Overview of Sensors and Detection Systems for Wildlife Hazard Management

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Airport Safety Management Program

Introduction

The University of Illinois Center of Excellence for Airport Technology (CEAT), Airport Safety Management Program (ASMP) has been the performing partner for the Federal Aviation Administration Airport Technology R&D Branch safety technology assessment and testing since 1999.

ASMP has tested sensors and systems, deployed technology to airports, conducted performance assessments, and used reports to support development of requirements and standards.

We have tested a wide range of technologies using a range of sensors.

ASMP staff are not technology specialists, rather we are scientists and engineers skilled in the conduct of science-based assessments.

Key to these assessments is an understanding of fundamental science (mainly physics), developing an appreciation of sensor/systems operation, and testing in the complex environment of airports.

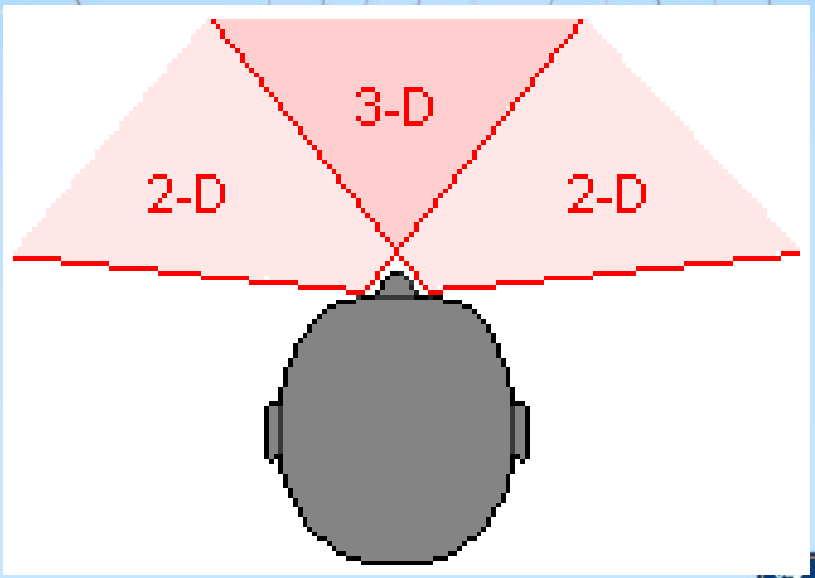
In all of our assessments we recognize that intellectual property concerns and the associated engineering, fiscal, and any number of practical and business constraints are a part of the technology design which will influence performance. We cooperate with developers!

Our approach has been to identify vendor performance claims, consider fundamental issues and bird targets, and then use a science-based assessment approach that has a focus on in-the-field testing.

We start our assessments with the a basic requirement: The technology must assist in the observation and enumeration of birds and other wildlife on, and around, airports!

We will consider any technology that will supplement identification and counting as a candidate for assessment although the FAA's primary criterion is commercial availability. We are not in the development business of R&D!

As a starting point let me quickly review what we are trying to supplement – human vision/observation. Humans have an overlapping field of view of 160° to 180° with stereoscopic vision in the middle 120°. It is very difficult to duplicate human vision and technology often sacrifices full situational awareness for target identification.



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The “mark-one” eyeball connected to a very capable processor so human vision is really the benchmark for technologies.

It is very difficult to duplicate or replace human vision with technology. Although we have made advances in the sensor area, processing is still far from human capabilities.

A conclusion I have reached is that technology often sacrifices situational awareness for target detection, tracking, and/or identification.

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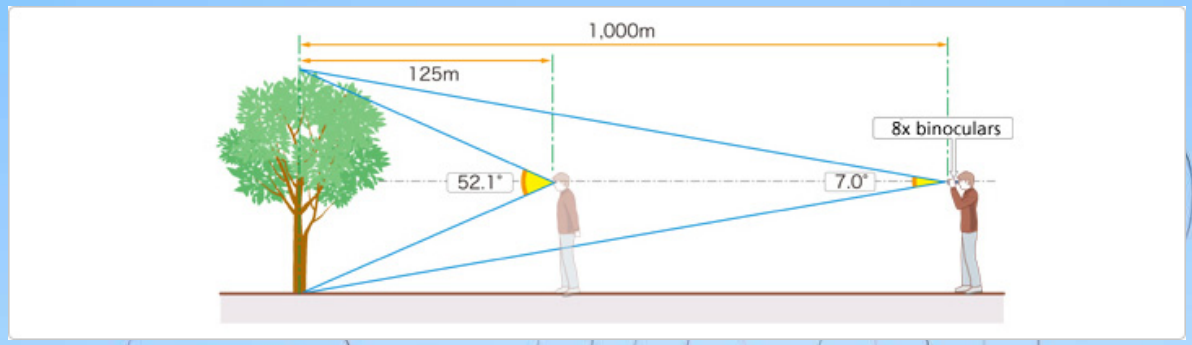
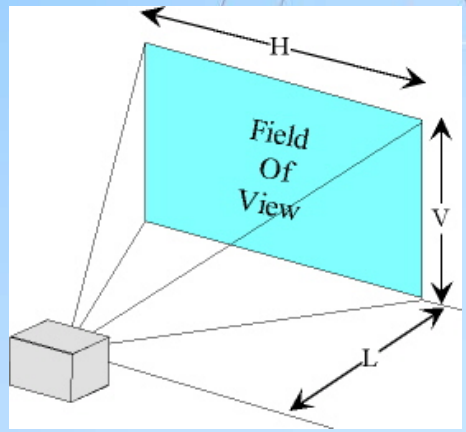
I would guess most of you are all too familiar with binoculars and spotting scopes. This technology has been around since the early 1600's. These optical supplements increase the apparent size of the target and allow observation of small targets at greater distances.

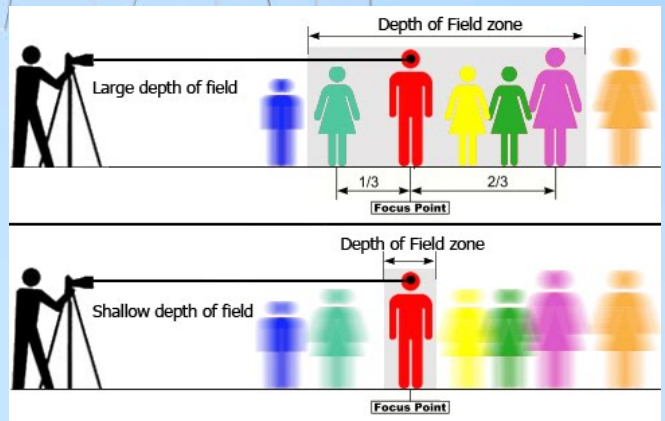
I don’t intend to review optical physics but you should note that with optical technologies distance from the target, field of view, and depth of field are all important in wildlife observations.



Nikon.com



www.tlvexp.ca



rowleyf.blogspot.com

In my assessments we start with these characteristics of human vision and build criteria that focus our testing protocols and procedures.

We know that distance to the target, FOV, and resolution are critical in the use of optical supplements. Environment also plays a role where background contrast, lighting, and conditions that obscure targets (heat waves or precipitation) play a role in identification and counting. Our technology assessments attempt to account for these, and other, issues.

This leads to a critical point!

Technology is only a tool that is used to improve human capabilities. It is critical to select the right tool for the task, and multiple tools may be required for adequately address a tough or complex problem!

So let me review technologies that provide us with tools to better address wildlife hazard issues. I include hazards to aircraft as well as hazards to wildlife.

I divide my analysis into sensors and systems. I focus on sensors because it is trough the sensor that data is obtained. I then consider systems because it is through system design that data becomes information making further operational processing is possible.

My categories for ***sensors*** used in wildlife management:

- Optical
  - Video
  - Image intensification
  - Thermal
- Radar
  - Airport
    - Legacy/COTS
    - Advanced
  - Regional
- Multiple use
  - FOD
  - Surveillance

My categories for ***systems*** issues is incomplete but a starting point for review:

- Optical
  - Observation supplements
  - Automated Processing/Intelligent vision
- Radar
  - High threat design
  - Multiple sensor
    - Overlay/Integration
    - Sensor Fusion
  - Regional Integration
- Multiple use
  - FOD/wildlife
  - Surveillance
- Other
  - Big data
  - Global connections

So, let's review the list section by section!

- **Optical**
  - **Video**
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The most common optical technologies, other than binoculars, are video cameras. Critical sensor-related issues are resolution (pixel size/definition) and optics quality/capability. Important systems issues involve multiple cameras and automated/intelligent processing capabilities.

Many advances have occurred, providing higher definition sensors, better optics and options for fixed and pan/tilt mounts to provide better coverage.

The area where we have the most to gain is in automated processing and intelligent vision.

Video cameras are sensors that capture images so we not only have target detection we also support target identification.

We simply do not want to watch the length of the video record, we could likely “see” more by just watching. The solution is processing that identifies when targets of interest are present. Driven by advances in security, intelligent vision capabilities are ready to explode on wildlife management!

Further, it is possible to process images to come closer to human vision!

For example the FOV can be extended by stitching views from multiple cameras.

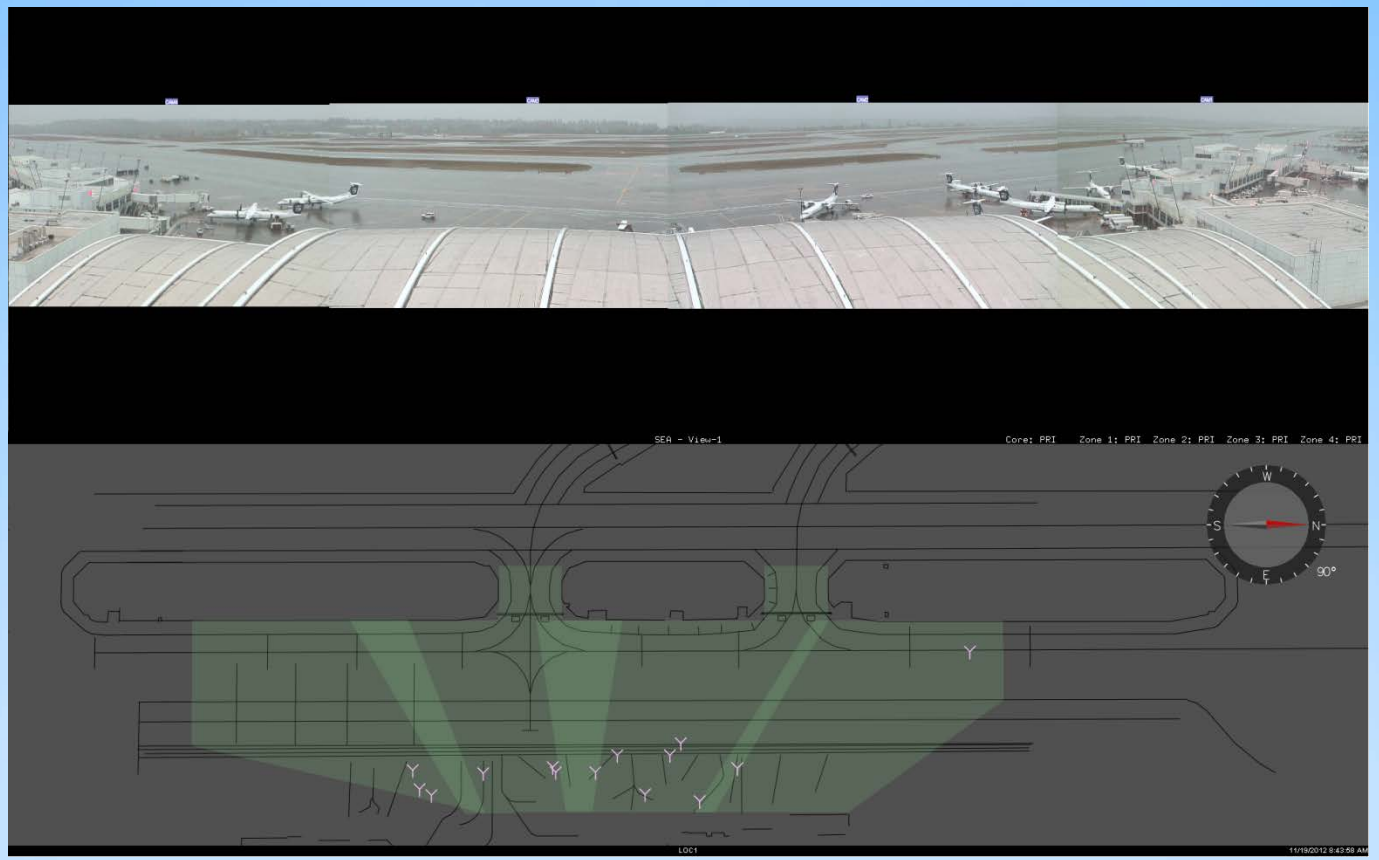

Image from Searidge Technologies IntelliDAR System installed by CEAT at Seattle Tacoma International Airport.

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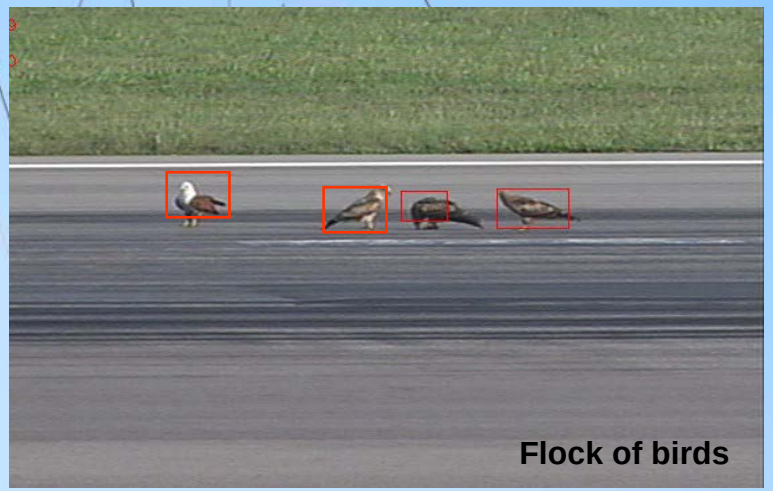
Magnification can reveal detail needed for identification.



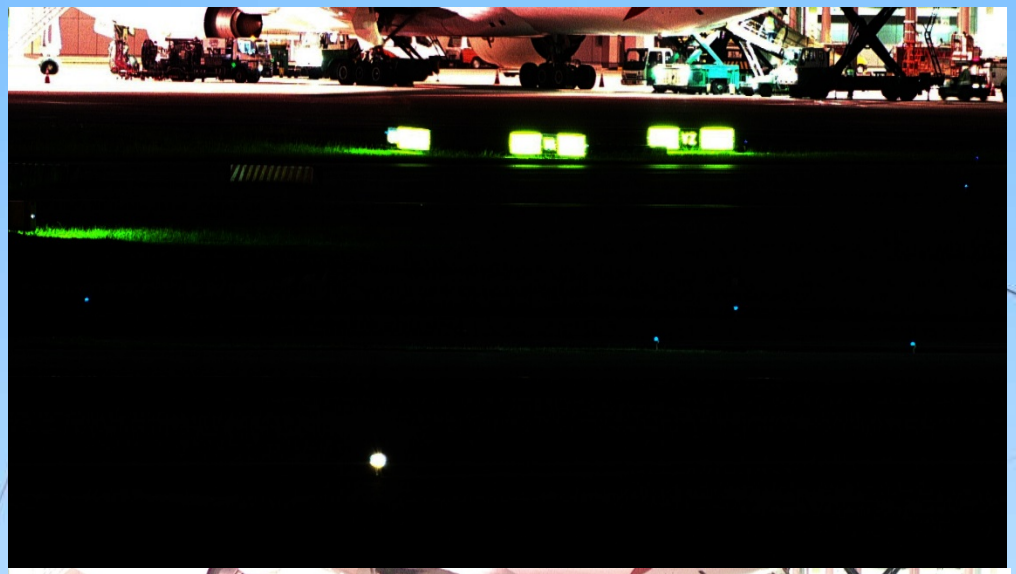
Pictures from Stratech Systems Ltd iFerret FOD detection system

Illumination makes night time observations possible. Here a near infrared camera uses an illuminator to capture images.

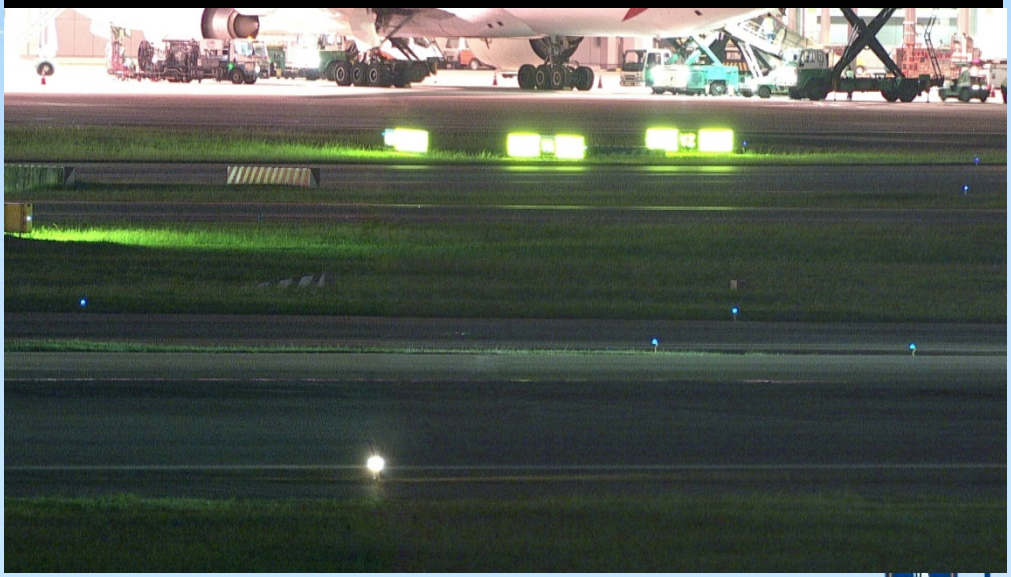
Pictures from Xsight Systems FOD Detect runway FOD detection ssytem.

And automatic/intelligent processing can turn night scenes to meet daytime sensibilities!

What we see!



What the processed image looks like!



Images from Stratech Systems Ltd iFerret FOD detection system

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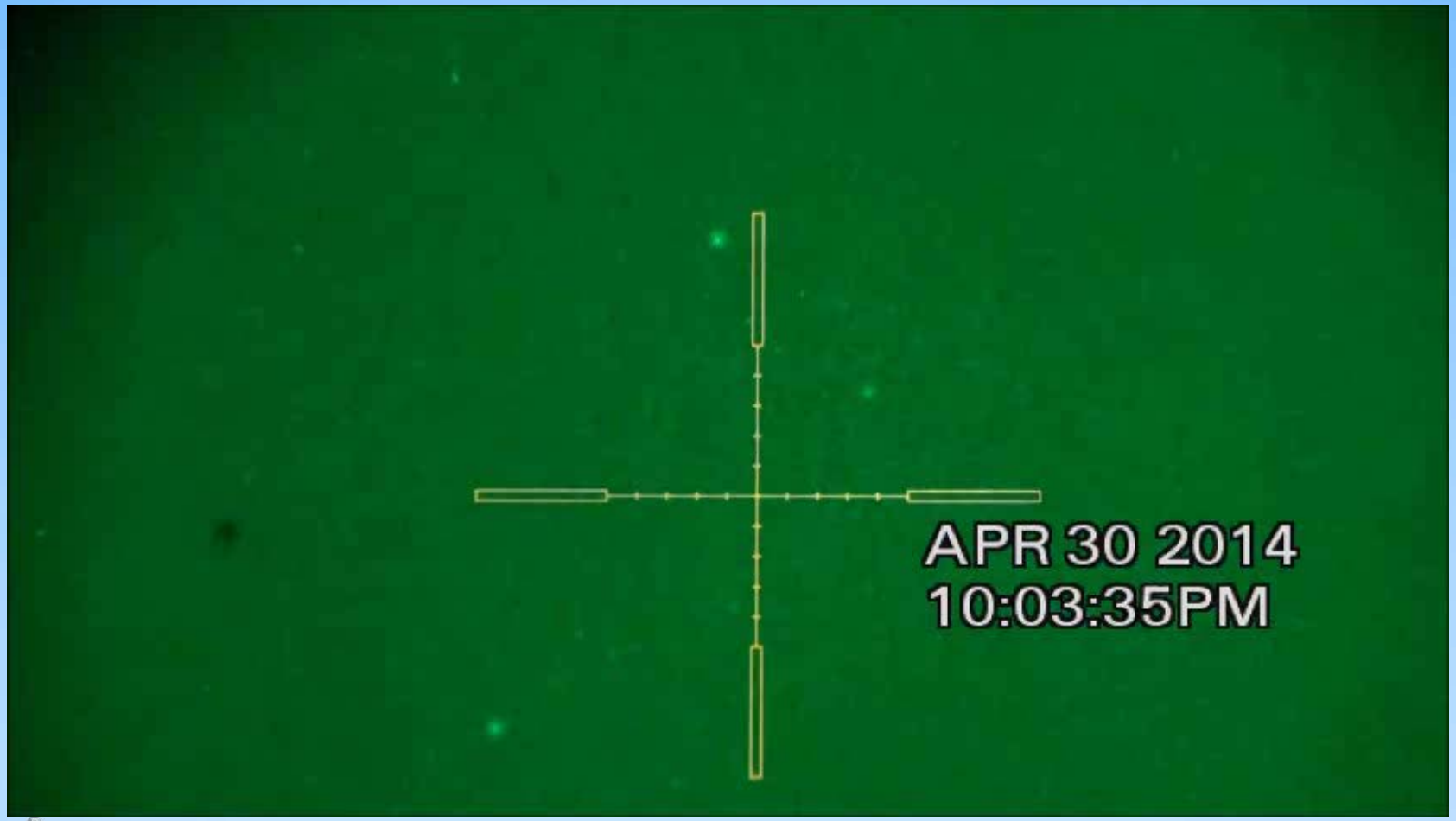
It is also possible to amplify available light. We use an image intensifier supporting both real –time observation and recording.

This is an example of a recorded image. The unit is pointed straight up at a location near a hotel in Dallas. Light from local sources illuminates the underside of passing birds.



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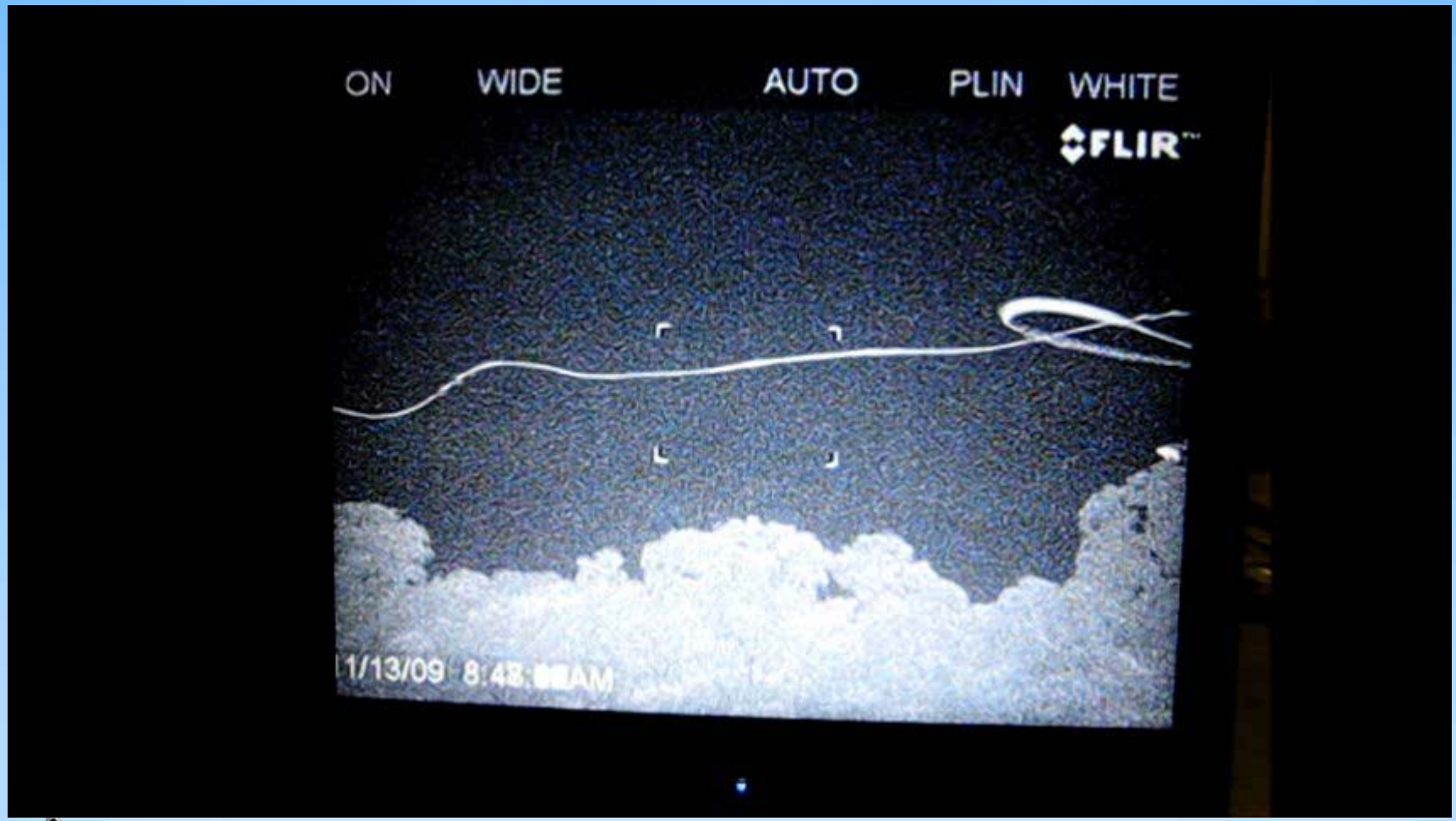
Thermal; Thermal imaging also supplements observations at night. This is a movie made using a thermal imager observing flight of a Red tail hawk at a range of approximately 1.5 km.



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Operating in another part of the spectrum, radio frequency technologies, specifically radar, offer additional supplements to human observers.

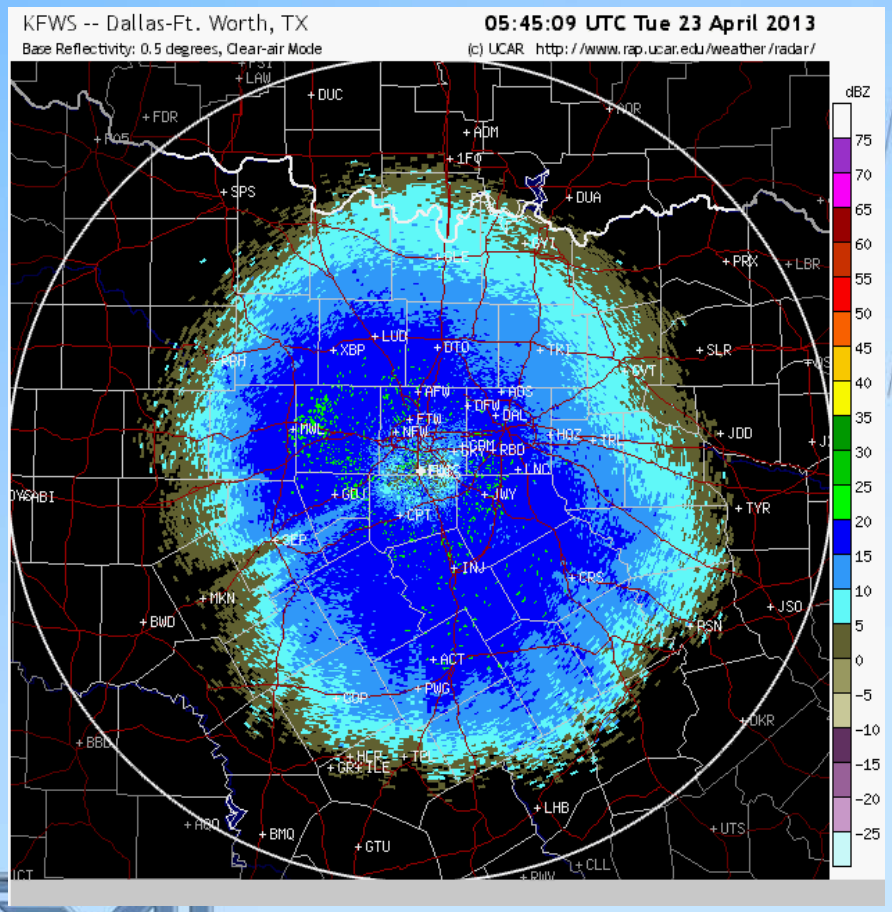
Radar is well known, but I think very misunderstood!

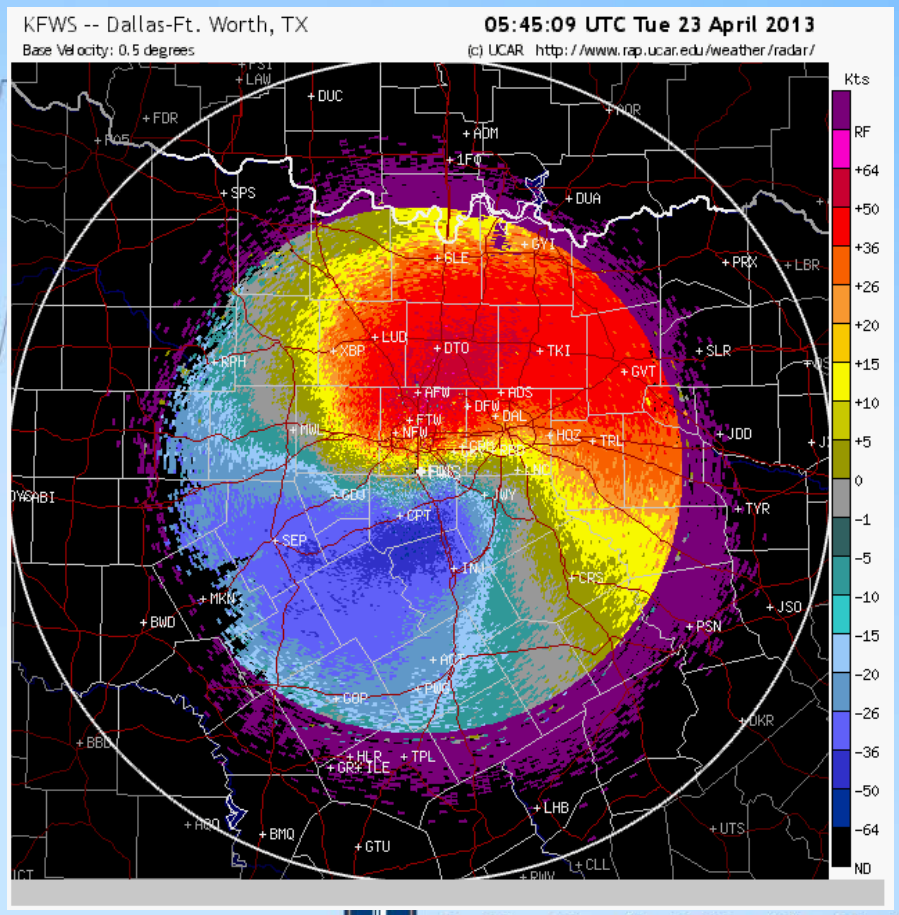
We have avian radars of two main types. One takes advantage of large defense and weather radars to track seasonal movements. The second uses smaller radars focused on the airport environment

The use of wide coverage radars is common, but because these radars have been designed for other purposes detection and tracking of birds has received sporadic attention. Considering large scale issues of migration, we can expect advances in better use of available radars.

For smaller radars we are at an exciting threshold. Legacy sensors and systems depended on COTS marine radars. We are now seeing advanced radars specifically designed to provide location, with altitude, and tracking of bird targets.

Weather and defense radars have been used for quite some time to track major bird movements. These radars are really underused in aircraft safety management.

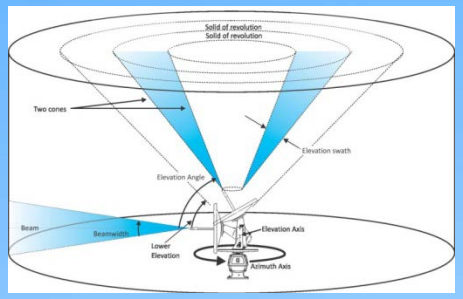


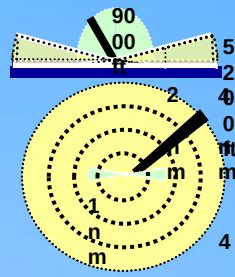


The smaller radars are available from a variety of vendors and there is much innovation in this group of technologies.

The innovation has been applied to legacy radars with upgrades to solid state circuitry. There are new antenna designs that support a range of operational applications. There have also been advances in digital processing.

The advanced radars employ designs with FMCW transmitters and phased array antennas that provide excellent altitude resolution with Doppler.





Vertical overlap

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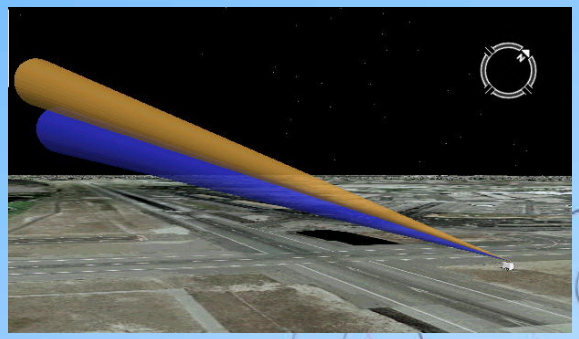

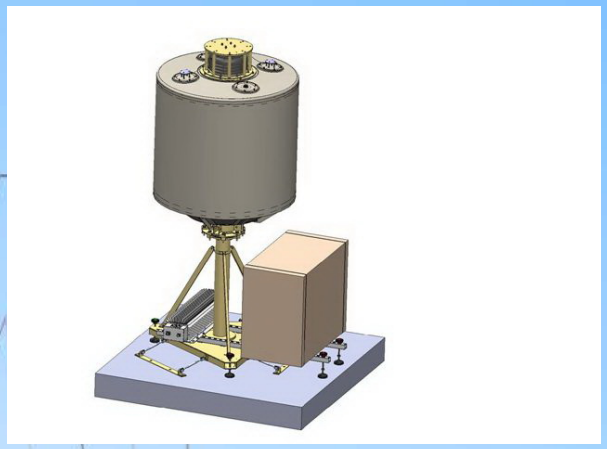

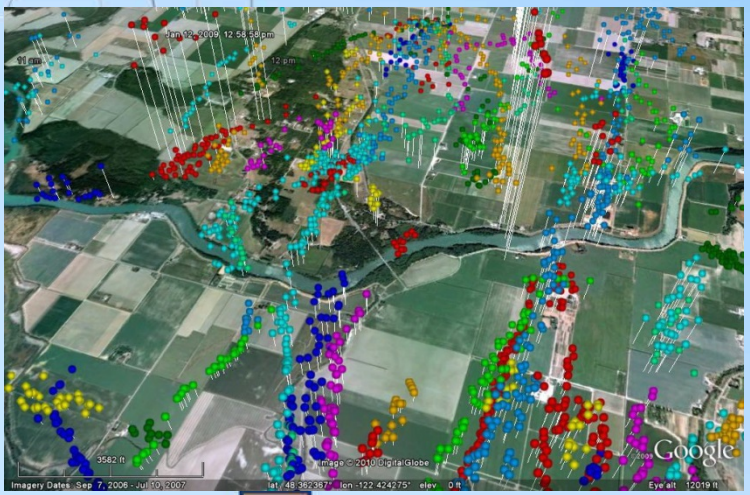

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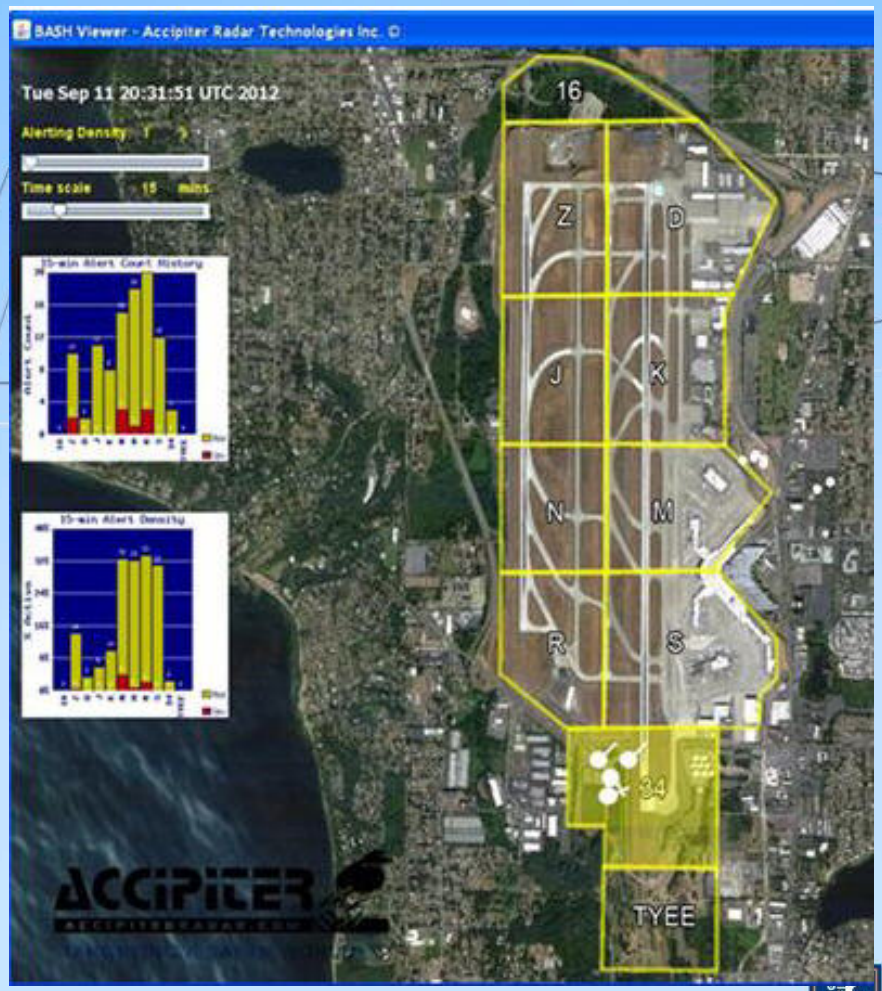
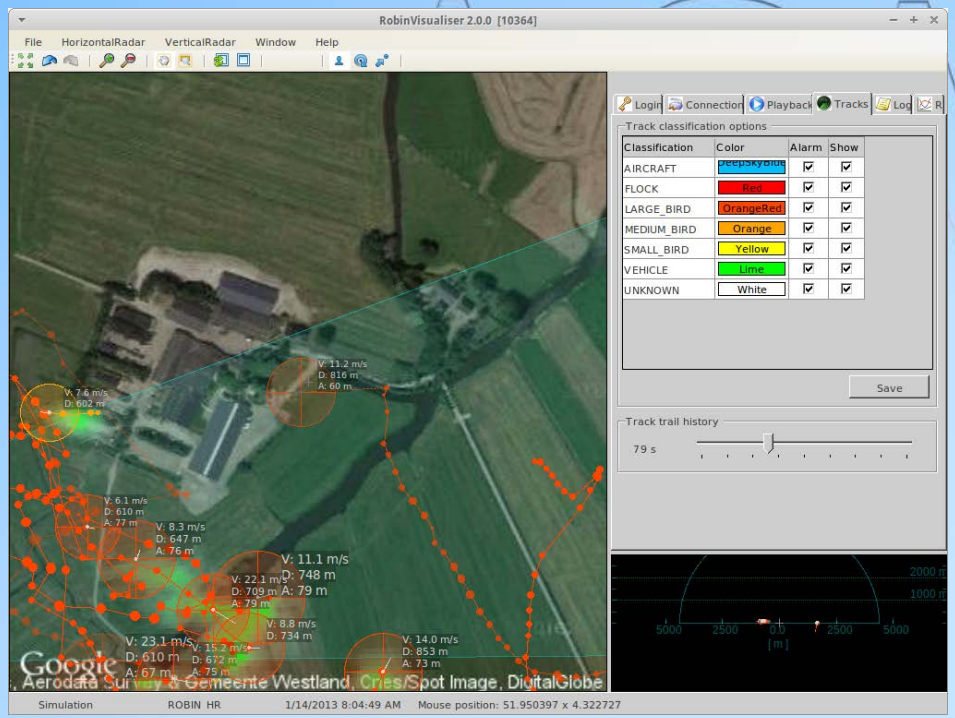
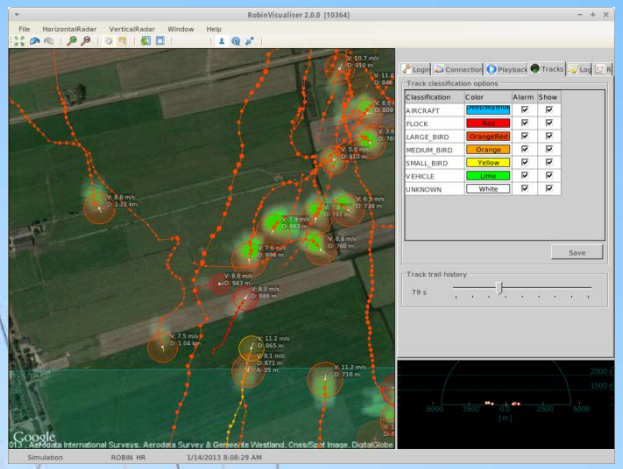
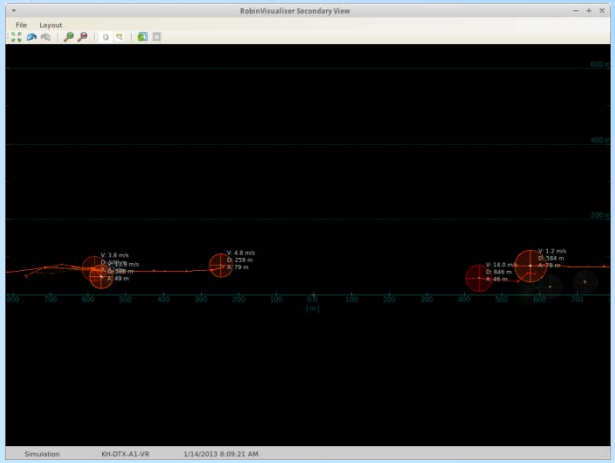
Threat environments are now being defined by radars. At Seattle Tacoma International a threat viewer has been implemented.



There have been advances in data fusion, fully coupling vertical and horizontal scans, and in target tracking.







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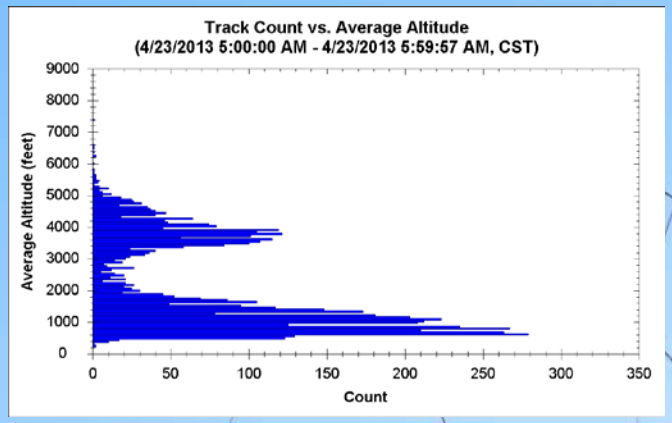
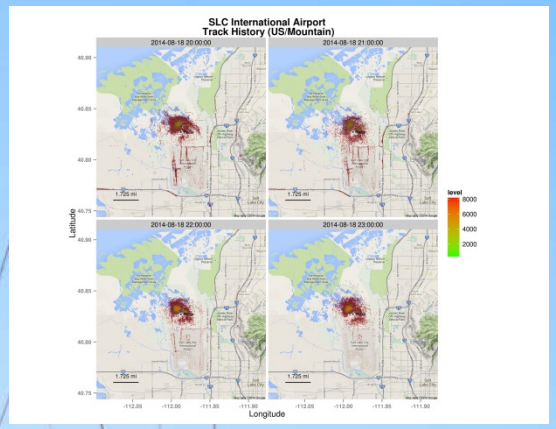
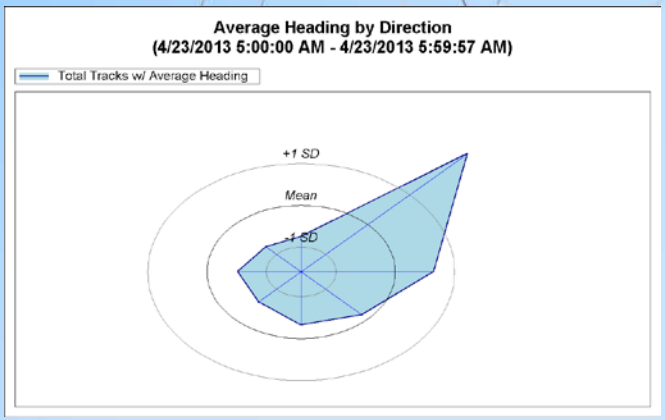
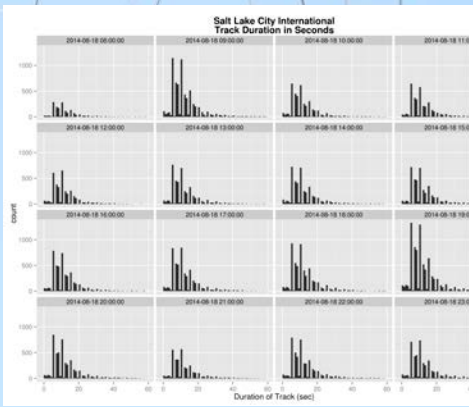
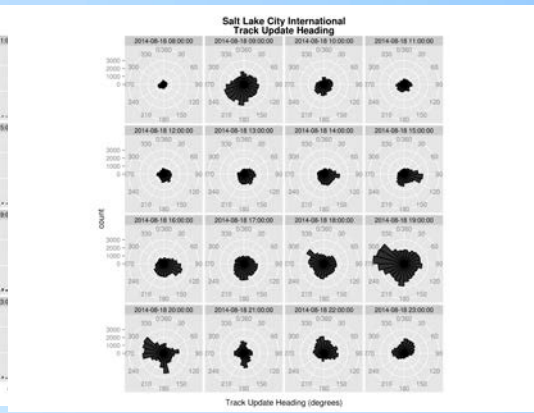
Improved data management tools support new approaches to data overlay and integration.











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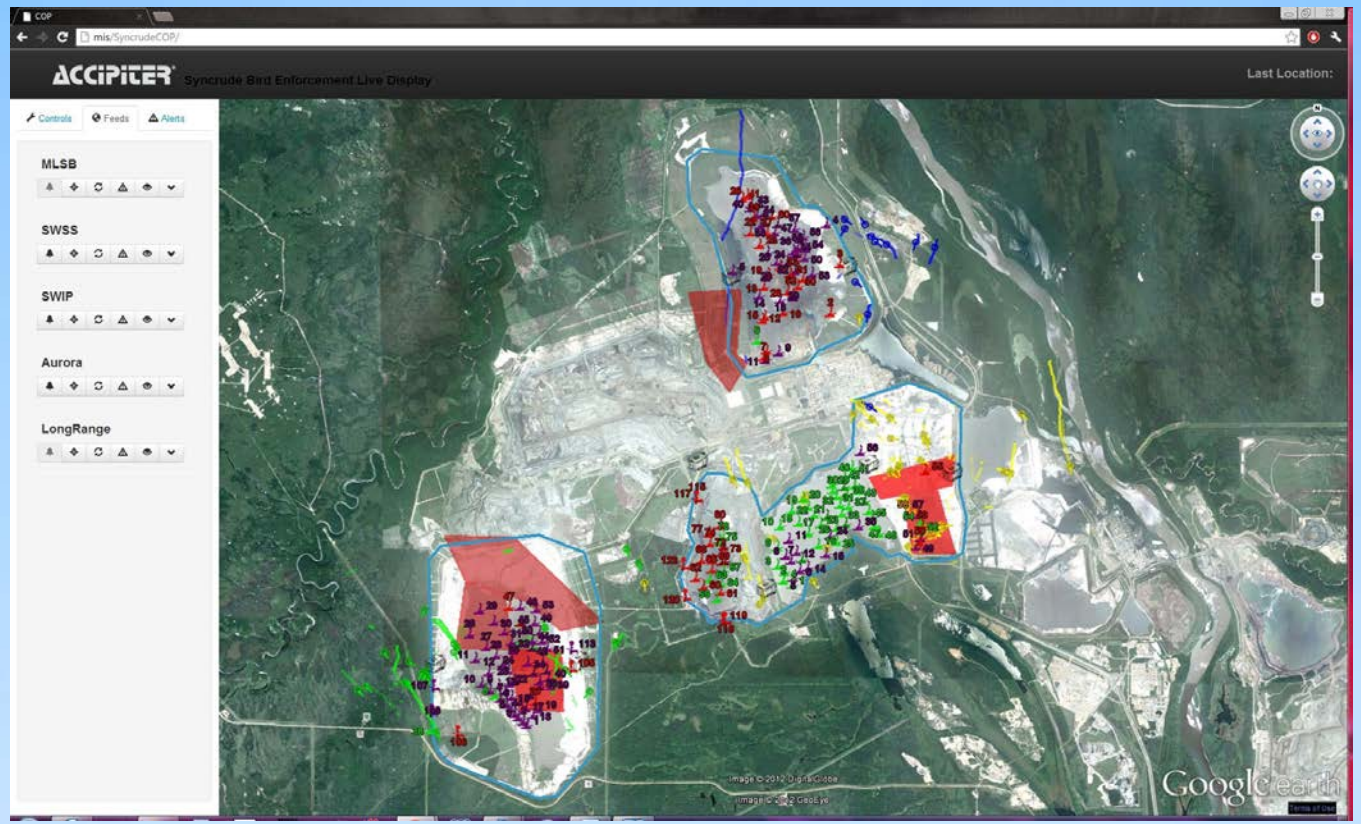
Wide area coverage by radars have been fully integrated and system integration has radars driving harassment devices. An excellent example is in the Alberta tar sands.



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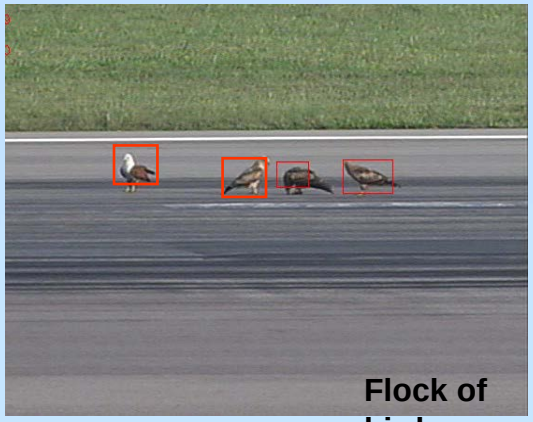
When we consider technology and wildlife, we must not forget that other sensors are now being deployed to airports. FOD detection systems are excellent wildlife detection devices and FOD systems provide wildlife detection on runways .



Flock of birds

Monitor lizard

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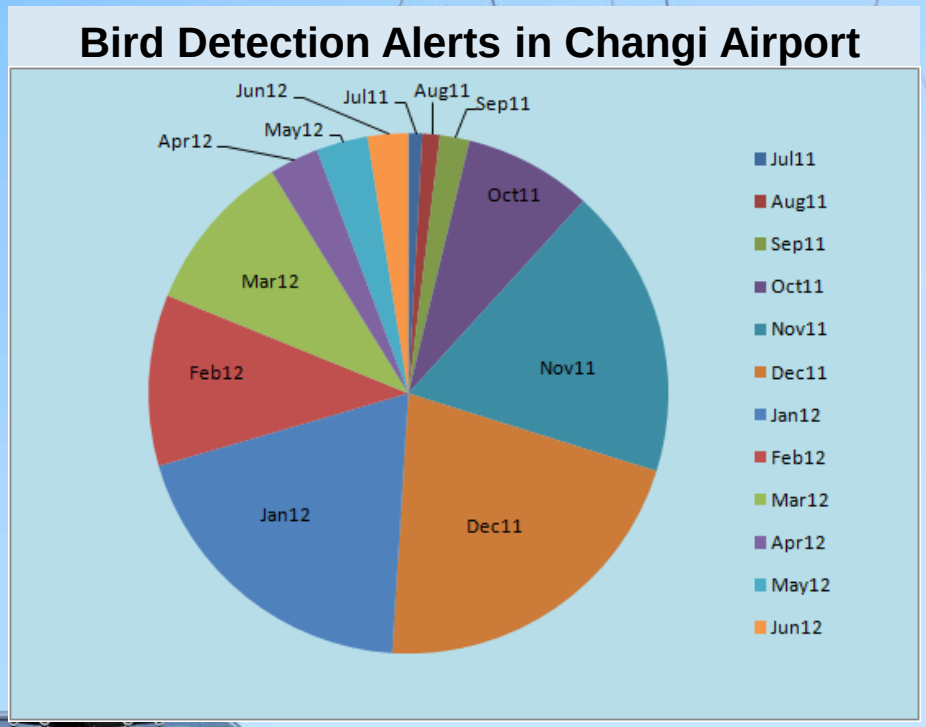
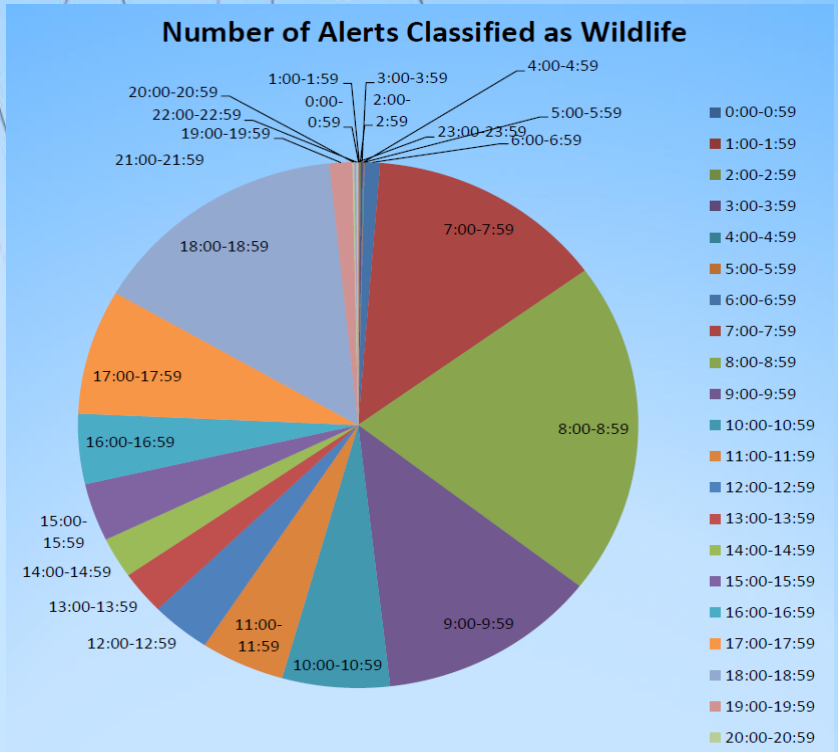
FOD detection systems also provide new data resources for wildlife managers with corresponding video records that confirm species/groups to support better hazard assessment.





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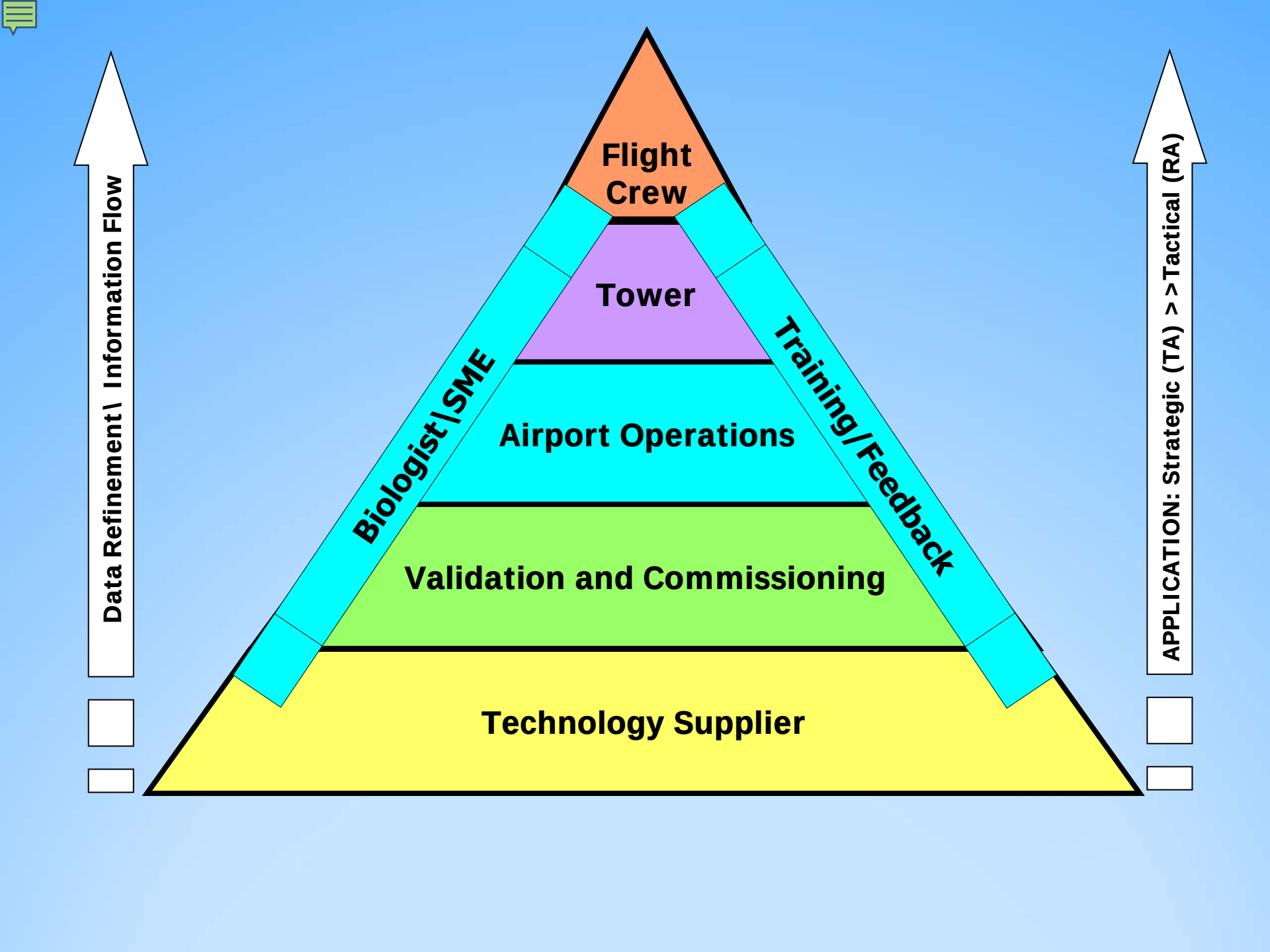
We can not ignore the advances in technology that modify the world where we live and work! Big data, the Cloud, hotspots all over the place, and countless other changes to the fabric of society are providing new options for old technologies and yet to be discovered options for present, and future, technologies.

We also need to consider the onrush of global connectivity! As things like birdstrike databases have web portals it is only a matter of time for harmonization. New options exist in webinars and distance learning. List servers are evolving to chat rooms and interactions among all of us see much happening between WBA conferences.

To end this presentation I would like to return to my earlier point. Technologies are simply tools for us to use. Although the Model T Ford could be maintained with a monkey wrench, modern times need modern tools!

One tool does not fit all in today's complex problem environment. We need to learn to select tools appropriate to need, and use multiple tools to maximize effectiveness.


Data Refinement\ Information Flow
Flight Crew
Tower
Airport Operations
Validation and Commissioning
Technology Supplier
Biologist\SME
Training/Feedback
APPLICATION: Strategic (TA) > >Tactical (RA)

Through all of our efforts to identify and use technology to supplement human capabilities and wildlife management, at airports we need to keep in mind the structure of the system where we operate.

Technology is only a starting point – there is much to be done in full operational integration that fully involves the human dimension.

QUESTIONS?

ASMP