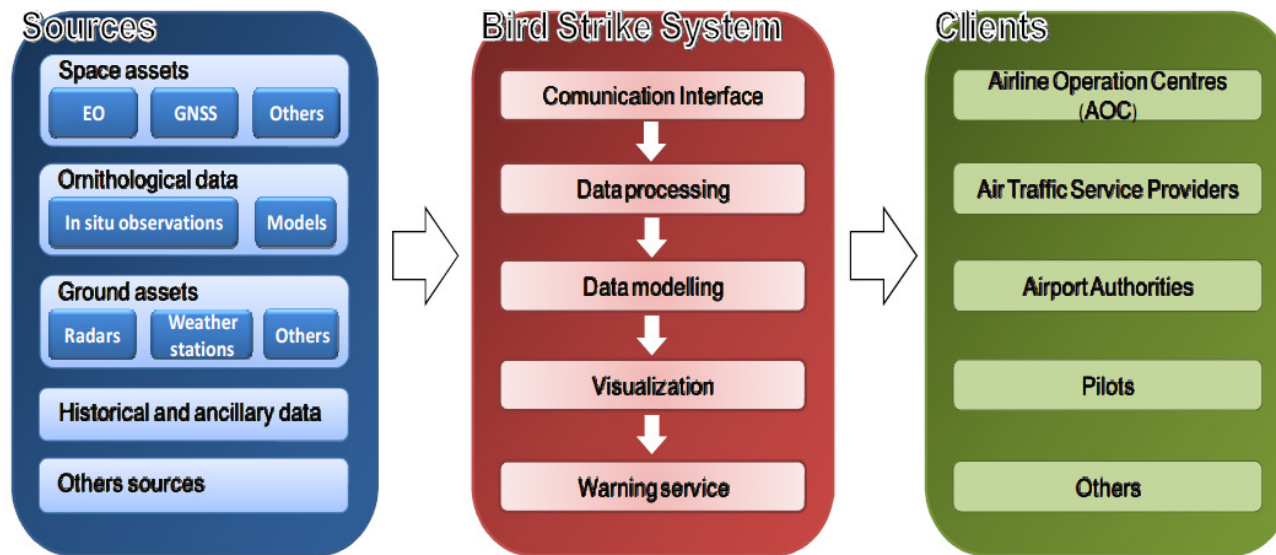


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Integrated Systems/Services approach

High level overview of an Integrated Technologies System-Service



To integrate several geospatial databases, obtained from direct and indirect measurements of bird movements, characterized from EO satellites, SatNAV/SatCOM, ancillary and historical data, in situ observations, etc, into a module of the system-service called bird strikes system. This module will be responsible for data harmonization and communication, data processing, data modeling, etc, delivering in the end improved risk assessment mapping products for the mitigation of bird strikes at and near airports



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Thank you for your attention

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