Using Radar for Minimizing Aviation Bird Strikes: Don’t Overthink It!

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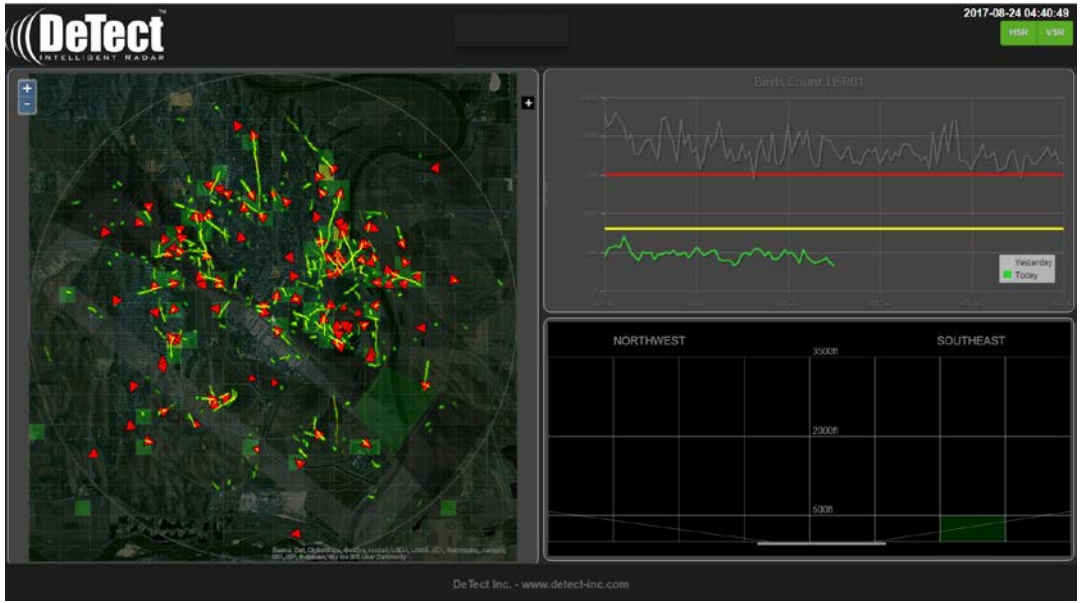

DeTect
INTELLIGENT RADAR

DeTect Inc.

- Integrated radar company founded in 2003
  - Research, engineering & manufacturing facilities in Florida USA
  - Offices in Washington DC & London England
- Over 400 radar systems delivered worldwide:
  - US, Canada, S. America, UK, Europe, Turkey, the Middle East, Africa, Asia & New Zealand
  - Representative customers:
    - US DoD (Air Force, Navy, Army, Marines)
    - US National Weather Service
    - NASA
    - Commercial airports
    - Utilities
    - Oil & gas companies
    - Mining companies

Factory, offices & corporate headquarters, Panama City, Florida USA

DeTect Global, Ltd. offices Horsham, England

DeTect
INTELLIGENT RADAR

DeTect Products

MERLIN

- Avian Hazard Advisory System
- MERLIN Aircraft Birdstrike Avoidance Radars
- MERLIN Avian Radar Systems
- MERLIN Bird Control Radars

HARRIER

- Airspace surveillance systems
- Marine surveillance network
- Ground Based Sense & Avoid (GBSAA)
- Aircraft Detection Lighting Systems (ADLS)

DRONEWATCHER

- RF detection & interdiction
- Smartphone drone detector APP
- Drone Surveillance Radar

NASA

NASA Avian Awareness Device for space shuttle launch support, Kennedy Space Center, Florida USA

Air & marine surveillance radar system, Kodiak Launch Complex, Alaska USA

ALASKA AEROSPACE CORPORATION

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Presentation Disclaimer

- I recognize that the title of my talk is a bit bold and some may take offense. That isn't my intent.

  "**Using Radar for Minimizing Aviation Bird Strikes: Don't Overthink It!**

- The goal of my presentation is not to scold the aviation community into using avian radars, but communicate that avian radars work and can be useful in minimizing aviation bird strikes.

- I am not trying to discredit all of the avian radar research that has been done. Research is good and needed. I support continued research and new tool development, as well as new techniques for synthesizing and using information.

- I am not a biologist, and I don't have any experience managing an airfield (excuse my ignorance).

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Personal Background

- My education background is Physical/Environmental Geography
- Graduate certificate in Geographical Information Systems.
- Although I am not a biologist, my entire career I have worked with biologists and biological data.
- I have been working with DeTect since 2006 on data analysis, radar siting and setup, software development, GIS, target classification, SQL database design/management and project management.

DeTect Solutions – Avian Radar Systems

Technologies originally developed by DeTect for the US Air Force (USAF) & NASA …

1. Avian Hazard Advisory System
    - ~40-45% of USAF birdstrikes occur on low level training routes & ranges
    - US national birdstrike risk alerting radar network
2. MERLIN Aircraft-Birdstrike Avoidance Radar (ABAR)
    - ~85% birdstrikes occur during airfield operations
    - New generation advanced aircraft-bird strike avoidance radars (ABAR)

USAF Avian Hazard Advisory System (www.usahas.com), CONUS

USAF 455th Expeditionary Wing birdstrike radar, Bagram Airbase, Afghanistan

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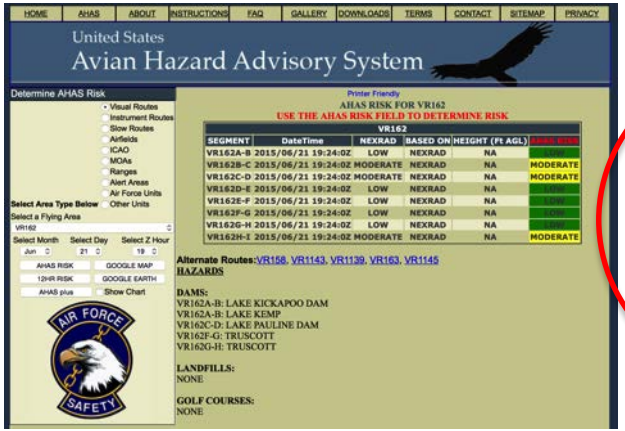
AHAS System

- Web-based system
  - Automated neural network system assigns risk levels on radar data & risk variables
  - Near-real time updates (6 minutes)
  - Includes historical radar data plus resource databases (wetlands, landfills, etc.) & birdstrike databases
- Bird strike risk advisories delivered upon user query through the AHAS website
  - Tabular or color-coded graphical risk data as LOW, MODERATE or SEVERE
  - Google Earth GIS-based system option
  - Email & text message alerts options
- Limitation – resolution too low for airfields



Use of AHAS has reduced low-level birdstrikes by over 50% in the 12 years it has been operating while increasing airspace availability

Using radars can reduce bird strikes

www.usahas.com

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MERLIN Aircraft Birdstrike Avoidance Radar

Operationally used birdstrike avoidance radar

- Real-time bird detection, tracking & strike risk-alerting for controllers, managers and bird control units
  - Programmable, solid-state Doppler radars developed specifically for bird detection
  - Bird radar software developed specifically to detect & track the unique characteristics of birds
- The most widely deployed bird radar with over 180 systems operating worldwide
  - Includes systems in operational use at military airfields & commercial airports since 2003

MERLIN™
AIRCRAFT BIRDSTRIKE AVOIDANCE RADAR

Jazan Airport, Saudi Arabia MERLIN system, General Authority of Civil Aviation

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MERLIN ABAR Evolution

- Early generation ABAR radar systems were useful in reducing bird strikes and providing situational awareness…..but….
- Improvement was needed

Common complaints from users

1) Too many dots on the screen. Unable to use information effectively.
2) High turnover rates with staff made it difficult to train new staff on the system
3) Persistent requests to simplify display and or customize
4) Avian Reports were not timely enough to make useful decisions and impact planning efforts.
5) Missions varied between commercial and military uses of the system.
6) Some users didn't trust that the system was detecting birds because they couldn't see them all with their eyes. False positives, vehicle tracking, airplane tracking, radar shadows, all can generate issues in employing a successful avian radar program.

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MERLIN ABAR Improvements

- DeTect worked closely with users to develop new concepts and displays (through workshops and project reviews)

The result of these efforts required DeTect to completely redesign our system in order to accomplish the needs of our users and the aviation community

- Merlin’s database platform migrated from MS Access to MS SQL Server. DeTect began to write data direct to an enterprise database system (revolutionized our technology).

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SQL Database system

SQL platform improved technology and user buy in

- Data is written directly to a spatial database which enables the user to define custom zones and user defined risk areas.

- Risk thresholds and the lookback time can be customized with database look up tables and user defined variables.

- Users have the ability to run multiple profiles with one radar (different displays and thresholds) based on aircraft type (heavies vs. fighter).

- Database platform permitted customers concepts and ideas to come into fruition without a complete overhaul of the software. Missions vary between airfields (flexibility was needed).

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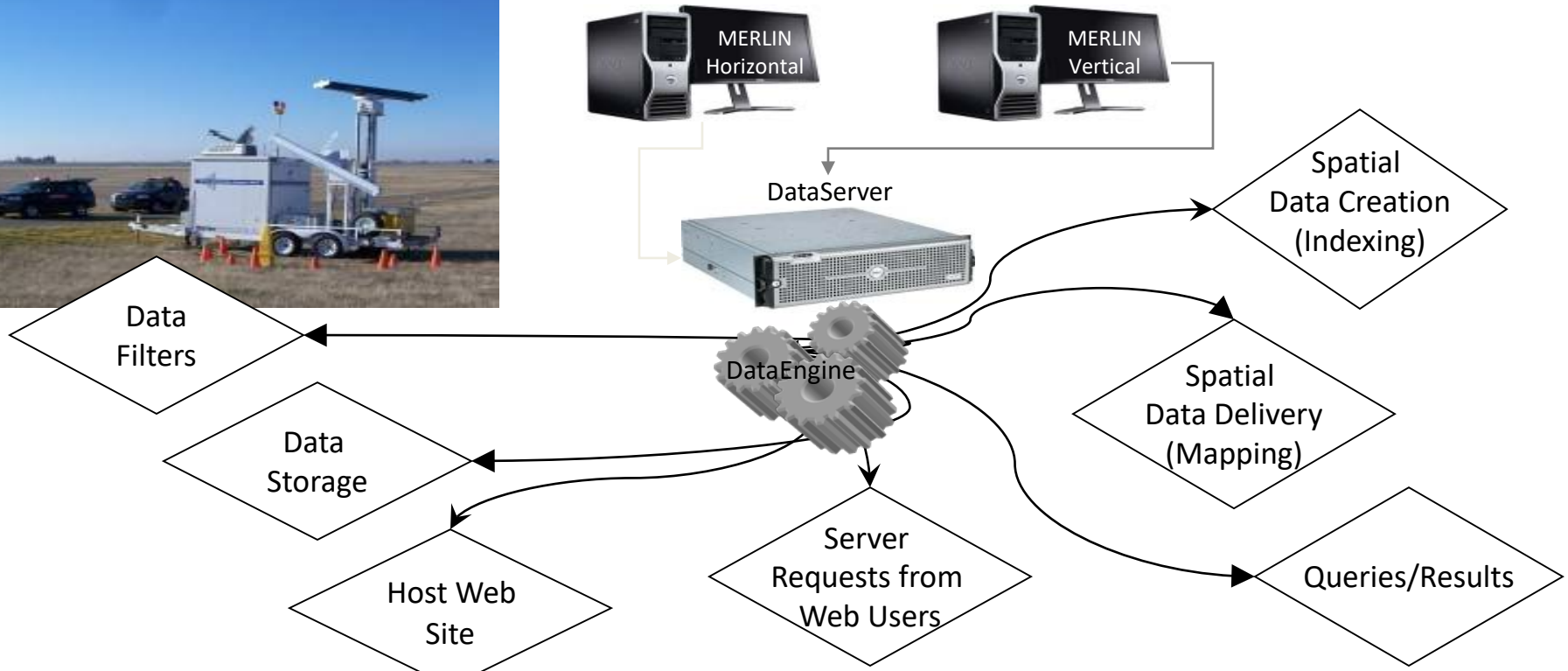
SQL Database system (continued)

- Avian reports could now be generated very quickly (available at the start of the workday)
- Avian reports can be generated on the system for much longer time periods (annual, seasonal, weekly, etc.).
- Displays moved to a web-based platform. Streamlined display updates.
- Allowed multiple users on the airfield to get access to the display.
- Data integration from other systems can be integrated with ease (ADSB, cameras, TCAS, DroneWatcher Detections).
- Display is based on a GIS platform. New data is added as a layer that can be turned on and off by the user.

Functions of MERLIN SQL Server



MERLIN Birdstrike Risk Alerting

The Challenge:

Avian radar can ‘see’ more birds than the human eye in all directions & at greater distances

Hundreds to thousands of birds can be active around an airport at any time

What a human observer ‘sees’

USAF 509th Bombing Wing birdstrike radar system, Whiteman AFB, Missouri USA

MERLIN Birdstrike Risk Alerting

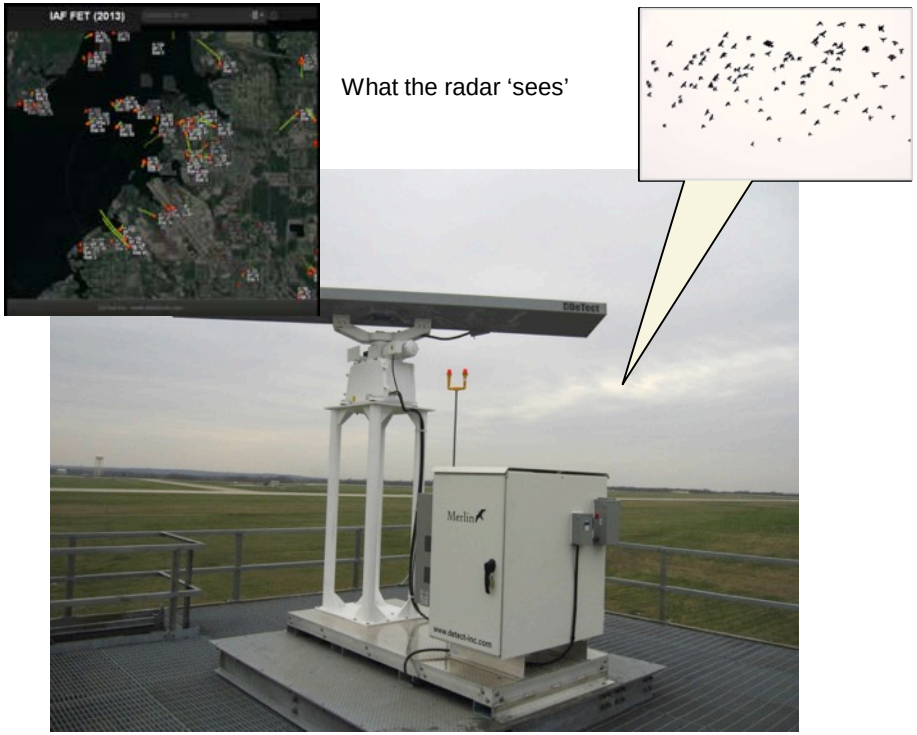
The Challenge:

Avian radar can ‘see’ more birds than the human eye in all directions & at greater distances

Hundreds to thousands of birds can be active around an airport at any time

Too many targets for a controller to assess & determine level of risk manually

How do you ‘distill’ the bird radar data in real-time into information that is usable to controllers, airfield managers & pilots in the high tempo environment of an airfield?



USAF 509th Bombing Wing birdstrike radar system, Whiteman AFB, Missouri USA

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MERLIN Birdstrike Risk Alerting – MERLIN Advisor

The Answer:

MERLIN Advisor …

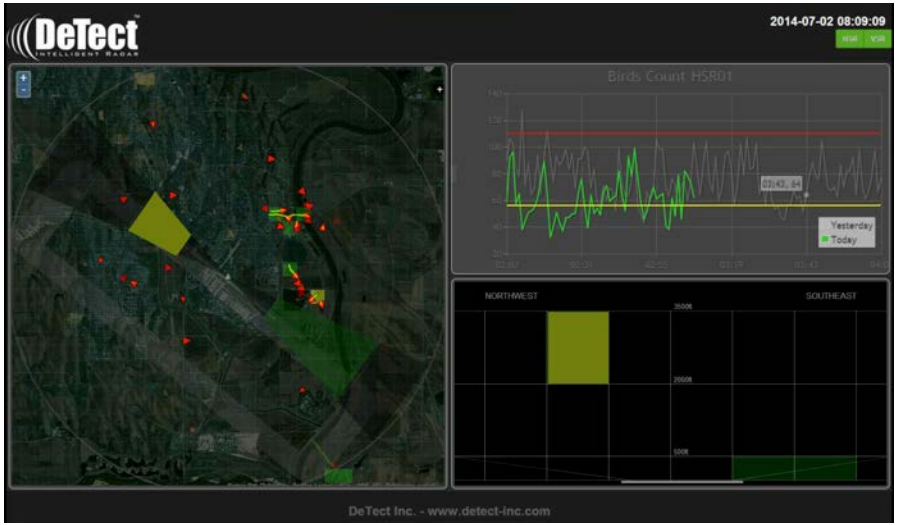
- Web-based, user programmable information, real-time display
- Continuously monitors current bird activity by user defined zones
- Internal SQL Datasystem converts activity based on location, size, mass & number to color-coded risk

  Green = LOW

  Yellow = MODERATE

  Red = SEVERE

- Visual, audible & text message/email alerts to local & remote user displays



USAF 55th Intelligence Wing birdstrike radar system, Offutt AFB, Nebraska USA

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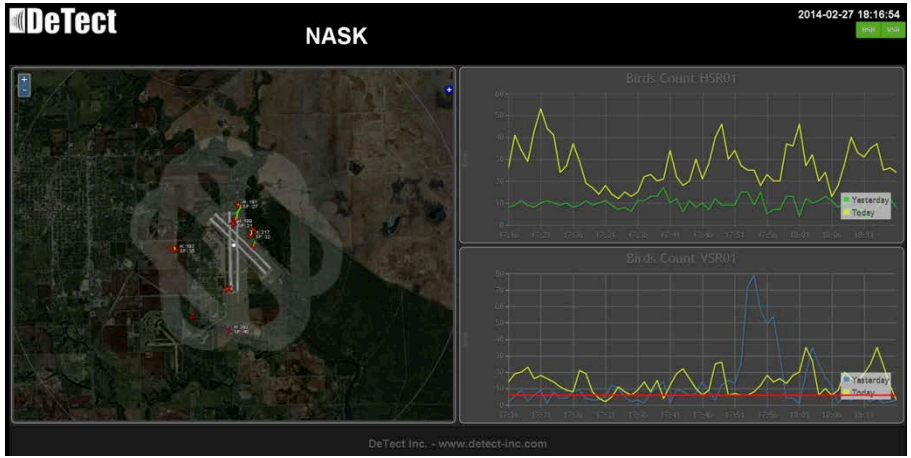
MERLIN Advisor

- Developed with input from Air Traffic Controllers, Flight Safety Officers & pilots
  - The only automated birdstrike risk alerting system in operational use at military airfields
- Highlights bird activity areas for prompt advisories to pilots
  - Audible & visual alerts when risk changes (increase & decrease)
  - User adaptable system provides as much or as little detail as each user requires
- MERLIN SQL Datasystem archives all data in real-time
  - Real-time forecasting of risk based on historic information
  - Historical trend BASH reporting



US Navy Training Wing 2, Naval Air Station Kingsville, Texas USA

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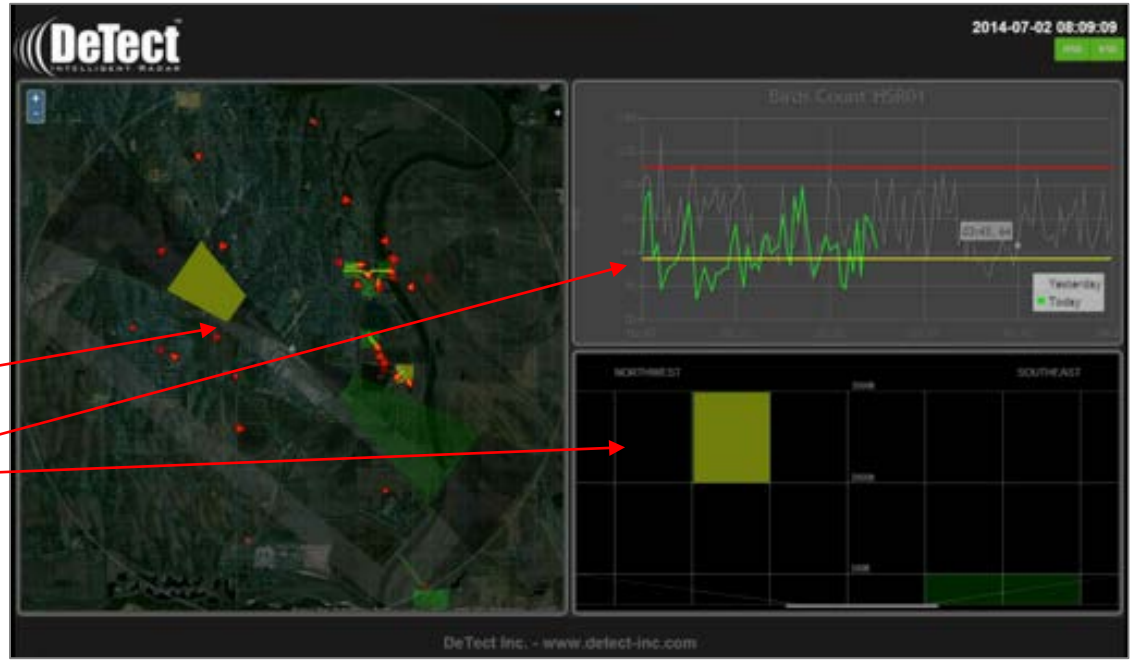
Merlin Advisor Display Panels

The MERLIN Advisor Displays combines both Vertical and Horizontal risk activity on one display.

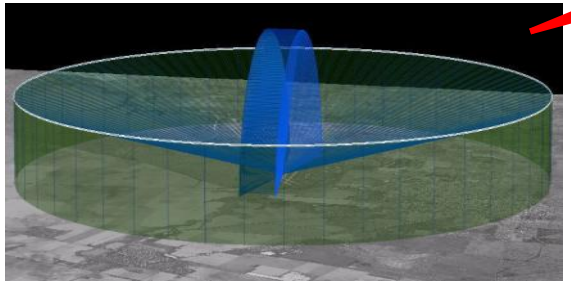
The display is made of 3 panels

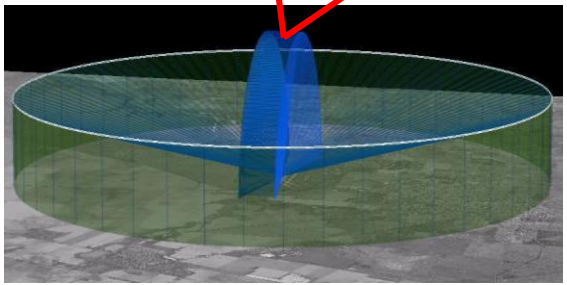
1. **Main overview both HSR &VSR info**
2. **HSR graph (providing risk threshold info)**
3. **Side profile VSR grids (providing altitude and range info)**



Radar Coverage Area

This is a breakdown of the HSR and VSR coverage area and where each panel gets it's information.





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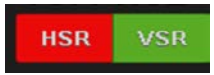
Horizontal / Vertical Display Features

- Zoom Selections
  (Double clicking on the display also allows you to zoom in)
- Display Settings
- Radar Status Indicator

[Note: in this example the red HSR (Horizontal Scanning Radar) would indicate the HSR is down but VSR in green is ok.]



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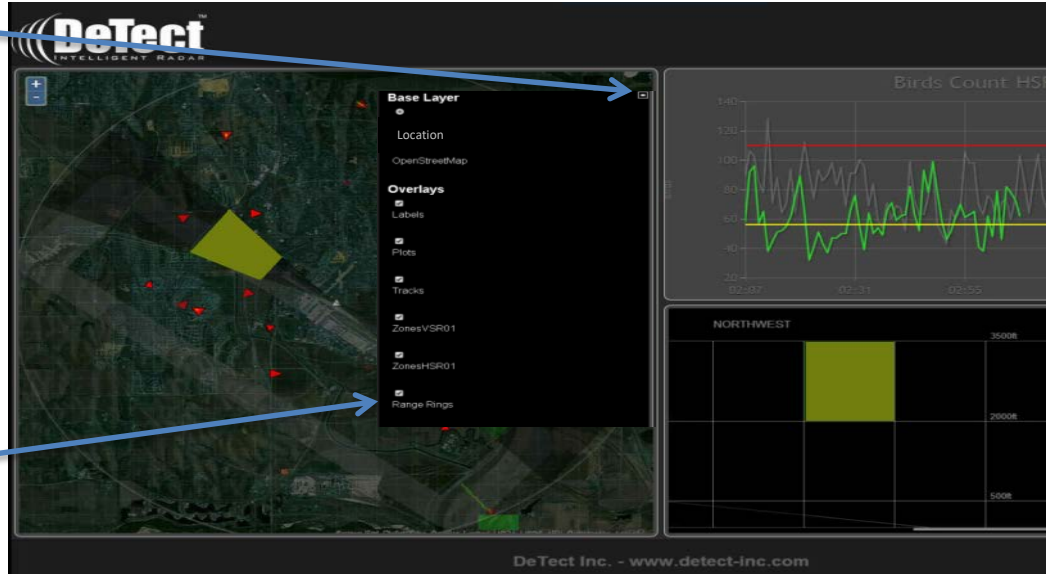
Display Settings Drop Down Menu Options

- Located in the upper right hand corner of the display, is a  To display the drop down menu click on the 
- This allows you to change options for what you would like displayed.
- Display options:
  - Labels
  - Plots
  - Tracks
  - ZonesVSR
  - ZonesHSR
  - Range Rings



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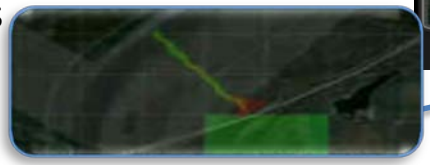
Drop Down Menu - Plot ( ) and Tracks ( ) Options

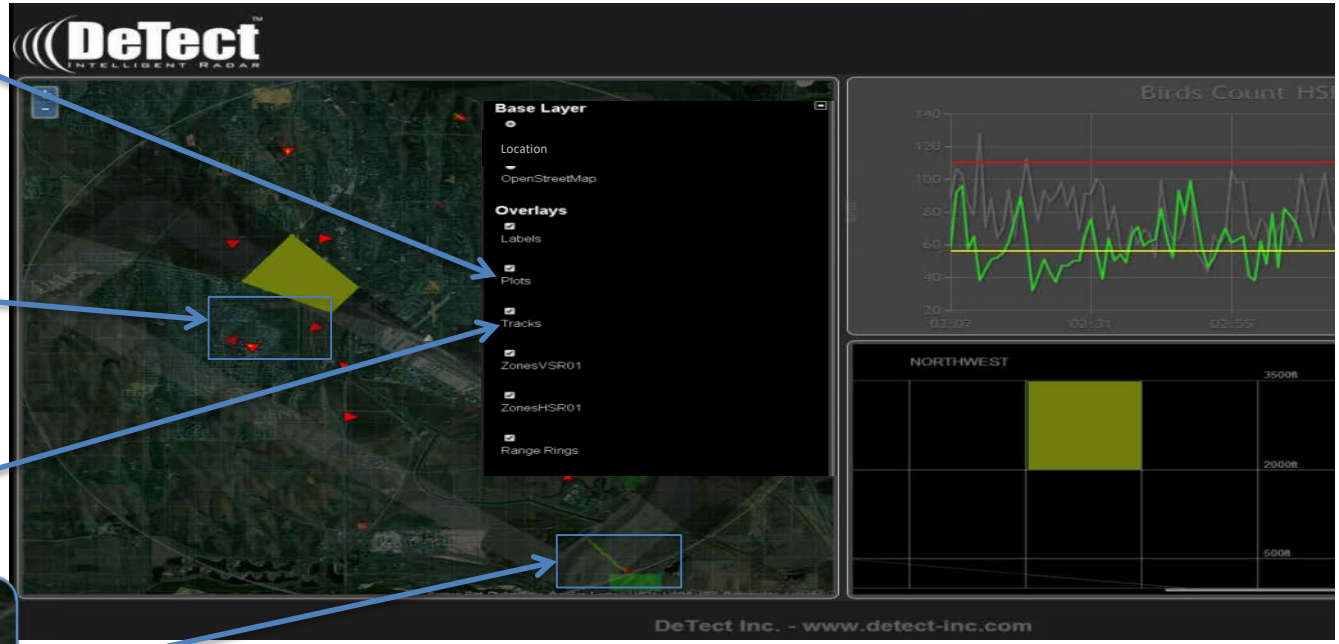
- Clicking (Plots) turns on the red triangles (the size of the triangle represents the size of the bird being tracked)

(Zoomed in view - Plots)

- Clicking (Tracks) turns on the yellow line behind the plots



(Zoomed in view -Tracks)



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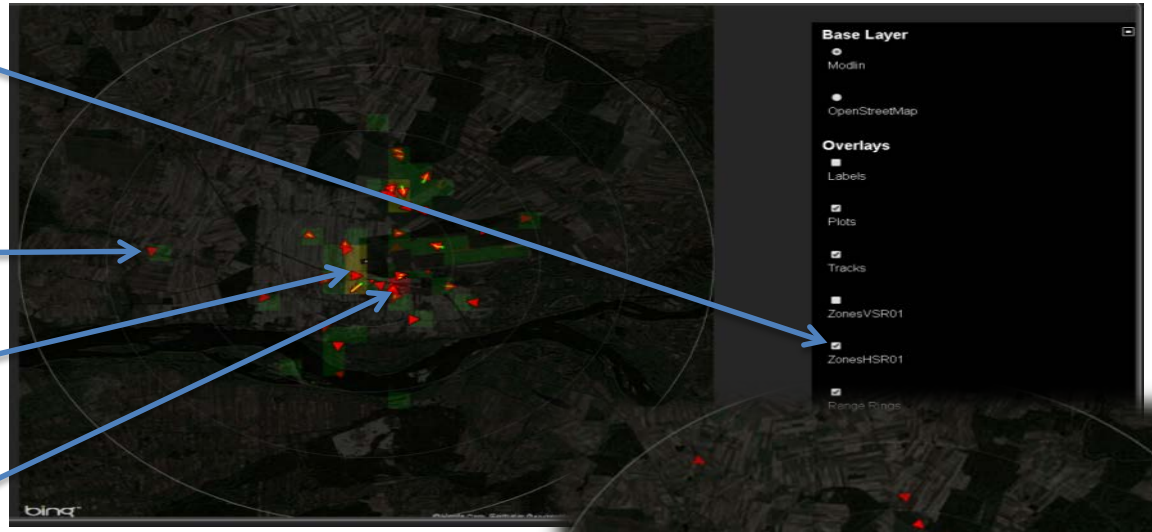
Drop Down Menu – ZonesHSR01 ( ) Option

- Clicking (ZonesHSR01) turns on the transparent zones. They are color coded for the Risk Level:
  - Green Low
  - Yellow Moderate
  - Red Severe

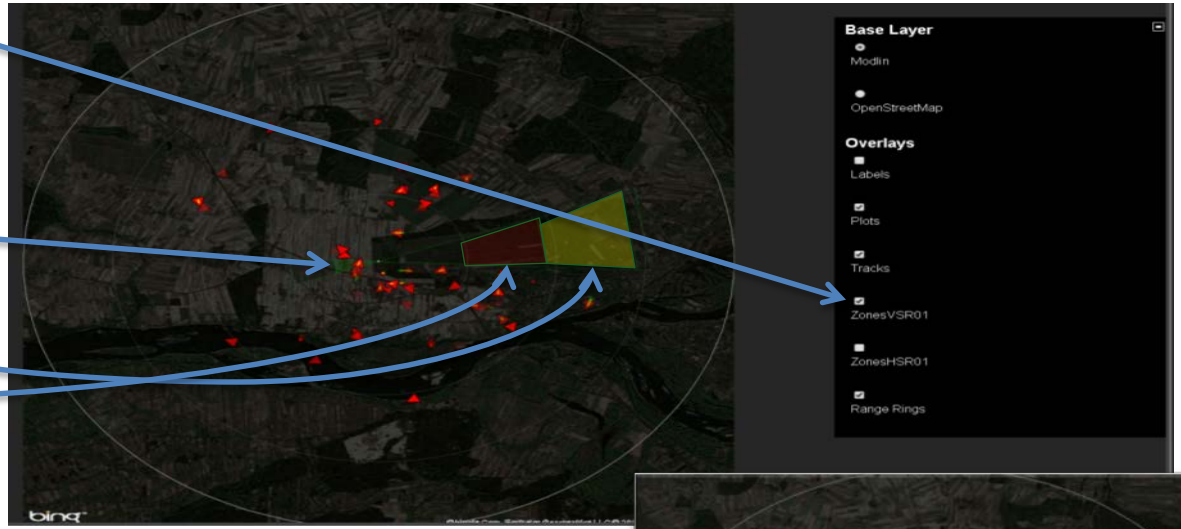


- The risk level is determined by how many targets are in the zone.

- Image with ZonesHSR01 turned Off

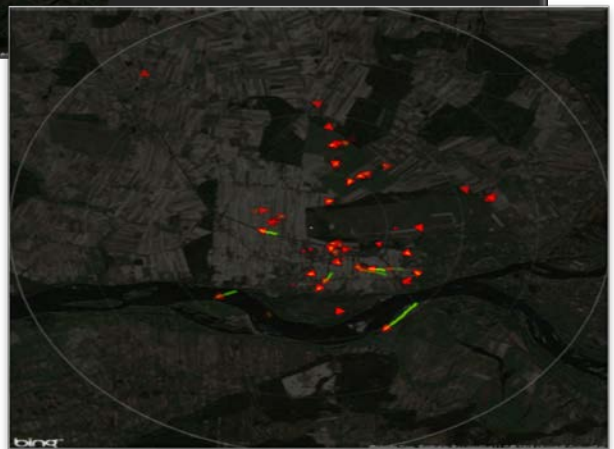
Drop Down Menu – ZonesVR01 ( ) Option

- Clicking (ZonesVSR01) turns on the transparent zones. They are color coded for the Risk Level:
  - Green Low
  - Yellow Moderate
  - Red Severe



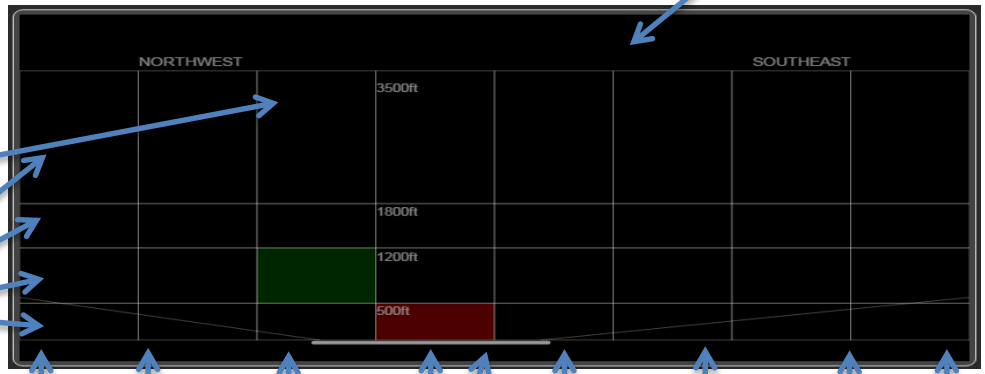
- The risk level is determined by how many targets are in the zone.

- Image with ZonesVSR01 turned Off



Vertical Zone & Altitude Band Panel

- The bottom right panel provides zone and altitude band information. This is a side profile view of the vertical coverage area. This sample shows 4 zones for the approach and 4 zones for the departure a total of 8.
- In this example each zone is broken into 3 altitude bands. Band 1 is 0-500-ft AGL, Band 2 is 500-2000-ft AGL and Band 3 is 2000-3500-ft AGL.
- This display can have multiple zones and up to 5 different altitude bands.
- The bands can be in feet or meters, and can cover any variation of altitude measurements (only limited to max VSR coverage area).



Altitude Band Showing Moderate Risk

4 Altitude Bands

4 Approach Zones

Runway

4 Departure Zones

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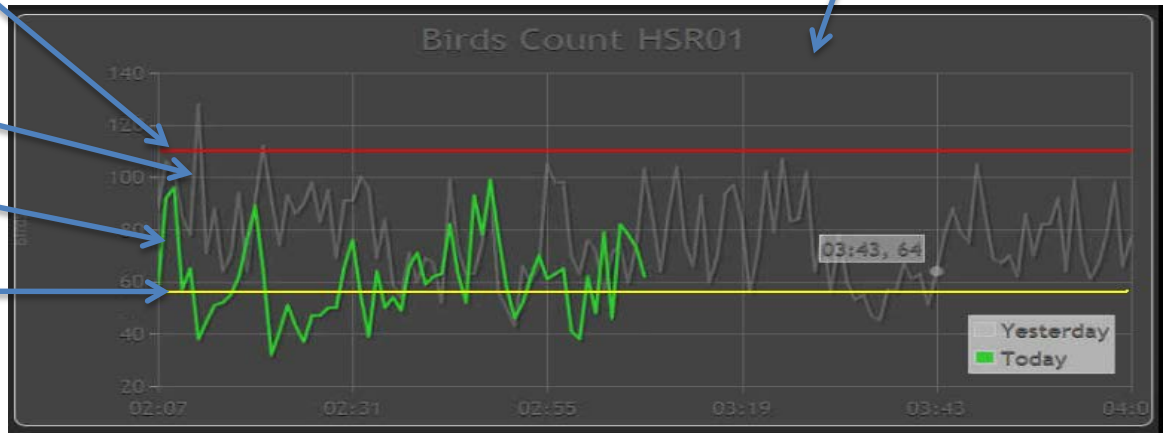
Horizontal Graph Panel

This HSR Graph is a real time update of the total activity in the HSR coverage area. Note where the green line stops is real time data and updated every 2 seconds. The gray line is displays 1 hour into the future to allow for comparison of upcoming spikes in activity from the previous day.

- The Red static line indicates the "High Risk Threshold" (this is site specific and based on birdstrike data and radar data)
- The Gray line indicates "Yesterdays Activity"
- The Green line indicates "Today's Activity"
- The yellow static line indicates the "Moderate Risk Threshold" (this is site specific and based on birdstrike data and radar data)



Note: The graph scales to the current level of activity so often the red and yellow lines will not be present. They will only be present when the activity reaches the threshold levels set.

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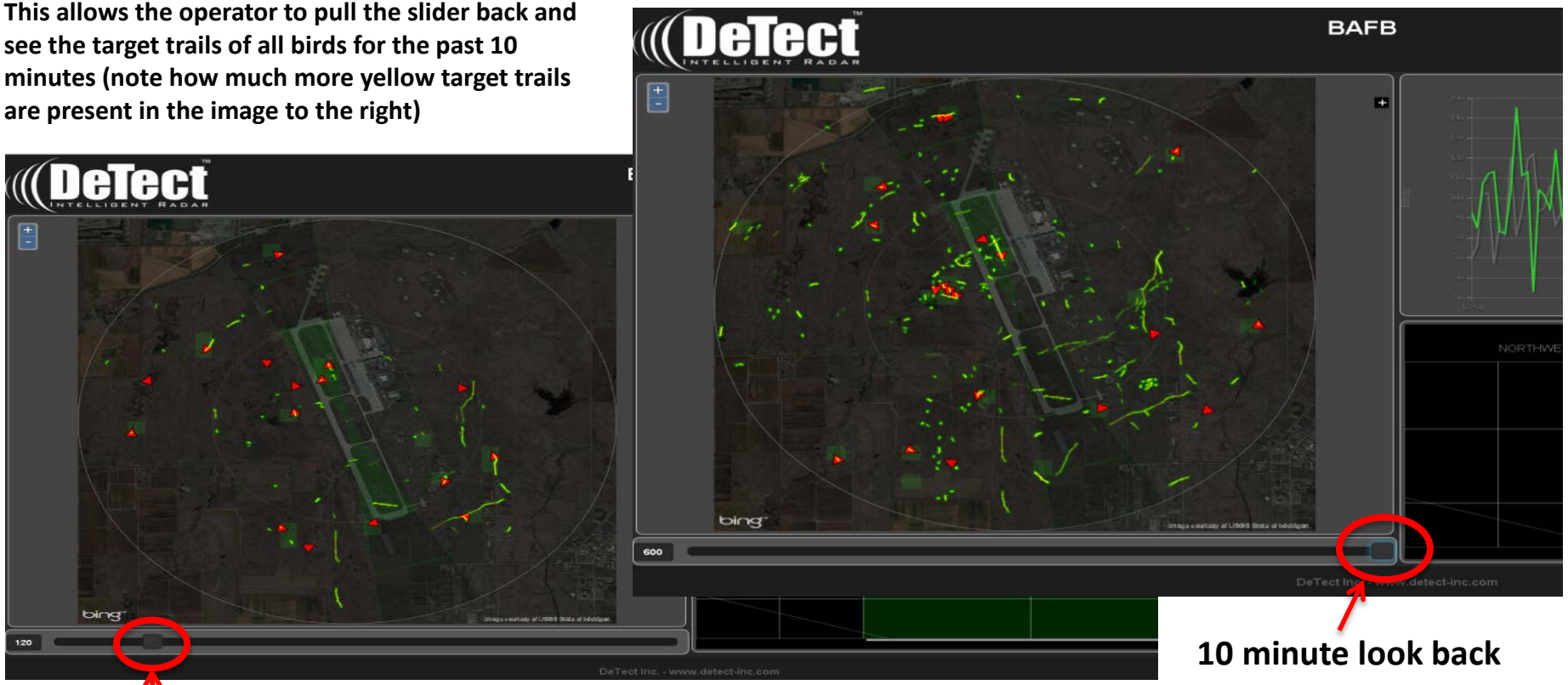
Current time with 10 minute look back

This allows the operator to pull the slider back and see the target trails of all birds for the past 10 minutes (note how much more yellow target trails are present in the image to the right)



10 minute look back

Slight look back

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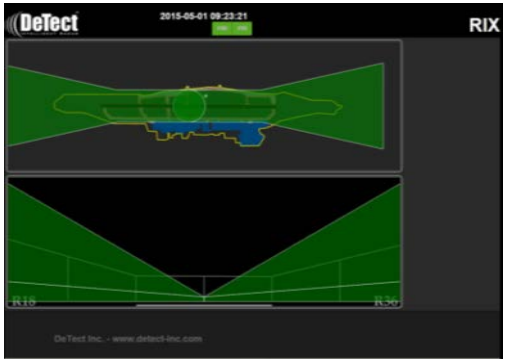
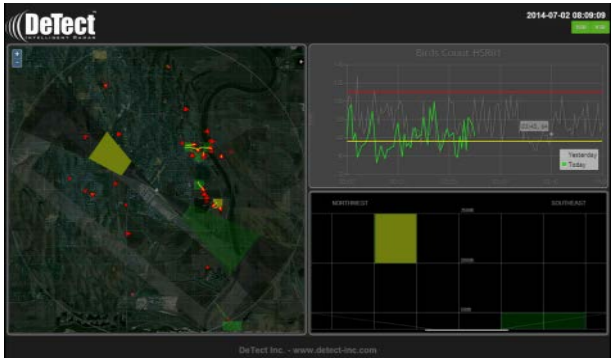
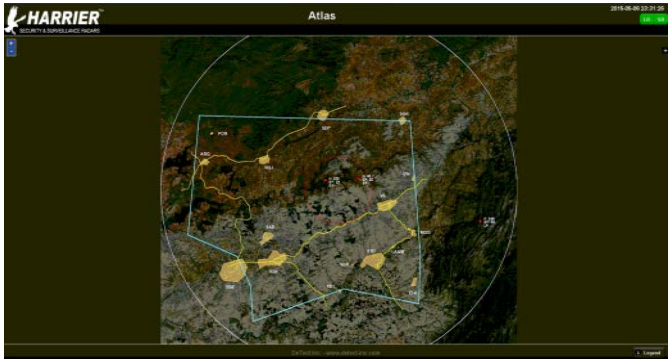
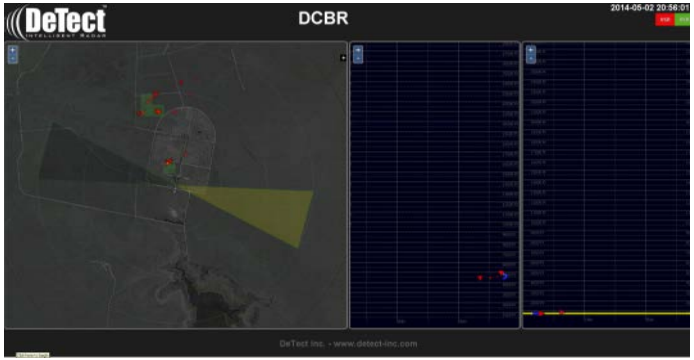
Display Options









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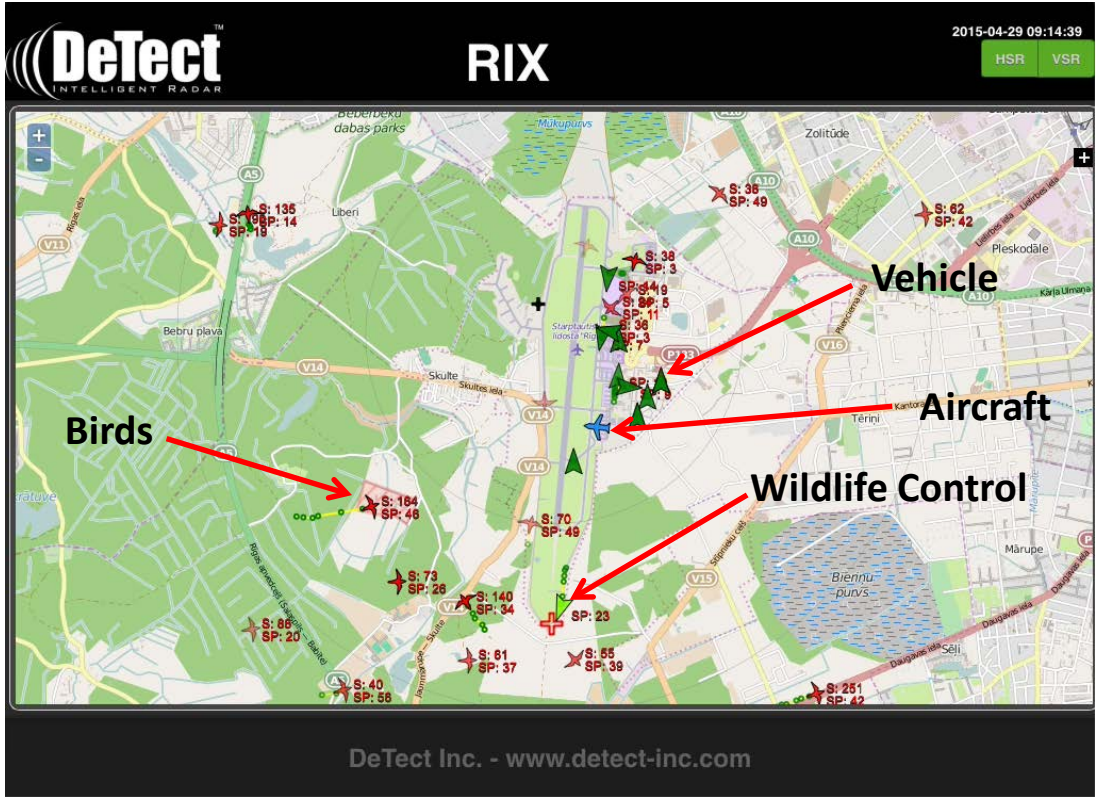
Display Options (ADSB)

Binding targets from multiple devices and outputting them onto one display.

- Birds
- Aircraft
- Vehicles
- Custom tag for Wildlife Control



Radar-based Industrial Bird Control

- Add-on functionality to MERLIN
- Provides automated activated of bird deterrent devices when birds are detected by the MERLIN radar
- Interfaces with most bird deterrent devices (gas cannons, bioacoustics, LRADs, lasers, pop-up effigies)
- User definable, unlimited number of control zones
- Variable deterrent application lowers habituation risk

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Advanced Deterrent Units

- **Extended Range Bioacoustic Units**
  - Focused, long-range speaker units
  - Effective bird hazing at up to 1 km
  - Most effective bird control device available
- **Laser Deterrent Units**
  - Bird hazing lasers (eye-safe green or blue)
  - Computer controlled to sweep pond surfaces
  - Effective in low light & fog conditions

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NASA Avian Awareness Device

- Turkey vulture strike during 2005 space shuttle launch
  - Second highest safety risk for space shuttle Return-to-Flight
- NASA & Navy radar engineers evaluated and tested radars at KSC in 2006
- NASA selected MERLIN to support the return-to-flight launch (STS-121) on July 4, 2006
  - Required custom radars, safety features & displays
  - System certified by NASA as a critical safety system for the shuttle program
- MERLIN successfully used on 22 shuttle launches with 100% uptime

Turkey vulture strike at launch, July 2005

"Your system worked like a champ and allowed us to launch the Space shuttle Discovery safely July 4, 2006 on her STS 121 Mission to the International Space Station."

- Mike Leinbach, NASA Launch Director

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MERLIN – Military Airfields & Ranges

US Navy Dare County Bombing Range, North Carolina (2003, upgraded to solid-state in 2013)

USAF Dover AFB, Delaware (2006, scheduled for solid-state upgrade)

USAF Whiteman AFB, Missouri (2007, upgraded to solid-state in 2010)

USAF Beale AFB, California (2008)

USAF Offutt AFB, Nebraska (2009, replaced with solid-state unit in 2014)

USAF Bagram Airbase, Afghanistan (2010-2014; now at Offutt AFB)

US Navy Kingsville Naval Air Station (2011)

US Navy Townsend Bombing Range (2014)

USAF Randolph AFB, Texas (2016)

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AIRCRAFT BIRDSTRIKE AVOIDANCE RADAR

US Navy Beaufort, Townsend Bombing Range, Georgia USA

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MERLIN - Commercial Airports

- Louisville IAP, Louisville, Kentucky, USA (2004)
- Durban IAP, South Africa (2008)
- Riga International Airport, Latvia (2010)
- Abuja International Airport, Nigeria (2012)
- Warsaw-Modlin IAP, Poland (2012)
- US Federal Aviation Administration (2010)
- Jazan IAP, Saudi Arabia (2015)

Dashogouz IAP, Turkmenistan (2015)

Turkmenabat IAP, Turkmenistan (2016)

Ashgabat IAP, Turkmenistan (2017)

Panama City IAP, Florida USA (2017)

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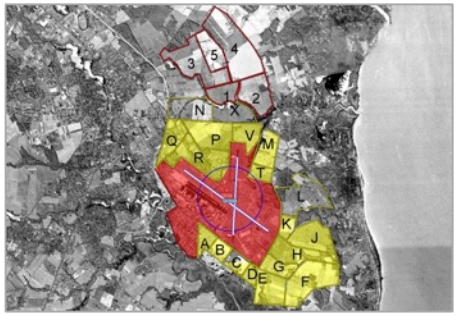
Concept of Operations (CONOPS)

How is MERLIN Advisor used to reduce bird strike risk?

1. Tactical (real-time):
    a. ATC advisories to pilots
    b. Wildlife control dispersion
2. Strategic (management & planning):
    a. Trends analysis for high risk periods for flight planning
    b. Identify ‘hotspots’ of bird activity on & off the airfield
    c. Use trend data to improve management initiatives



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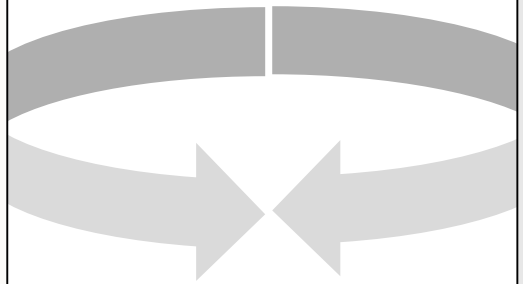
Tactical Use of MERLIN Advisories

Users – Procedures & Responses

Air Traffic Control

1. Advise aircraft on approach
2. Direct & coordinate Wildlife Control Team dispersal actions
3. Hold departing aircraft until risk lowers or is dispersed



Wildlife Control Team

- Directs team to high risk areas
- Track birds as they are dispersed from hot spots to determine next location
- Pursue birds to off airport locations when necessary

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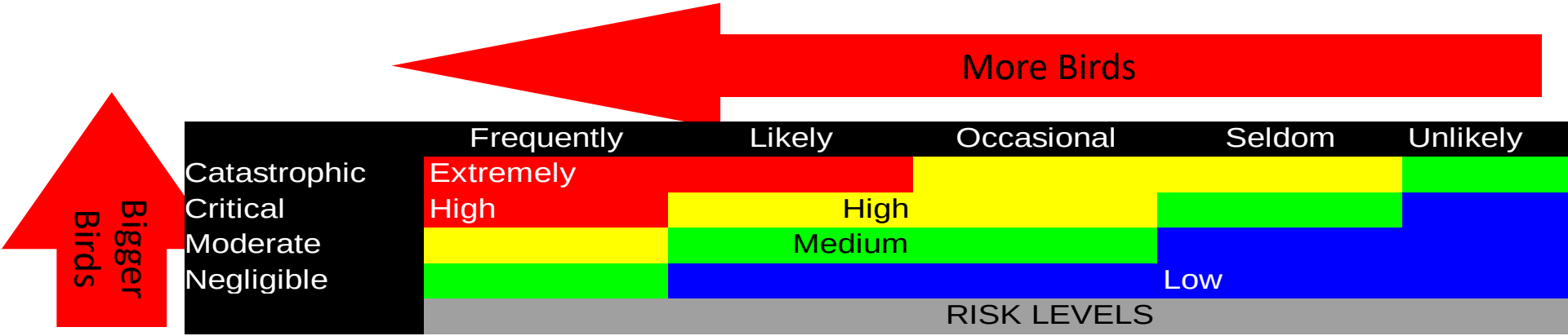
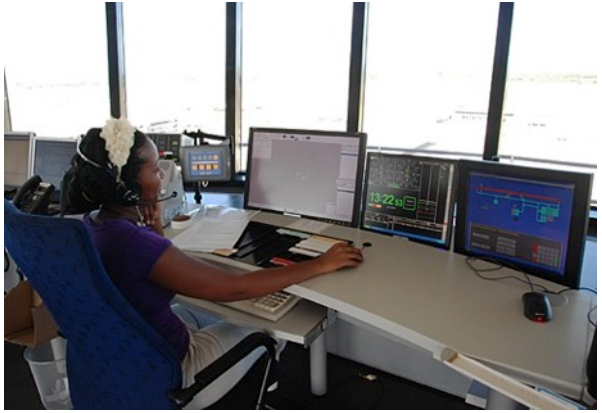
MERLIN: Concept of operations for Civil Aviation

- Radar-based Risk Calculations
  - What is Operational Risk?



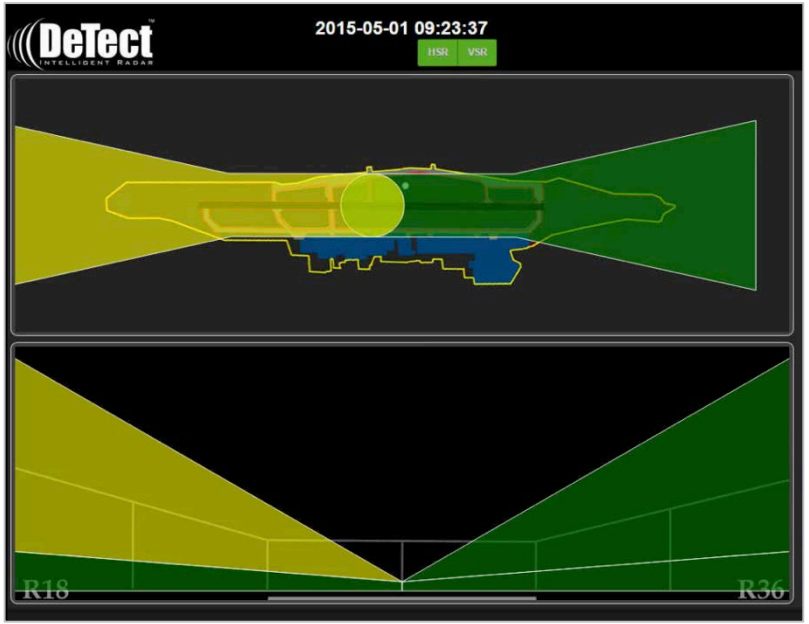
Tactical – ATC (DUR) Low Level Detail



- King Shaka La Mercy IAP, South Africa was the first airport in the world to use real-time bird radar advisories in the tower (2009)
- DeTect worked with ACSA & the South African National Air Traffic Navigation Services (ATNS) to develop the first national rule for use of bird radars in national airspace
- The tower uses a custom MERLIN Advisor ‘Go’ (GREEN) or ‘No Go’ (RED) audible and visual alerting display to relay real-time risk to pilots

Tactical – ATC (RIX) Mid Level Detail

RIX
RIGA INTERNATIONAL AIRPORT



- Riga International Airport, Latvia uses a zoned MERLIN Advisor display in the air traffic control tower
- Provides real-time, color-coded & audible risk alerts to controllers who relay the information to pilots
- Display is color-coded into zones for risk for the AOA & approach & departure corridors by position & altitude

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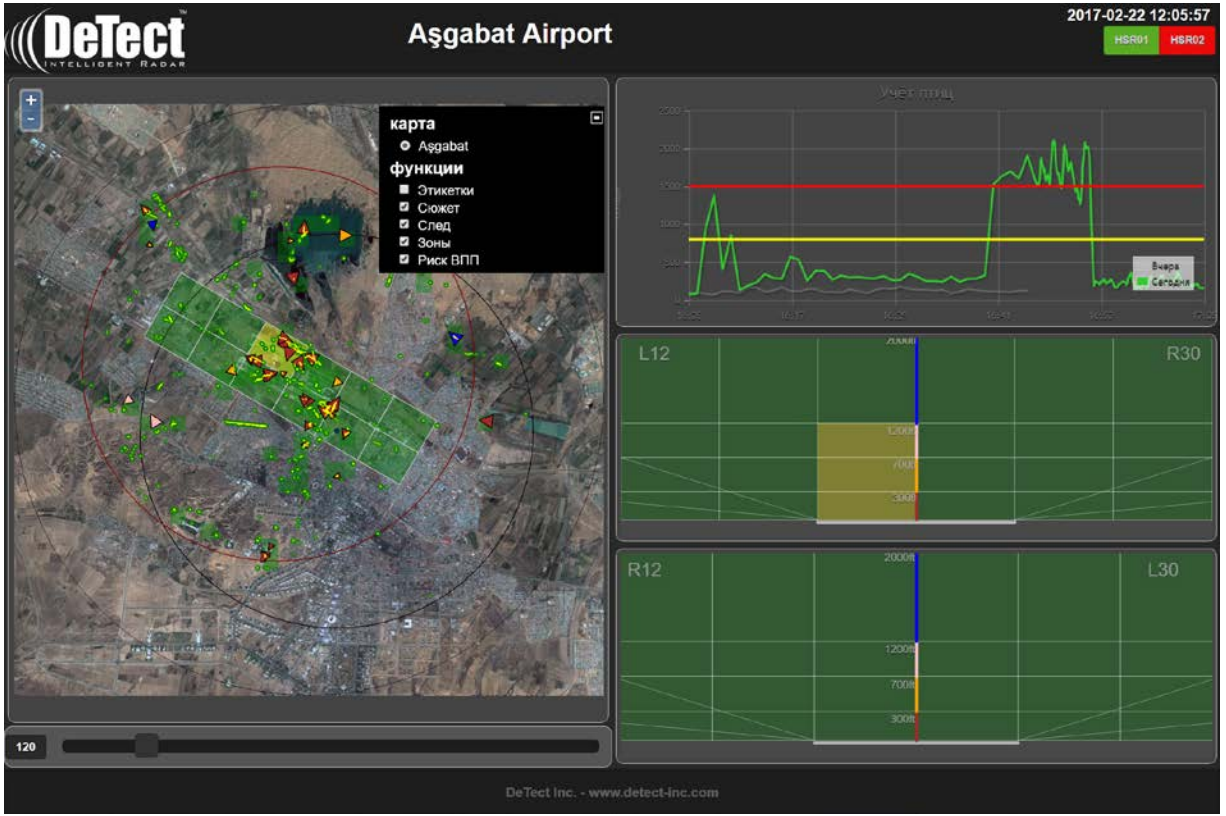
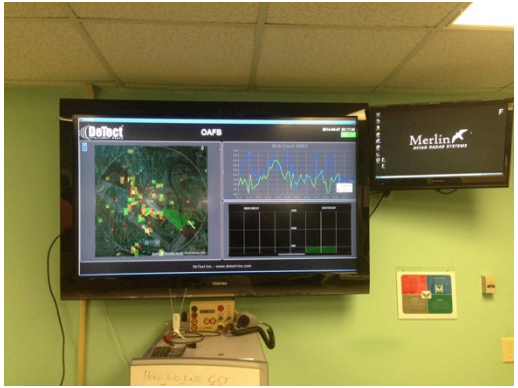
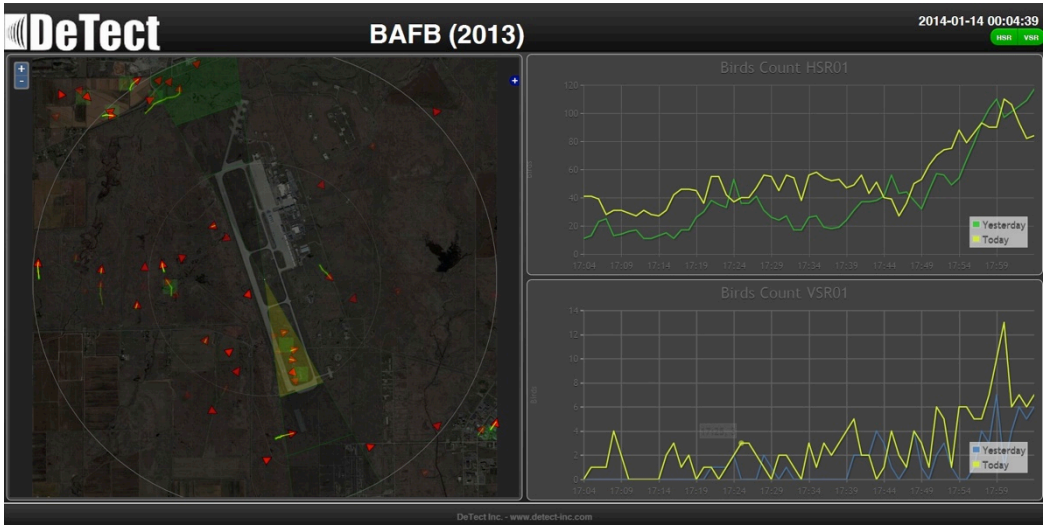
Tactical (3D) – ATC (ASB) Mid Level Detail



Tactical – ATC (USAF/USN) High Level Detail



- Zoned MERLIN Advisor display in ATC
- Real-time, color-coded & audible risk alerts to controllers who relay the information to pilots
- Color-coded risk zones & graph for the airfield & approach & departure corridors



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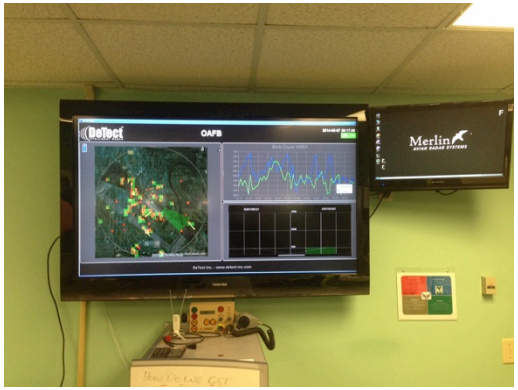
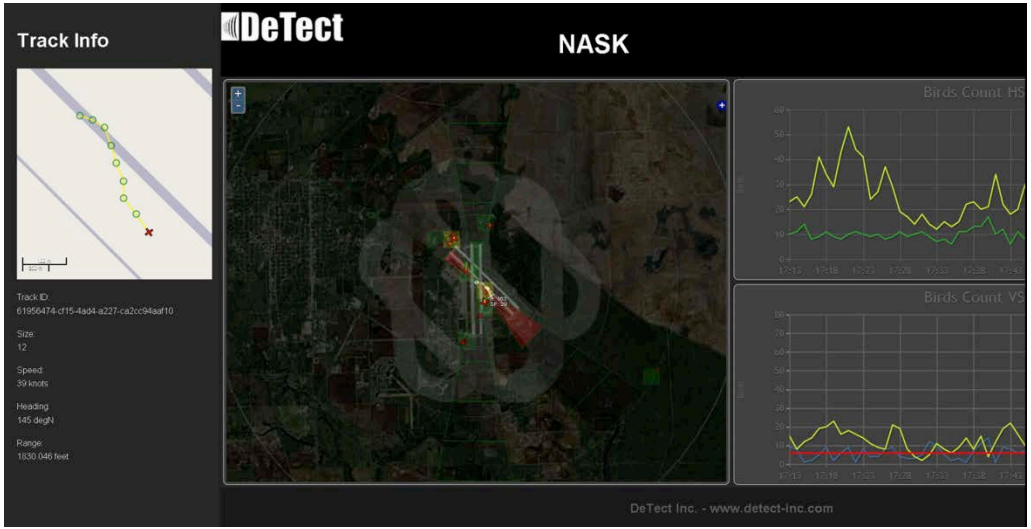
Tactical – ATC (USAF/USN) High Level



- Zoned MERLIN Advisor display in ATC
- Real-time, color-coded & audible risk alerts to controllers who relay the information to pilots
- Color-coded risk zones & graph for the airfield & approach & departure corridors
- Onscreen user detail selection
- Track inspector (online zoom feature)



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Tactical – Wildlife Control (WMI)

warsaw modlin airport

Bird radar displays & alerts of high activity areas are relayed in real-time to Bird Control vehicles

Different symbols for aircraft & birds

Use remote, mobile tablet & notebook displays via airport wireless & cellular network

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MERLIN Results …

- Since implementing the DeTect-developed US National Avian Hazard Advisory System (AHAS) in 2003, the US Air Force has reduced bird strikes & damage costs on low-level routes & ranges by more than 50%.
- USAF Dare County Bombing Range, North Carolina USA has eliminated Class A, B, and C strikes at the range as well as increasing range operation availability, saving over $4 million (USD) annually since installing a MERLIN system in 2003.
- USAF Offutt AFB has dramatically reduced reported strikes while opening the airfield for increased operations during migratory season.
- USAF Dover AFB, Beale AFB & Whiteman AFB have all increased airfield operating windows during hazardous seasons while reducing damaging strikes.
- US Navy Naval Air Station Kingsville credited MERLIN Advisor with preventing a Class A strike that would have likely resulted in loss of the T-45 trainer & a potential student pilot fatality.
- NASA used the MERLIN ABAR system for all of the final 22 shuttle launches without incident or delay (100% uptime).

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Airport/Regulatory Considerations

- While the issues are complex, a lot of the hard work has been done over the years by customers, airfield operators, biologists, scientists, regulators, and radar vendors. It isn't necessary to start at square 1.
- Purchasing a new asset can be a challenge for an airport. (Lease vs. Buy)?
- Who is going to use it? How is it going to be used? Who is going to manage and maintain it?
- Work with your radar vendor on explaining how you envision the system helping with your BASH program. What is a realistic approach to phasing this into operations?
- Understand that this is a tool in the toolbox. Users that embrace this mentality get positive results.
- **Liability is a major concern for users. Action and/or in-action is a concern that some users are not willing to accept. This can be a crippling mentality to embrace and is preventing broader use of avian radars, despite advances in technology and proven results. Don't overthink it!**

DeTect INTELLIGENT RADAR

Questions?

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