Sensors for UAVs

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CECOM Bottom Line: THE WARFIGHTER

Outline

- Sensor Technologies for TUAV and Larger
  - Advanced EO/IR Payload
  - Airborne Video Surveillance
  - Aided Target Recognition
  - Advance Payload Concepts
  - Hyperspectral Technologies
- Sensor Technologies for Small UAVs
- Summary

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Sensor Technologies for TUAV and Larger

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What is TUAV

US Army's Tactical Unmanned Aerial Vehicle

- **Mission radius: 200Km**
- **Endurance: 6-8 hrs**
- **Payload Capacity: 50lbs**
  - **Includes Mode IV IFF and VHF Radio**
- **Weight: 300 lbs**
- **Ceiling: 15,000ft**
- **Tactical, portable, 3-man operational**
- **Manual or automatic (parachute) recovery**

AAI's Shadow 200

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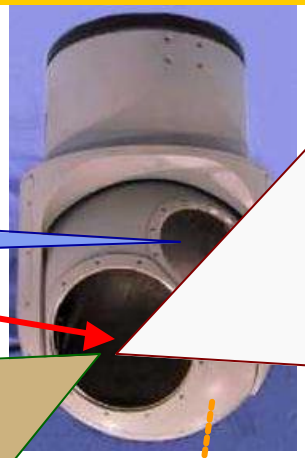
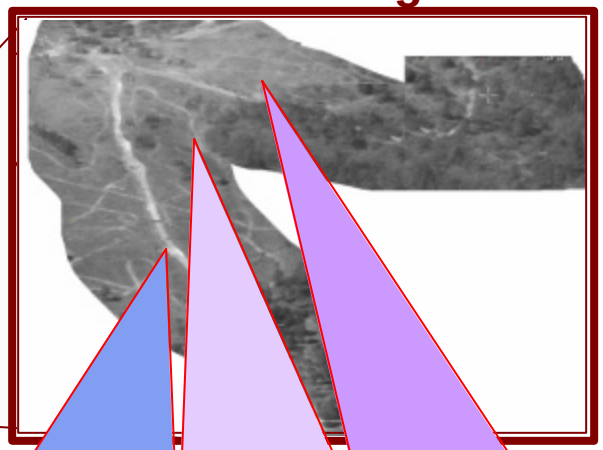
Advanced EO/IR Payload

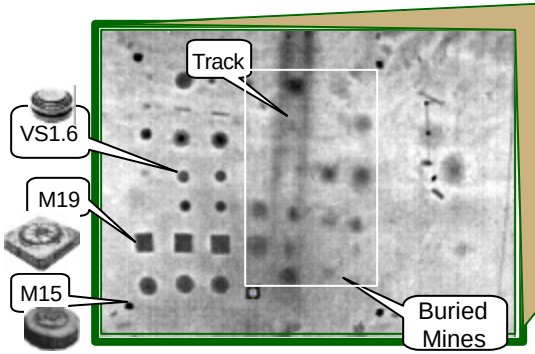
Long Range, High Quality, All Digital Imagery

One Payload (47 lbs)



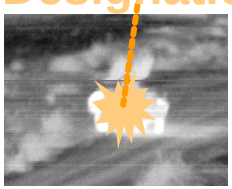
Wide Area Search Sensor with AVS Image Mosaics & Precision Geo Registration

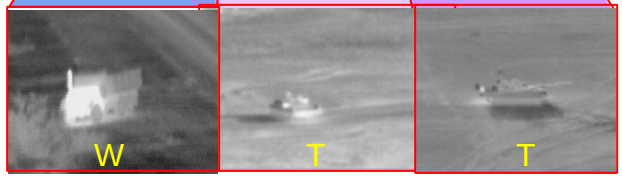




Day Time Mine Detection

Growth to Laser Designation





Aided Target Recognition

An Affordable, Lightweight, High Performance Multi-Mission Payload

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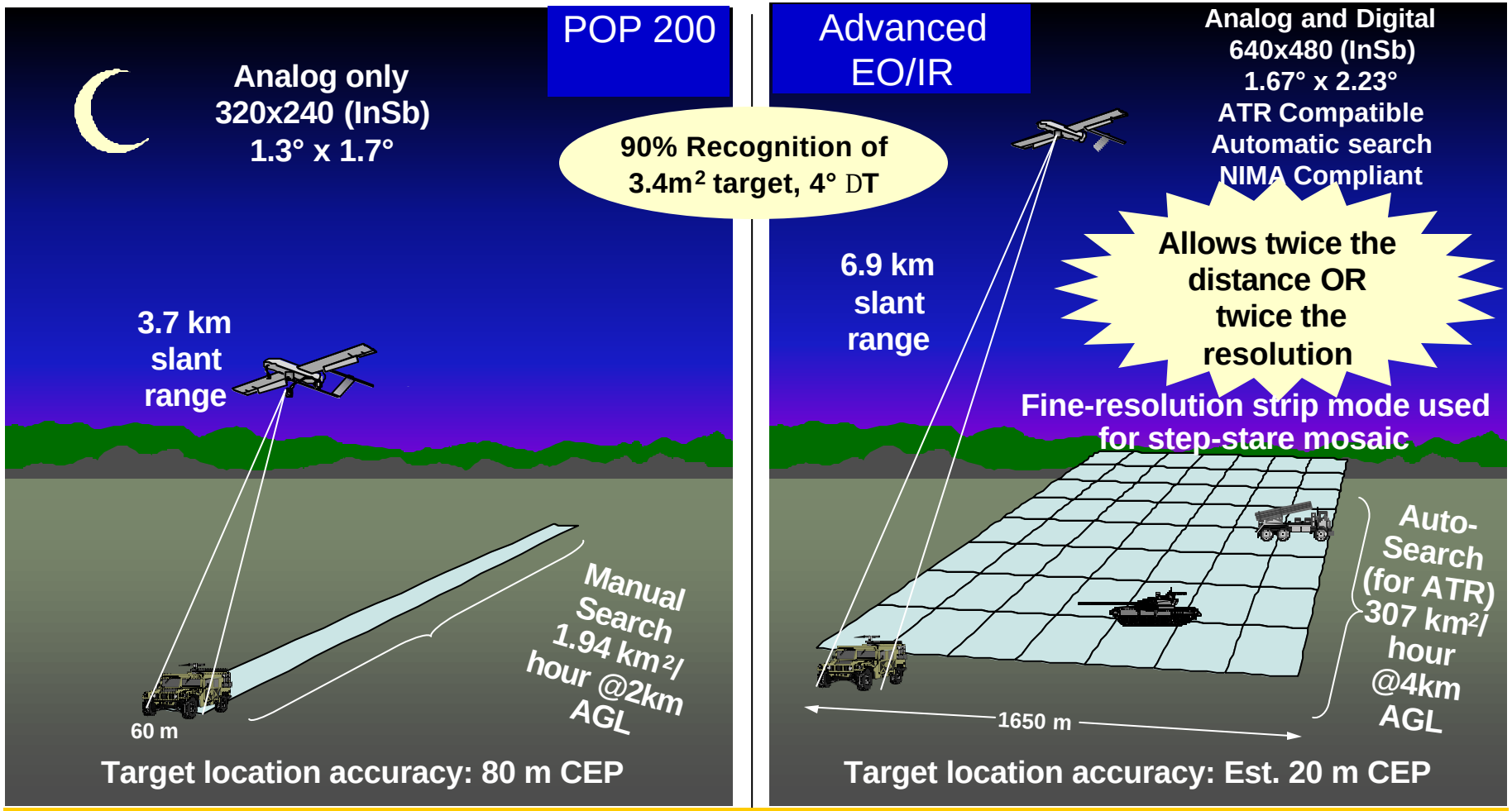
Comparison of TUAV POP-200 with the Advanced EO/IR Payload



POP 200 Meets TUAV Threshold Requirements.

The Advanced EO/IR Payload Satisfies TUAV Objective Requirements.

Adv. EO/IR Mounted Under Twin Otter

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Napa Valley
WFOV, ~4250 ft AGL

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Target Field
MFOV, ~4250 ft AGL

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People Walking in Field, NFOV 6000 ft AGL

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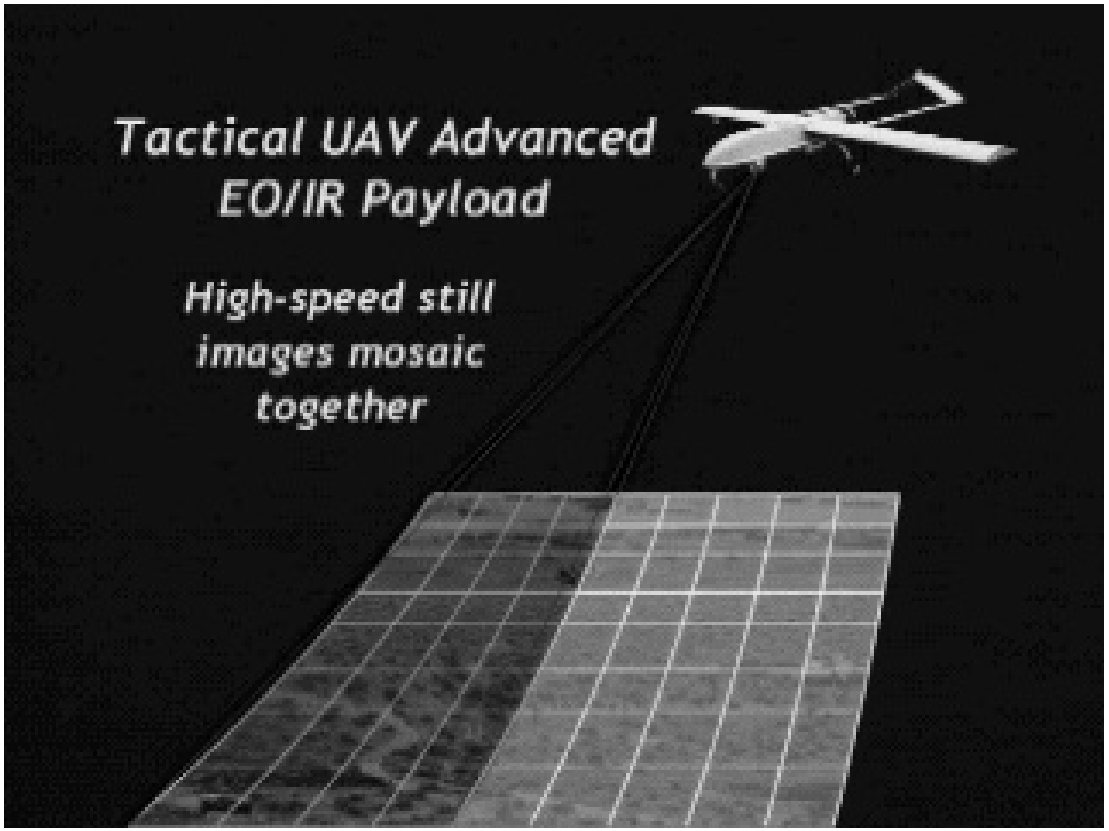
Step Stare Wide Area Search



BW reduced to 320x240 @ 15 Hz for Power Point display purposes

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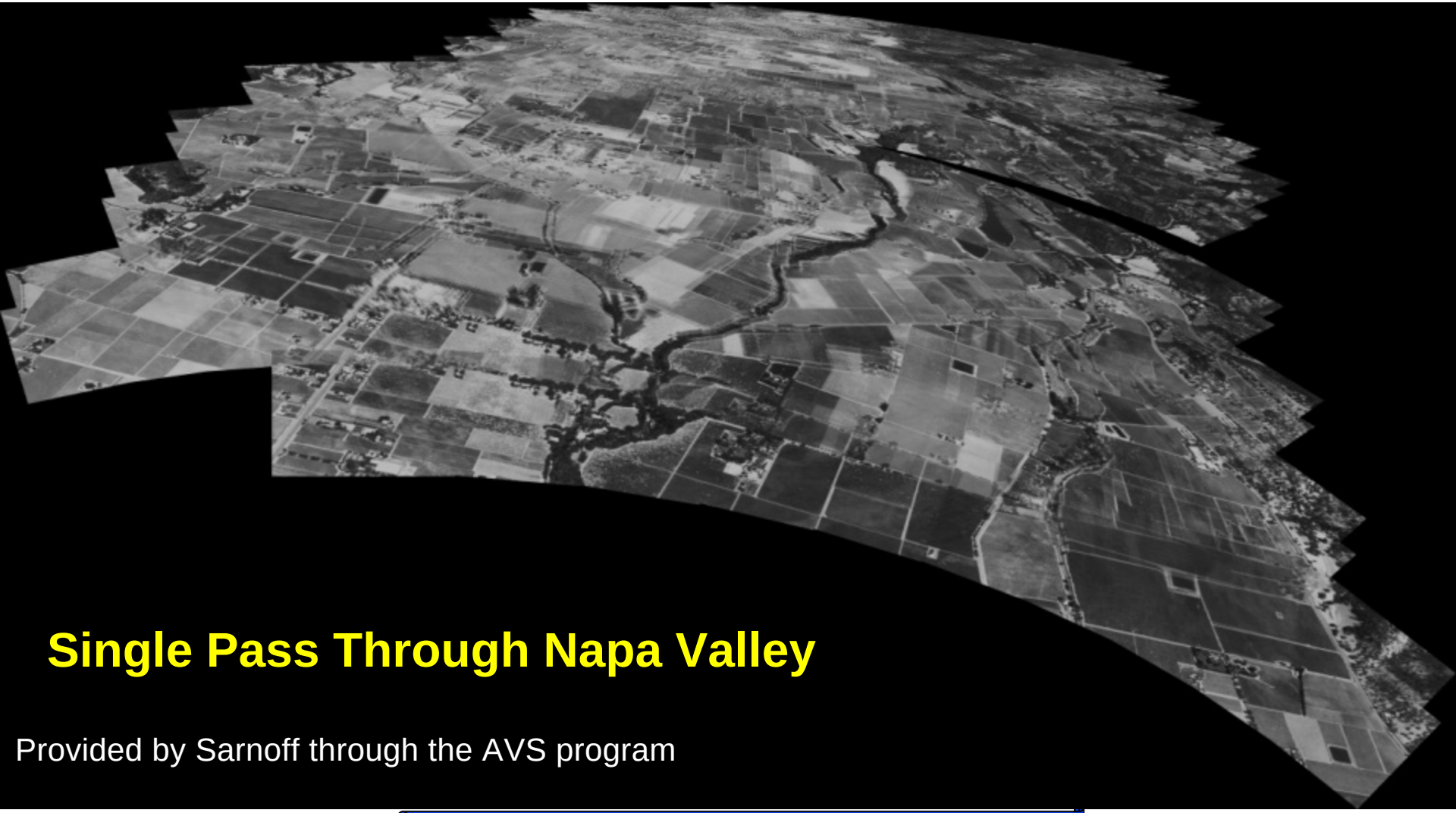
MFOV Strip-Mode Frame-to-Frame* Mosaic Example



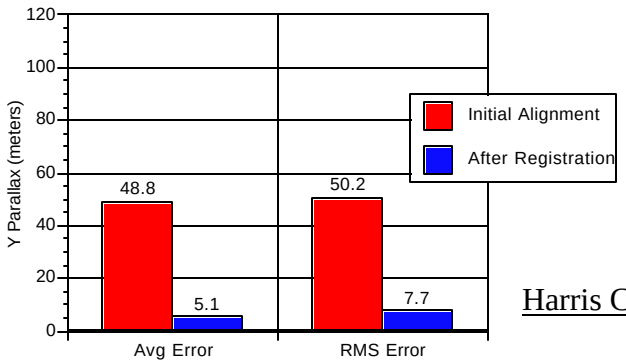
Single Pass Through Napa Valley

Provided by Sarnoff through the AVS program

Airborne Video Surveillance Program
Precision Video Geolocation

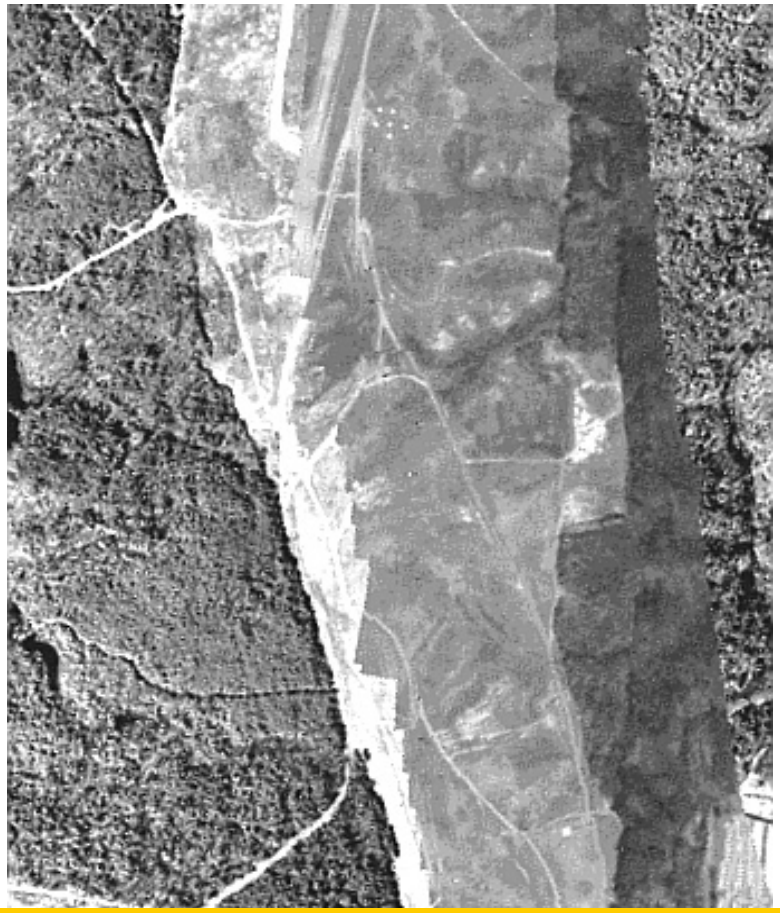
Technology and Goals

- Automatic generation of tie points between video and reference imagery at real-time (1 Hz) rates
- Characterize performance vs. terrain type, imaging geometery, seasonal variations, etc.



Harris Corp. Data

Oct 1999, U.S. Army test site
Video Frames Registered within 1m of DTED III
Auto-registered Frames overlaid on reference imagery



89% of frames registered to less than 10 meter relative error for various levels of DTED data, U.S. Army test site data (0.1 Hz rate)

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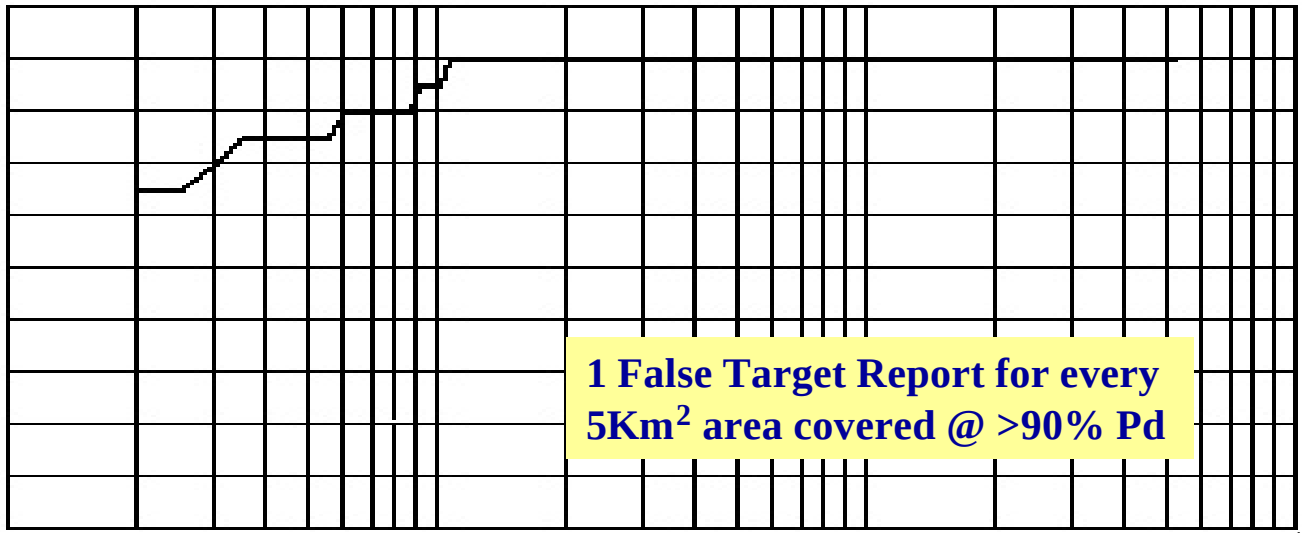
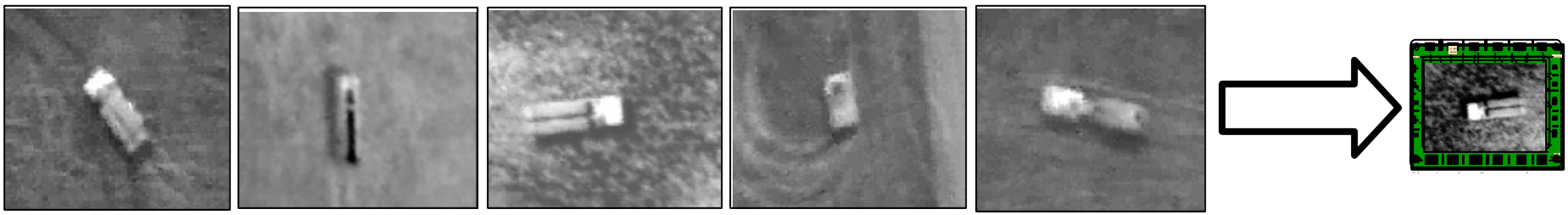
Aided Target Recognition Performance



Data Collected at U.S. Army test site: Moderate to Low clutter

Target Types: Tanks, APC's, Trucks at various aspects



NGC ATR Provides Rapid Search with Low FAR

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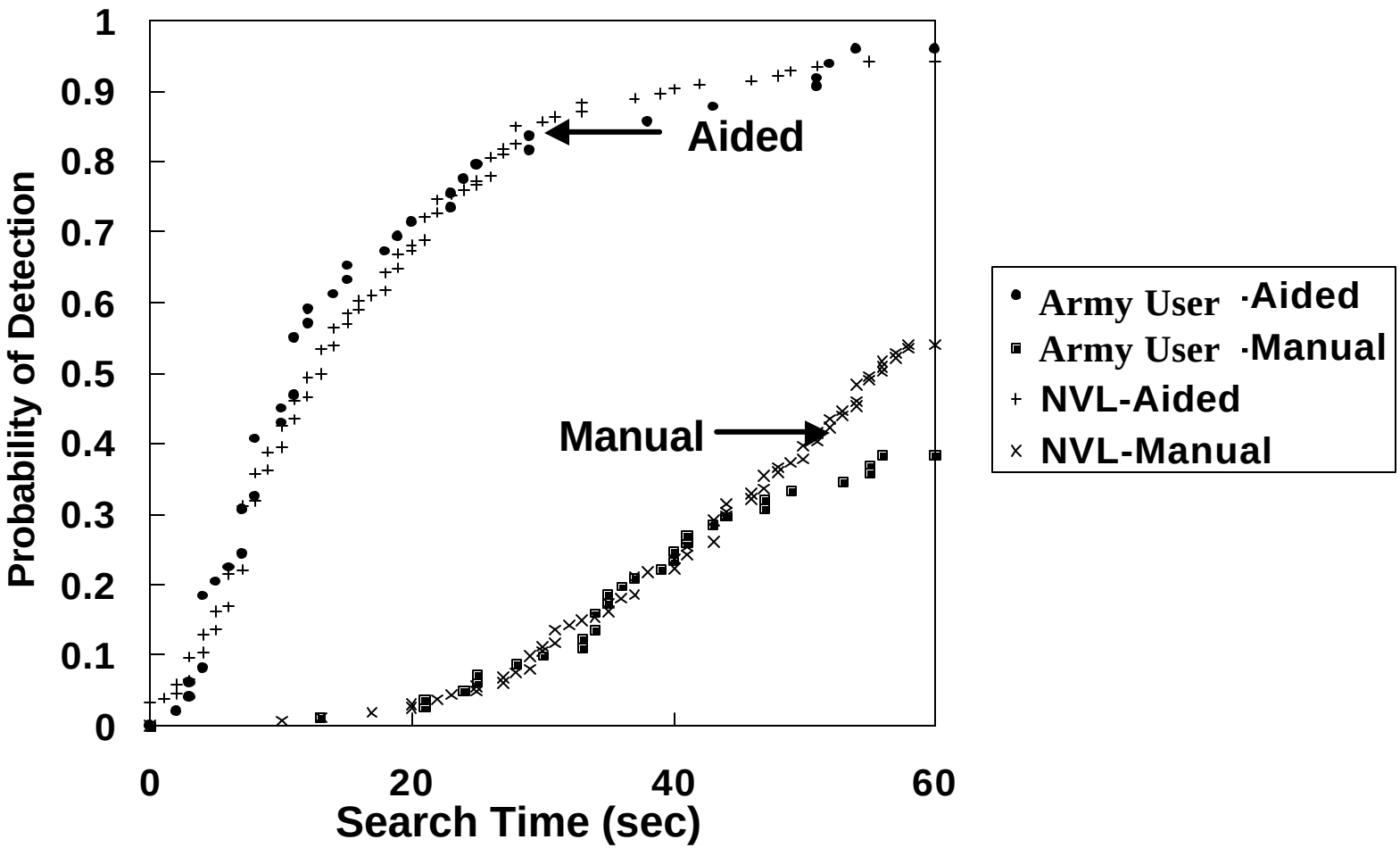
Comparison of AiTR with Human Search Performance



AiTR Finds Targets Faster with Higher P_d and lower FAR

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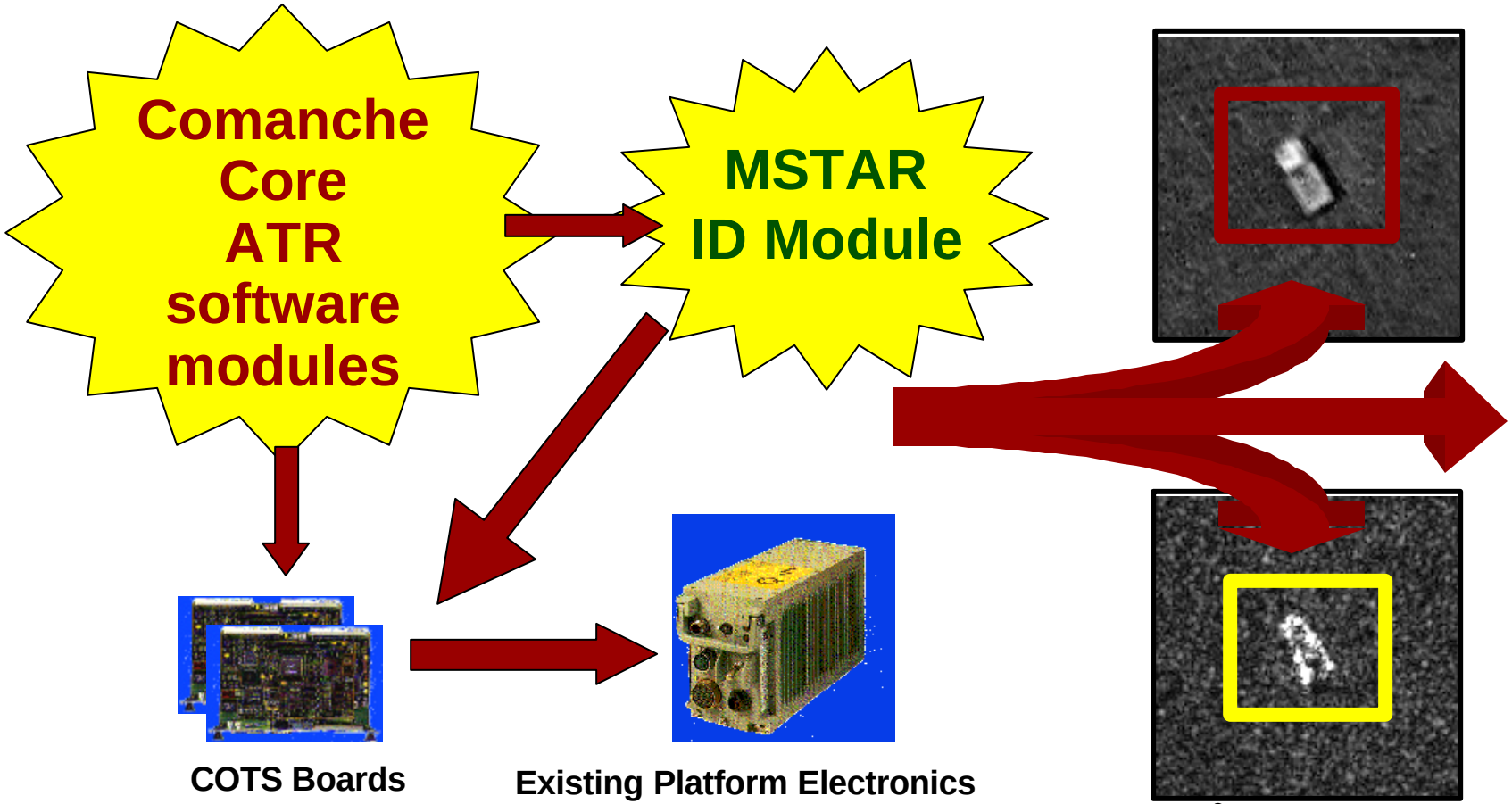
Real-time embedded strike and Surveillance Target Acquisition and Recognition (RsSTAR)

- **Leverage existing programs to integrate *Common FLIR/SAR* ATR software modules into COTS processor.**



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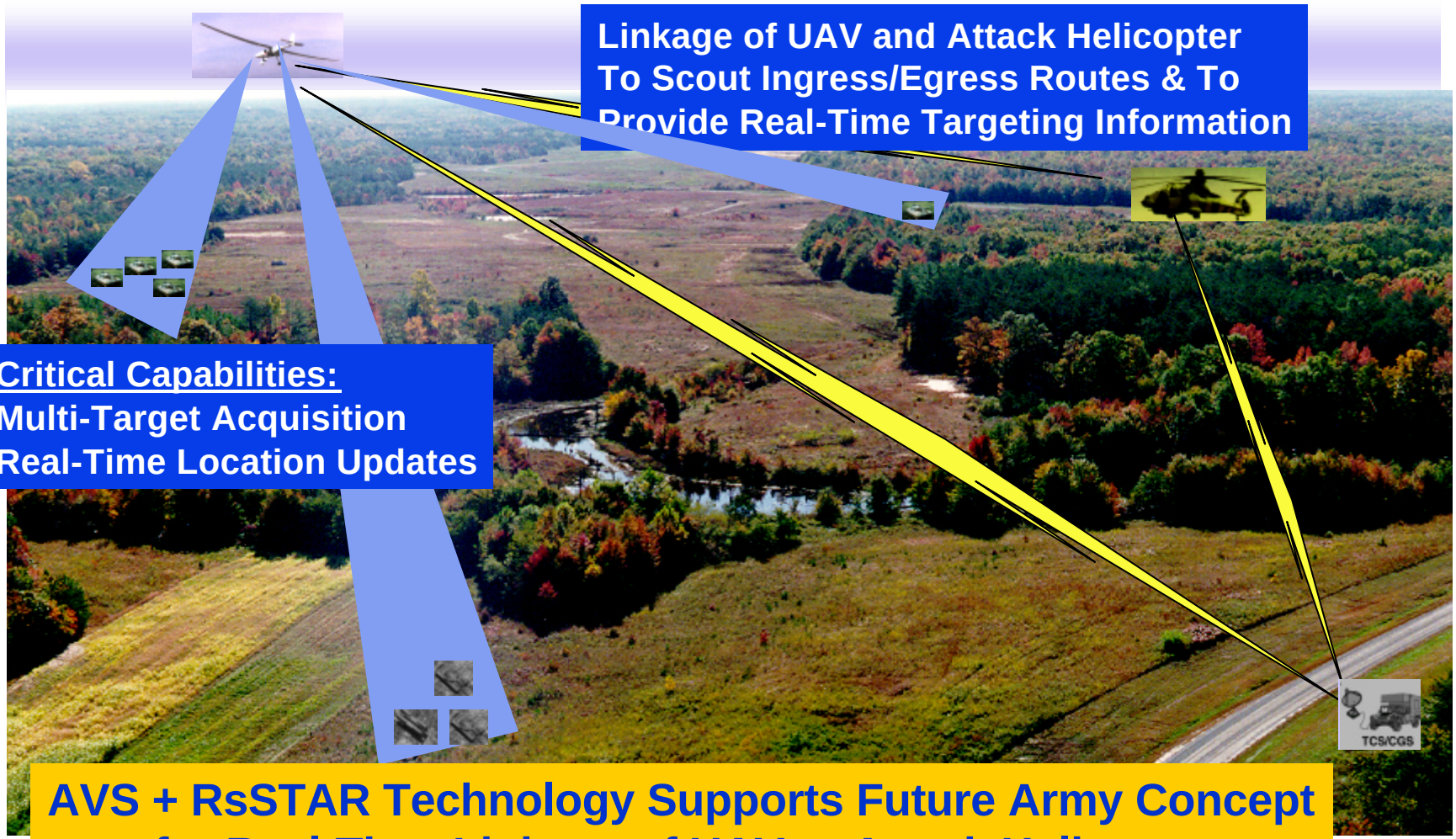
Manned-Unmanned (MUM) Scenario



AVS + RsSTAR Technology Supports Future Army Concept for Real-Time Linkage of UAV to Attack Helicopter

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Notional Concept for Longer Range Requirements

90% Probability of:	WFOV	MFOV	NFOV	UNFOV
Detection	*	6.0 Km	12.5 Km	17.6 Km
Classification	*	**	7.2 Km	12.7 Km
Recognition	*	**	4.0 Km	8.0 Km
Identification	*	**	2.0 Km	4.5 Km

2-7.6 Km

Advanced Stabilization Techniques Enables Compact Low Cost Packaging

Identify 4.7 Km

Classify 8.0 Km

Recognize 12.7 Km

Detect 17.6 Km

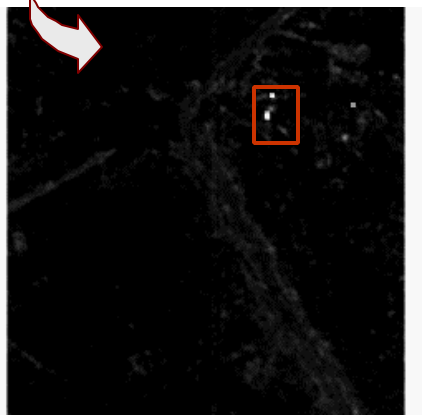
Swath 800 meters *

* Width of Swath Altitude Dependent

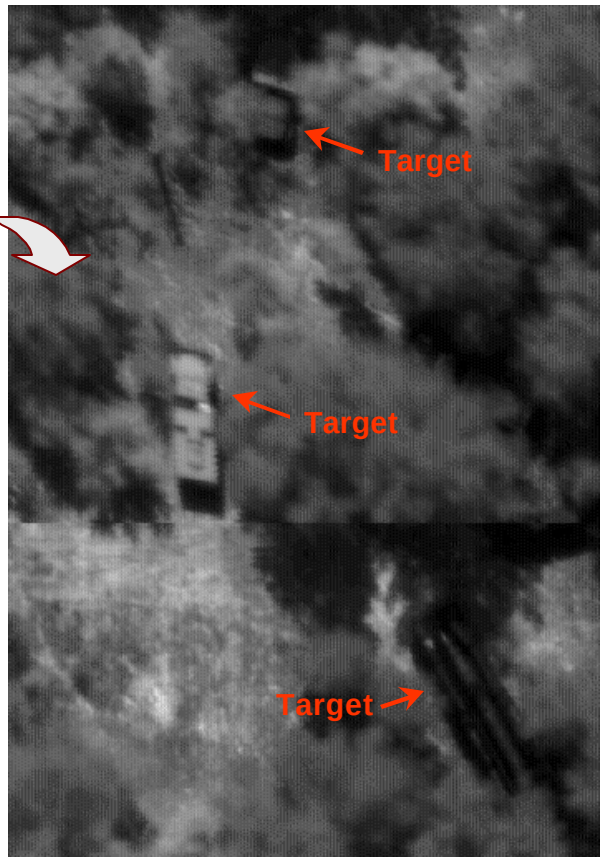
Real-Time Hyperspectral Concept

- Hyperspectral detection of camouflaged and concealed mobile tactical vehicles
- Algorithm-based detection processing
- Detection-cued imagery

RGB from HS Data Cube



Output from Detection Algorithm



Cued High-Resolution Image Chip

Target Cues Reduces Imagery Analyst Workload

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Hyperspectral Programs

- **NVESD is Developing Hyperspectral Imagers**
  - **Day Time: very compact, lower cost, small platforms**
  - **Day/Night: compact, closed cycle, larger platforms**
- **NVESD is Supporting HSI Operational Concept Development**
  - **UAV Real-Time HSI Utility Demonstrated in JCF-AWE**
    - Onboard Processor
    - Cued High Resolution Imagery
    - Downlink of HRI ‘Chips’, HSI signatures
    - Image Analyst Exploitation of Downlink Data
  - **Data Storage for In-depth Post-Processing**

Sensor Technologies for Small UAVs (SUAV)

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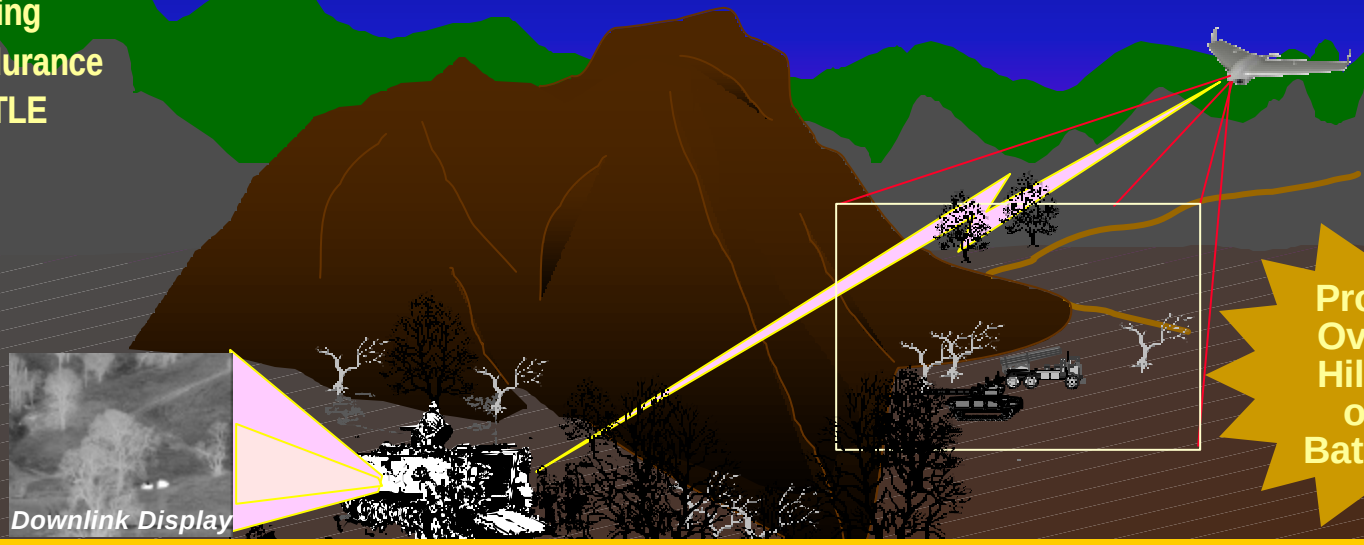
SUAV Payloads
Addressing Draft ORD Requirements

Requirements Proposed

- Fixed Wing or VTOL
- Operational Range 5(T) – 8(O) Km
- Day & Night sensors
- Quiet Operation
- 500(T) – 1000(O) FT AGL
- Single Man Portable
- Autonomous Operations
- Dynamic Retasking
- 110 Minutes Endurance
- 80(T) – 50(O) m TLE

Sensor Technology Options

- Uncooled IR Þ 8-12 mm Bolometer
- E-O Þ Visible CCD
- Acoustic
- Chemical Detection



SUAV Provides Small Units with Organic RSTA Capability for Situational Awareness and Force Protection

Small UAV & Sensor Technologies

Pointer

Dragon Eye

VTOL

OAV

VTOL

MAV

VTOL costs more but provides greater operational flexibility and payload capacity

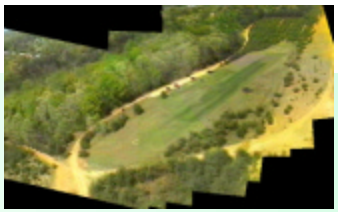
Indigo Alpha

- *160X120 Uncooled IR Camera*

Nytech MMB-U4000

- *320X240 Uncooled IR Camera*

Image Mosaic



- *256 x 256 MWIR*
- *Image Mosaics*

BAT Acoustic Probe

- *640x480 Uncooled IR Camera*
- *Chemical Swatch*
- *Geo Registration*
- *MEMS IMU*
- *Acoustic Search*

Jigsaw

- *Laser Illuminator APD array*
- *Jigsaw FOPEN LADAR*
- *Integrated ground station*

Lightweight Affordable Sensor Systems are Critical to Meet the Challenges of RSTA within Platform Requirements

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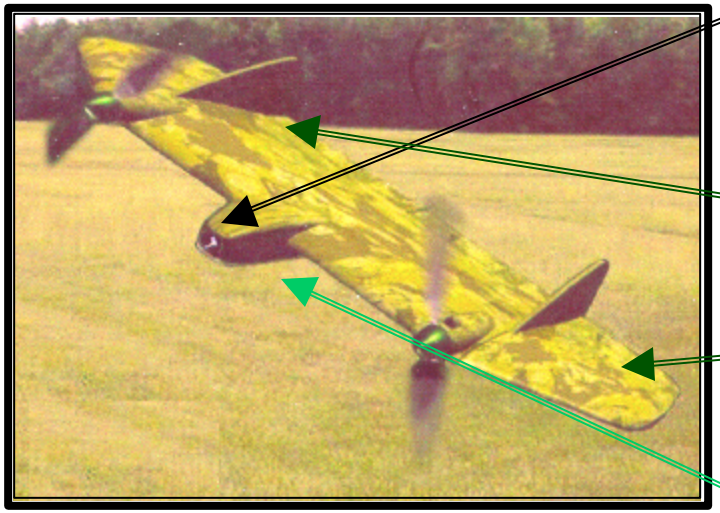
Non-Imaging Technologies for Small UAVs

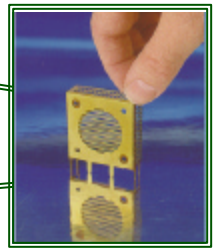
Small UAV



Low Cost, Autonomous and Attritable

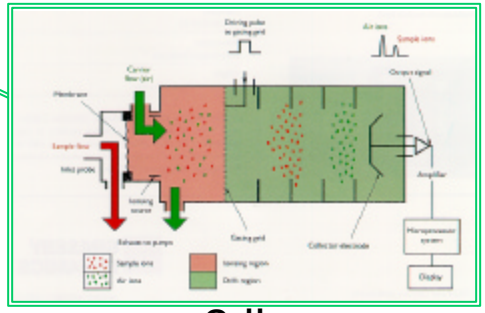
8 → 3 oz.

Long wave IR sensor locates potential cloud



1 oz.

Swatch can be passed through cloud and returned to a specific location for detailed analysis



<2 lbs.

Adapt handheld analyzer for non return analysis

Small UAV is compact and autonomous
It takes the risk instead of personnel

JIGSAW: Combine data from multiple views

Simulation data

LADAR data collected from multiple locations

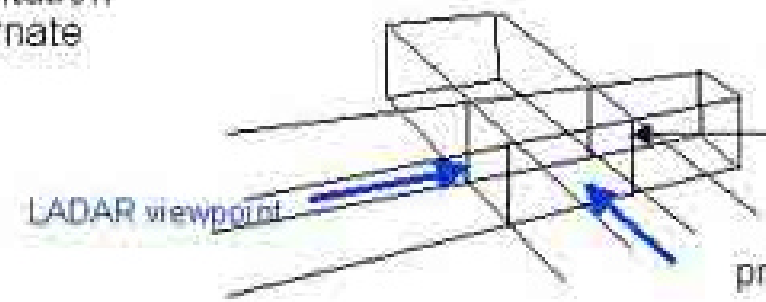
EO view from single viewpoint

Truck in trees

Single view of truck from LADAR through holes in canopy

Data combined from multiple viewpoints

- **Use LADAR data to sense 3-D information:**
  - To "see through" porous obstructions
  - To enable combination from multiple viewpoints
  - To enable presentation of data from alternate viewpoints



Voxel data from LADAR, combined from multiple viewpoints, presented from a different viewpoint

Image Mosaic and Stabilization

Non-Stabilized

Stabilized Real-time Mosaic

Full Resolution Mosaic Image

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Summary

- NVESD is developing a full range of imaging/non-imaging sensors and exploitation technologies for UAVs.
- Affordability, size, weight, and performance define the trade space for UAVs.

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