



For Airport Safety and Capacity

FODetect®

Automatic FOD Detection System

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Xsight Systems

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Proprietary and Confidential

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The Vision

To provide airport operators with absolute control and monitoring of their main source of revenue - the runways, and enhance safety of operations and capacity.

Since 2001!



THALES

18-Oct-10

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XSiGHT
Safe Runways. Always.

The FOD Problem



FODetect in News Broadcasts Worldwide



New York Times with the FAA



TF1 news – France



Channel 5 News - Boston

Videos can be viewed on the Xsight website,

www.xsightsys.com/newsbroadcasts.htm

THALES



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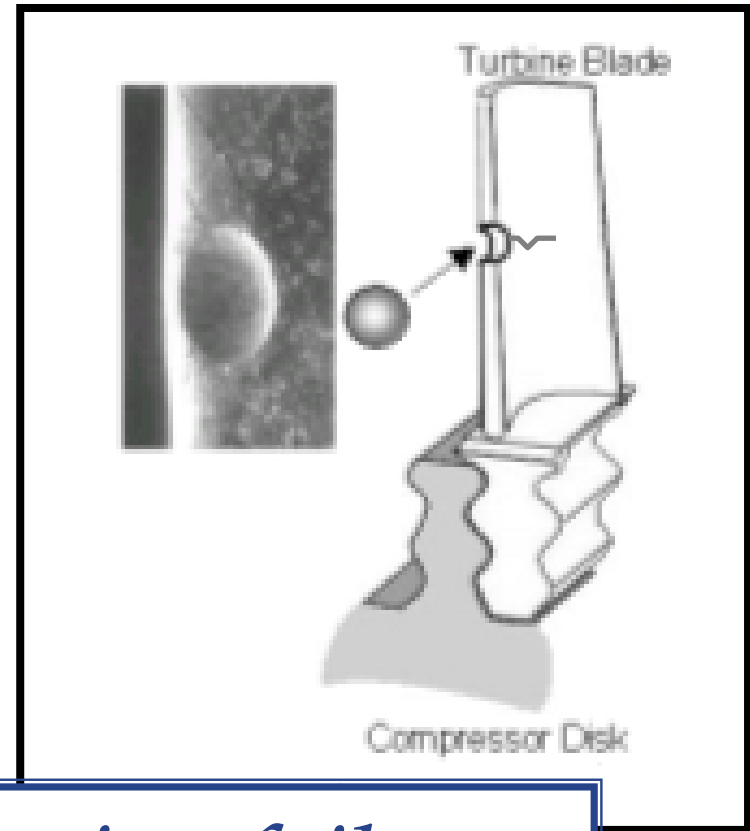
The FOD Problem: Tire Incident examples

- July 24, 2003 – B747 returned to Tel Aviv's Ben-Gurion A/P shortly after takeoff due to **damaged landing gear**
- August 11, 2005 – B747 tire punctured on landing at Tokyo's Narita A/P. R/W closed for **24 minutes**.
- December 19, 2005 – B747-400, **four tires blew** during takeoff from LAX. FODs were scattered across airport runways and taxiways.
- March 2, 2007, Newport News, Va. Bombardier Learjet 36A, FOD caused a **burst tire during takeoff**. Aborting the takeoff, crew tried to control the “fishtailing” and activate the drag chute unsuccessfully, the aircraft ran off the runway.
- October 1, 2008 Columbia (S.C.) Metro Airport, Learjet 60SE. Tire blow-out during takeoff, pilot aborts at 80 knots overrunning runway and perimeter fence and crossing a road.
4 fatalities, 2 survivors burned by post crash fire. NTSB currently investigating cause.



The FOD Problem: Turbine Blades

- Aircraft turbine engines routinely experience ingestion of debris resulting in FOD.
- Such damage can dramatically reduce the lifetime of engines.



FOD can cause engine failure

The FOD Problem: Annual Damage

- \$4b direct damage for entire industry¹
- Analysis of 300 largest airports:²
 - 70,000 FOD incidents
 - \$1.1Bn direct damage (maintenance)
 - \$12Bn inclusive damage (delays, inefficiencies fuel, etc)
- Direct cost to airlines
 - \$6-20M per airport
 - \$263K per 10K movements



¹ U.S. Air Force Research Lab at Wright Patterson AFB (Squadron Leader Richard Friend)

² "The cost of FOD" Research study by Insight SRI, UK


The impact of FOD on airports

- **Awareness:** Many airports are not always aware of the extent of the problem
 - DGAC study reveals 8 severe runway FOD findings a month at Paris CDG
- **Safety and potential accidents:**
 - Damage to reputation
 - Subject to liability
- **Delays and lost capacity:**
 - FODs cause monthly delays of over 200 minutes in the large airports
 - Damage to reputation and passenger dissatisfaction
- **Insurance:** Increased insurance rates for airports and airlines due to risk and damage
- **Financial:** Damage to aircraft are borne by airlines, MROs and equipment leasing companies (increased rates)

FAA Advisory Circular, issued 09/09

US Department of Transportation / FAA Advisory Circular, AC number 150/5220-24

Airport Foreign Object Debris/Damage (FOD) Detection Equipment

- Concludes 3 years of joint activity between the FAA and Xsight.
- Sets the standards for FOD detection equipment, and eligibility for Federal Funding (AIP and PFC)
-  **FODetect is fully compliant** with the AC and **meets or exceeds** the highest level of performance requirements in every parameter



Evaluation commenced January 2008:

FAA extensive evaluation of FODetect at Boston's Logan International Airport extending over two winters with heavy snow conditions, consistently yielded outstanding performance results throughout FAA assessment.

Evaluation of four technologies:

Stationary radar, stationary electro-optic, hybrid radar and electro-optic, and mobile radar. **Of all systems evaluated, only FODetect meets or exceeds the AC's highest performance levels.**

FOD Detection Systems

Key Requirements

FOD – Key Requirements

➤ Detection capability

To detect objects of all sizes and materials, with high probability, in all weather conditions in which an airport is operational

Objective: $P_d > 95\%$



FOD – Key Requirements

➤ Fast detection and action cycle



Objective:

Between-movements detection and decision

FOD – Key Requirements

- Ascription – Ability to associate detected FODs with the cause
 - Part dropped by aircraft
 - Tool or fastener dropped by maintenance, service



Objectives:

- Alert aircrafts for danger
- Identify FOD sources for preventive action

Key Requirements - Conclusions

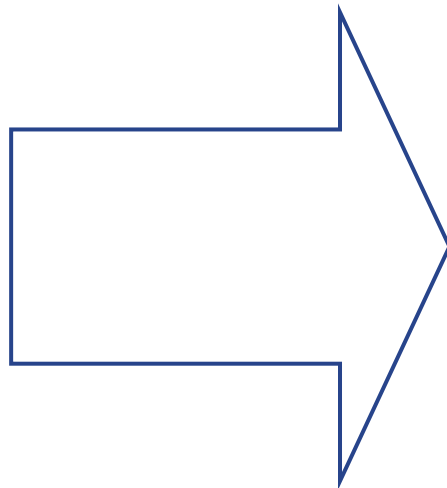
 Performance

 Visualization

 Ascription

 Scan time

 Affordable



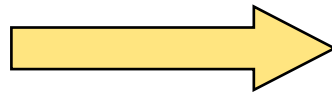
Closest to the scene

Vision/radar fusion

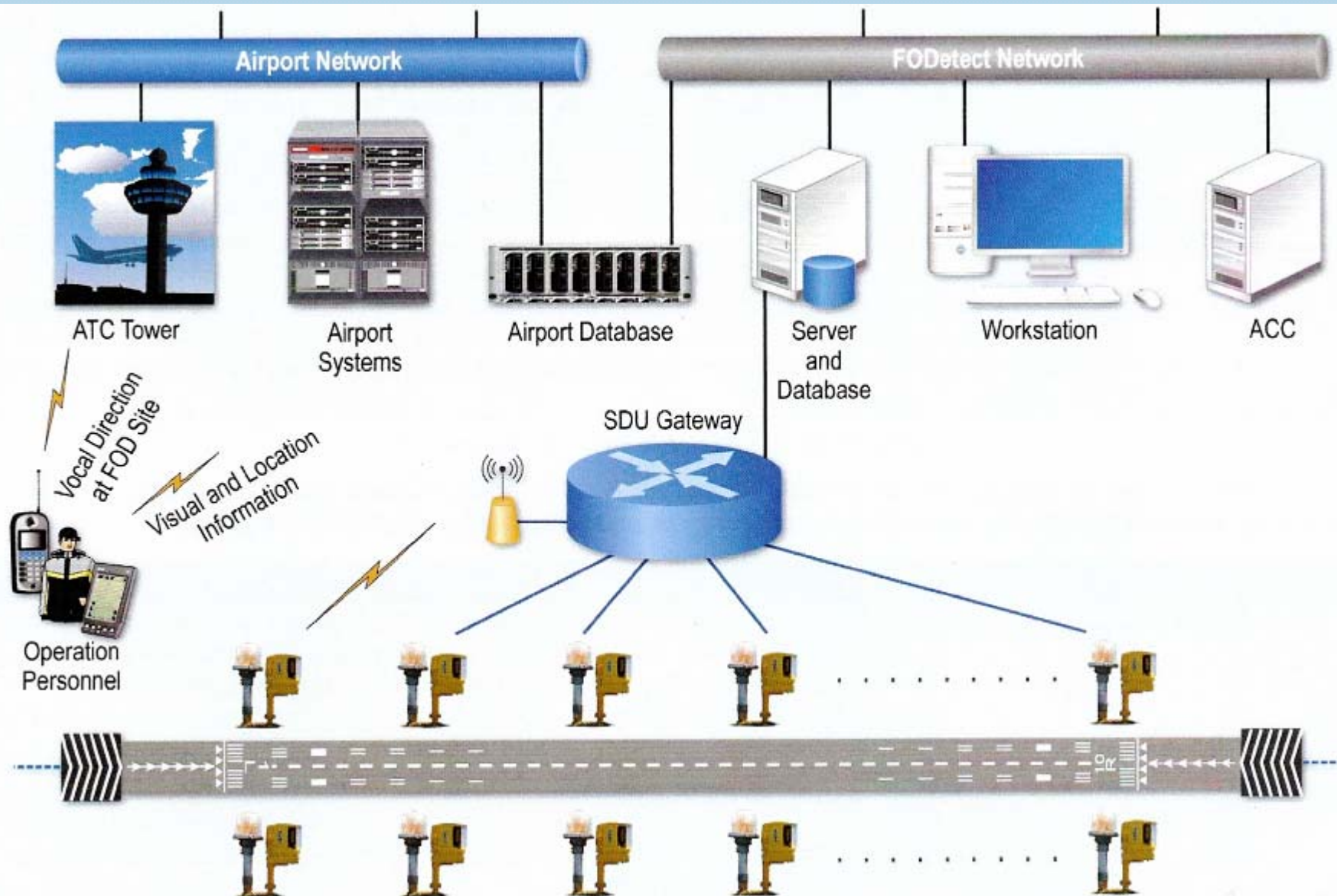
Distributed COTS networked system

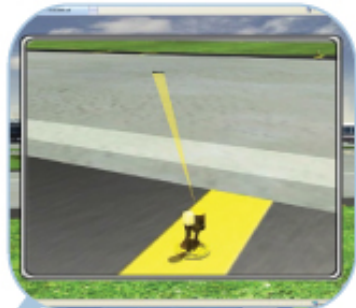
Distributed system solution

Sensors placed on the edge lights infrastructure.
The edge light becomes a *smart edge light*



System block diagram





1 Scan and Detect

Each SDU continuously scans a section of the runway using radar and advanced image processing technologies.



2 Alert

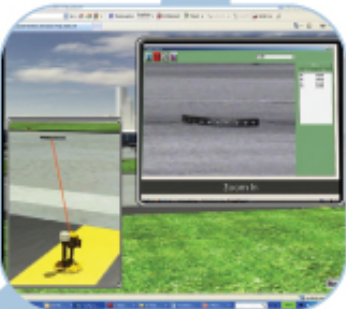
Upon detection of a FOD, an audio visual alarm is raised at the operator console showing the FOD location.

The FODetect Process



5 Document and Tag

FOD data and actual images are archived and FOD is tagged.



3 Interrogate & Classify

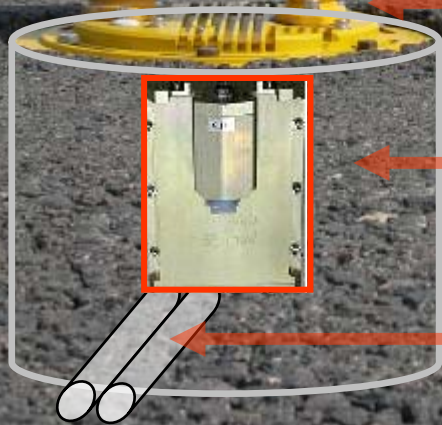
Operator views high resolution image and receives FOD physical data (size, location) from the SDU, supporting a decision for action to be taken.



4 Remove

An operations vehicle is sent to clear the FOD. GPS coordinates and laser pointer assist in efficient removal.

SDU - Surface Detection Unit Components



CCD camera with NIR
Tilt, zoom & focus control

77GHz Radar

Pan motion axis

Frangible coupler & quick
disconnect cable

Local CPU & Line Series
Power Supply

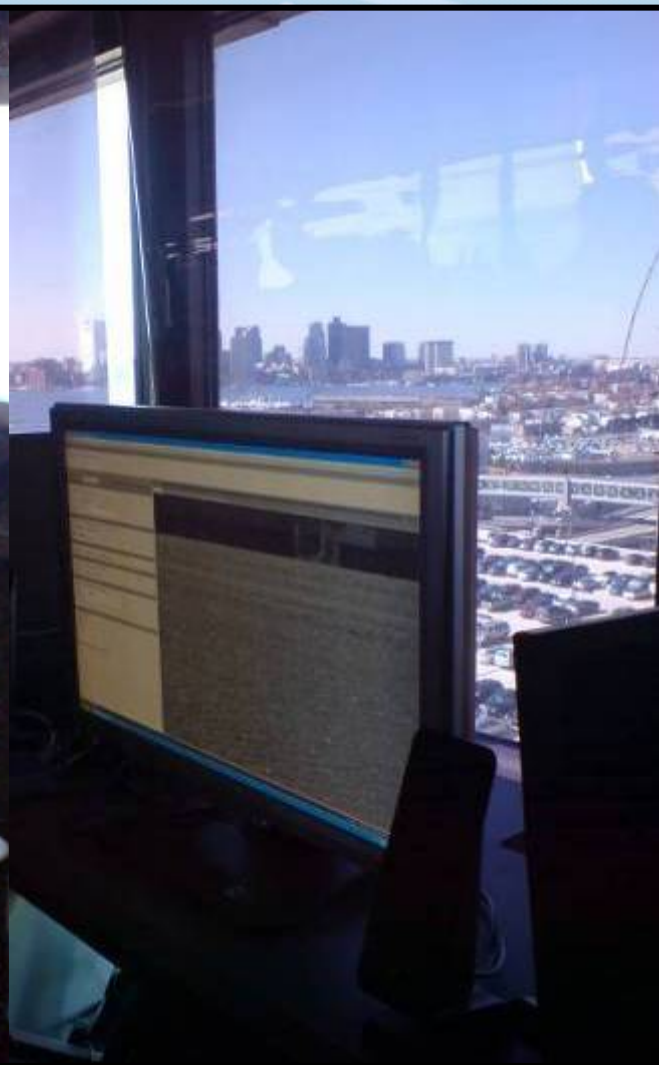
LAN / optic fiber communication

FODetect® milestones

- August 2007 - FAA selects FODetect for evaluation at Logan airport, (BOS) towards issuing Advisory Circular (AC)
- March 2009 - FODetect receives ATC Global 2009 emerging technology award
- September 2009 – FAA issues FOD AC based on evaluation results. FODetect eligible for FAA funding.
- May 2010 – FODetect selected by Logan airport Boston following competitive bid and analysis of all 4 technologies evaluated by FAA, for installation on all runways
- June 2010 – Leading European airport purchases FODetect for installation on busy intersections
- September 2010 – Ben-Gurion (TLV) selects FODetect as sole source supplier for both main runways

Installation at Logan

Operator console in Control Tower - 16th Floor



Runway 15R installation



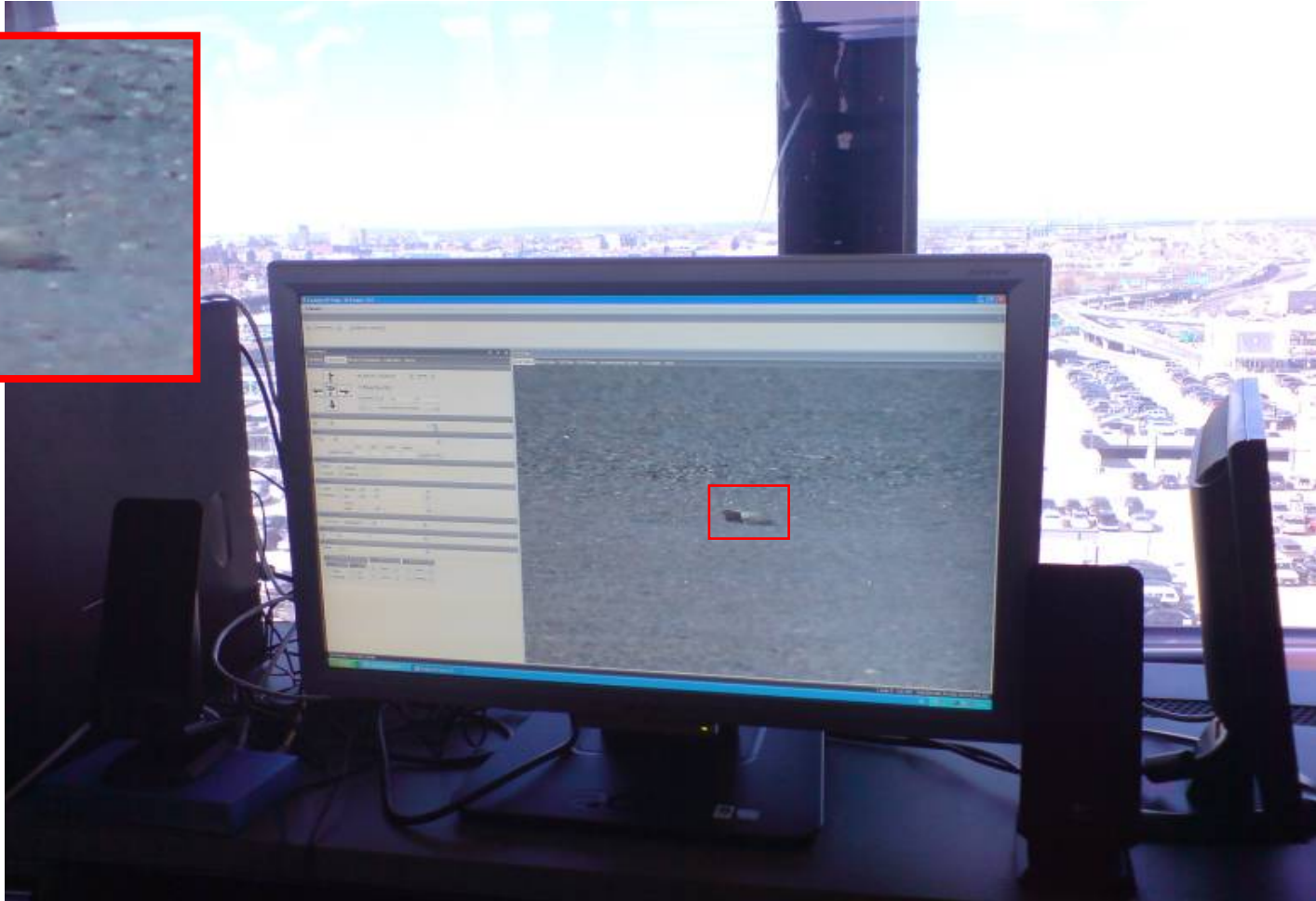
Seagull Detection

The image displays the xSIGHT software interface, which is used for video analysis and detection. The main window shows a video feed of a seagull standing on a ledge. A red bounding box is drawn around the seagull, indicating its detection. The interface includes several panels:

- Layouts:** A panel at the top left with "Disconnect" and "Take Control" buttons.
- Monitor & Debugging:** A panel on the left containing playback controls (Play, Stop, Single Frame), "Run To Frame" (Step 0, Frame 74), and recording options.
- Debugging:** A panel below the monitor section with checkboxes for "Record PDD", "Decline PDD", "Debug Current Frame", "Update Background", "PDD Testing", and "PDD Algo Enable".
- Light Mode:** A panel with radio buttons for "Day", "Night", "Dry", "Raining", "Wet", "Snowing", and "Drying", along with a "System Mode Change" button.
- Scale Mode:** A panel with radio buttons for "Video Only", "Radar Only", and "Combined", and sliders for "Gain", "Offset", and "Cycle".
- Temperature Control:** A panel at the bottom left with "Automatic Control" and "Lower Heater" options.

The video feed shows a seagull in profile, facing left. The background is a blurred industrial or airport setting. The software interface is overlaid on the video, and the Windows taskbar is visible at the bottom.

Clam-shell FOD Detection




FODetect System Operator console

Main Screen – showing SDU locations

XSight FODDetect™
Settings

System Status



The main map displays a road network with several SDU locations marked by white circular icons with a central dot. The roads are shown in grey and black, with green areas representing grass and blue areas representing water. The map is viewed from an aerial perspective.

Zoom X 12.00

Maintenance Details

Sensor	Status	Time
--------	--------	------

FOD Details

Location	Time	Priority	Status
----------	------	----------	--------

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789410.250359907 2959651.62337559 0 Fod Alerts 0 Maintenance Alerts 0 SDU Under Control

FOD detected – audio and visual alerts (see below) are issued

The screenshot displays the X Sight FODDetect software interface. The main window shows a map of an airfield with several sensor locations marked by white circles. One sensor is highlighted with a red triangle and a red 'A' icon, indicating a detected Foreign Object Debris (FOD) event. A dialog box titled 'A new FOD event had occurred' is open, showing a close-up image of the detected FOD (a small white object on a paved surface) and the timestamp '24/03/2010 10:13:13'. The dialog box includes controls for snoozing the alert, assigning it to an operator, and closing the alert.

FOD Details [Details View](#) [Images View](#)

24/03/2010 10:13:13

Snooze alert for:

Assign to:

0

Maintenance Details

Sensor	Status	Time
LOGAN_15R...	PENDING	

FOD Details

Location	Time	Priority	Status
> LOGAN_15R...	24/03/2010 ...	High	PENDING

FOD Investigation – operator can zoom in and identify the FOD

Xsight Base Form
Settings

LOGAN_IDR_0A

System Status
Close Fod Alert

Device Details | FOD Details

Time:	24/03/2010 10:02:10
Dimensions:	9.74903 [cm ²]
Priority:	High
Severity:	High
Certainty:	0.842516
Radar Intensity:	21 [dB]
Location:	15R
UTM Location:	North: 788481.36 East: 2059841.1
Status:	PENDING

Azimuth -79.10859
Elevation -0.27539

Zoom X 4

Focus

Shutter X 150

IR Lamp Laser
Pump Wiper

Move To POI Add POI

1 Fod Alerts | 0 Maintenance Alerts | 0 SDU Under Control

Bird detection at night

Food Investigation Screen


General Map Control Sensors Maintenance

LOGAN_ISR_1A

Close Food Alert

Runway Status Server Status

Azimuth : 25.09277
Elevation : 0.6011520



Optical Zoom X 11

Auto Focus


Shutter X 425

IR Lamp Laser

Pump Wiper

Alert Location

Move To POI Add POI



Sensor Details FOD Database

Time	9:45 AM
Date	7/13/2010
Device name	11-2055296574468 [v-4]
Priority	High
Severity	High
Confidant	0.6191469
Radius (M)	19.51466 (M)
Range	49.371202628915 (ft)
Location	ISR
UTM North	787630.8
UTM East	2960651.9
FOD Status	New Alert

FOD History

7/13/2010	Pending
7/14/2010	New Alert

LOGAN_ISR_1A Live Detector Realtime

0 Food Alerts 0 Maintenance Alerts 100 Under Control

FOD History - database

History Screen

Settings

Date From 08/03/2010 To 27/03/2010 Severity Low [Show History](#) [Chart View](#)

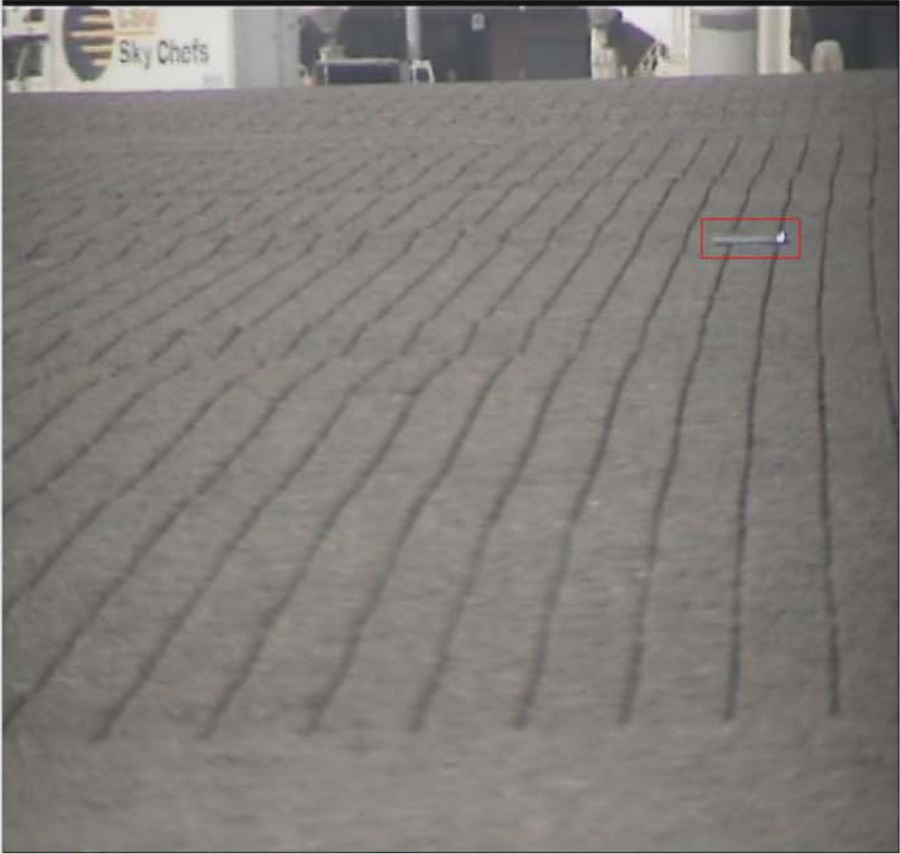
Time From 17:36 To 17:36 Runways 1SR [Details View](#)

FOD Status Pending Animal

FOD History Details

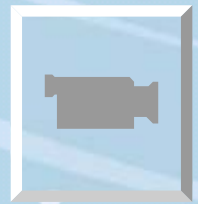
Status	User	Time
PENDING	System	14/03/2010 10:30:01
PENDING	System	14/03/2010 10:4...
PENDING	System	14/03/2010 10:50:39
PENDING	System	17/03/2010 13:49:08
PENDING	System	18/03/2010 09:39:15
PENDING	System	20/03/2010 19:40:05
PENDING	System	21/03/2010 13:51:58
PENDING	System	21/03/2010 14:44:51
PENDING	System	21/03/2010 14:48:42
PENDING	System	21/03/2010 15:04:10
PENDING	System	21/03/2010 15:07:41
PENDING	System	21/03/2010 16:36:37
PENDING	System	22/03/2010 15:50:50
PENDING	System	23/03/2010 11:32:07
ELIMINATED	System	23/03/2010 14:57:58

Time:	23/03/2010 12:57:58
Dimensions:	9.74983 [cm^2]
Priority:	High
Severity:	High
Certainty:	0.842516
Radar Intensity:	21 [dB]
Location:	1SR
UTM Location:	North: 788481.36 East: 2959841.16
Status:	ELIMINATED



Fod Img 17:37 Fod Img 17:37 Fod Img 17:37 Fod Img 17:37

Control Tower visibility limitations



- Runway viewed from the SDU camera in heavy fog -

The system cameras provide the control tower a clear view of the runways even in extreme low visibility conditions

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FOD Ascription

FOD-ID – Video Recording Unit

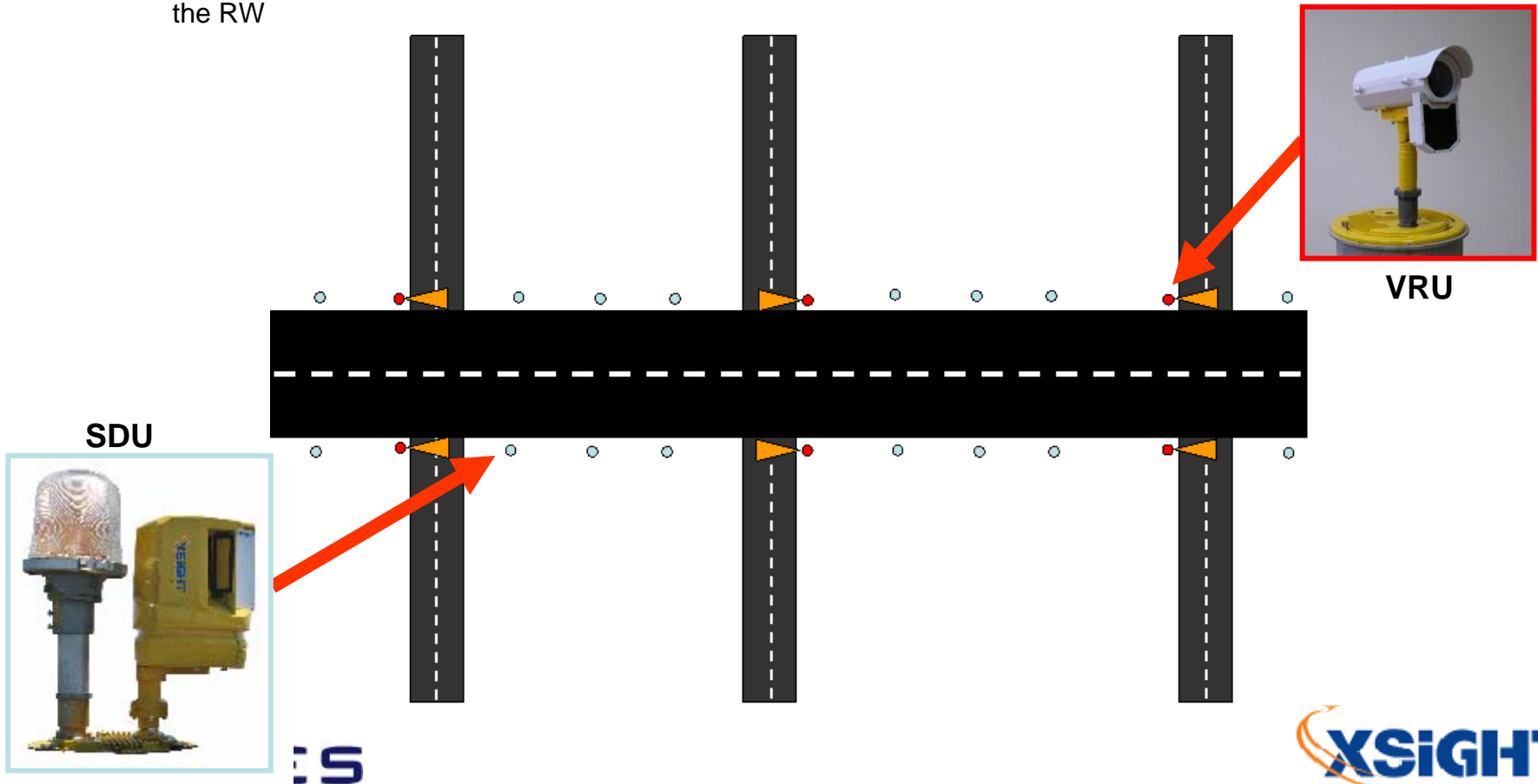
- Identifies sources of airport FOD
- Provides photographic evidence of FOD sources
- Uses existing lighting infrastructure
- Monitoring of intersection traffic
- Recording of runway incidents



FOD Ascription System Overview

Objective – associate the responsible vehicle/aircraft with detected FOD

- SDU – Surface Detection units - Scan RW and detect FODs
- VRU – Vehicle Recording units - Monitor RW entrances/exits and save images of every motion in and out of the RW



IS

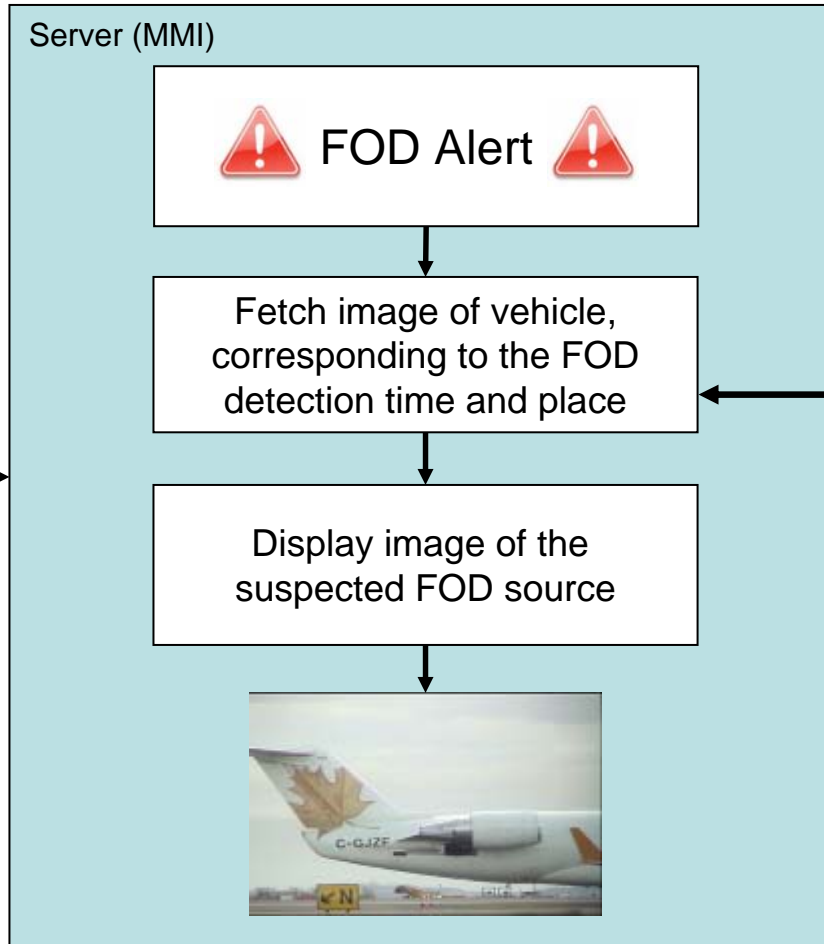
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FOD Ascription – FOD Alert Flow Chart



FOD Alert
&
FOD Image



Vehicle recording unit



FOD source image

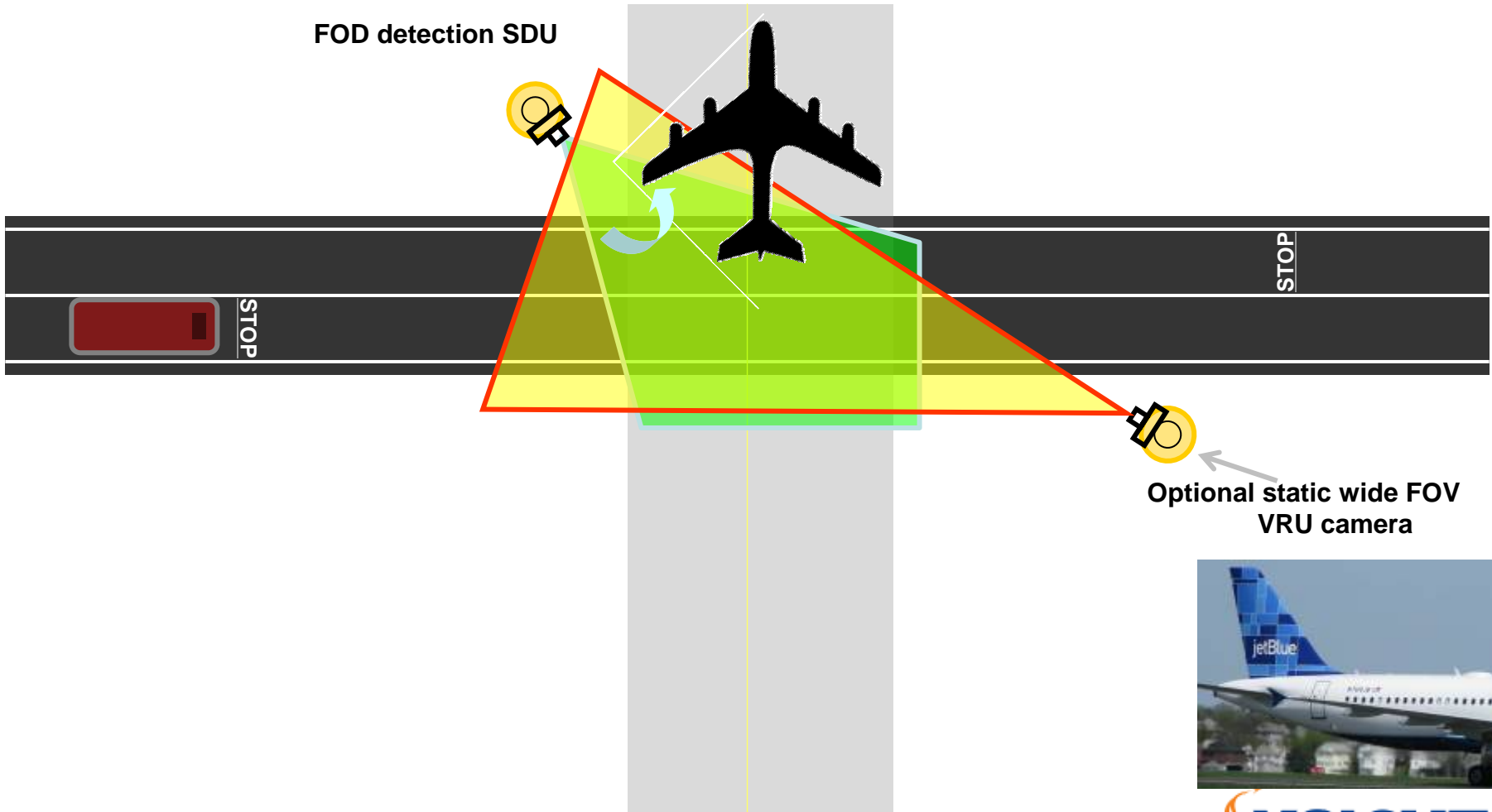
FODspot™ for Intersections and hot spots

- FODetect is a **scalable solution** can be installed on specific intersections or other hot spots
- Intersections are prone to higher incident rates of FOD due to increased traffic and nature of vehicles traversing the runway
- A number of different parties (service vehicles, aircrafts, etc) may be responsible for the FODs
- The responsibility often falls on the operations, due to lack of ability to identify the responsible party



Intersections and Hot-Spots Solution

FOD detection SDU



Optional static wide FOV
VRU camera



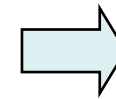
Safety Requirements

- **The SDU is designed to meet FAA/ICAO edge light safety requirements:**
 - **14” Height limitation**
 - **Frangible Coupler** – Use a frangible coupler according to AC150-5345-46.
 - **Quick-Release Connector** – use a quick-release connector according to AC150-5345-26.
 - **Wind** - designed and tested to meet AC150-5345-46b.

Runway Situational Awareness Additional Applications

- Wildlife detection and tracking
- Runway surface condition
- Runway lighting status and ILC
- Runway Security and Surveillance

ENGINE FOD



✓ Runway Command & Control



✓ Runway Command & Control



Add-On applications

✓ Security



Summary - FODetect Benefits for Airports

- Safety
- Early detection of runway FODs - Eliminate FOD damages
- FOD detection during operations
- Efficient pinpointing and removal of FODs – increase capacity and availability
- Reduce need for manual patrols which consume human resources and runway time
- Documentation of FOD incidents (time, location, images) – create much needed statistics
- Ability to correlate FODs to their sources, support incident investigation and preventive actions

Integrate runway sensing technology and achieve absolute control and monitoring of the runway; safety, capacity and operation continuity.

