

UNCLASSIFIED



RDECOM

**Briefing To: *United States / Republic of Korea*
*(US-ROK) Defense Analysis Seminar (DAS) XIV***



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Small UAS Laser Designation and Search and Target Acquisition in Urban Environment Analysis

14-17 APR 2008

Mr. Scott G. Schoeb

Chief, Intelligence, Surveillance and Reconnaissance (ISR) Branch

UNCLASSIFIED

Approved for PUBLIC RELEASE;
Distribution is UNLIMITED.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE APR 2008		2. REPORT TYPE		3. DATES COVERED 00-00-2008 to 00-00-2008	
4. TITLE AND SUBTITLE Small UAS Laser Designation and Search and Target Acquisition in Urban Environment Analysis				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research, Development and Engineering Command (RDECOM),Intelligence, Surveillance and Reconnaissance (ISR) Branch,Aberdeen Proving Ground,MD,21005				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 16	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

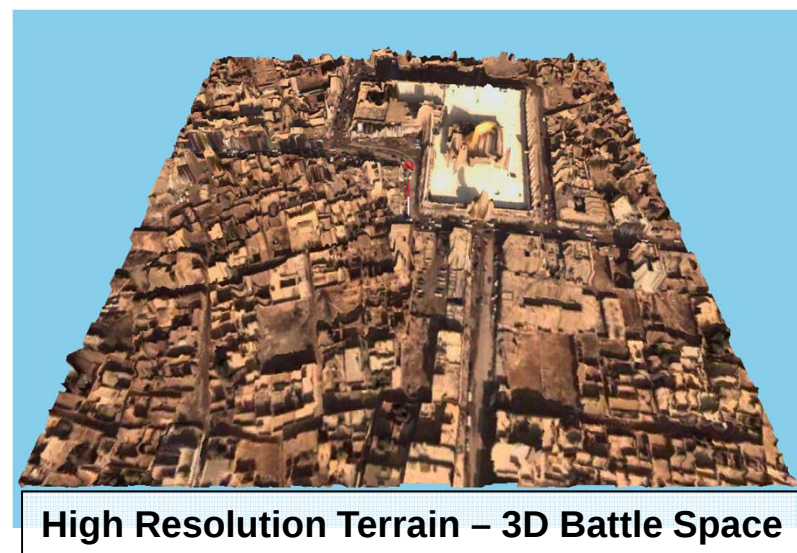
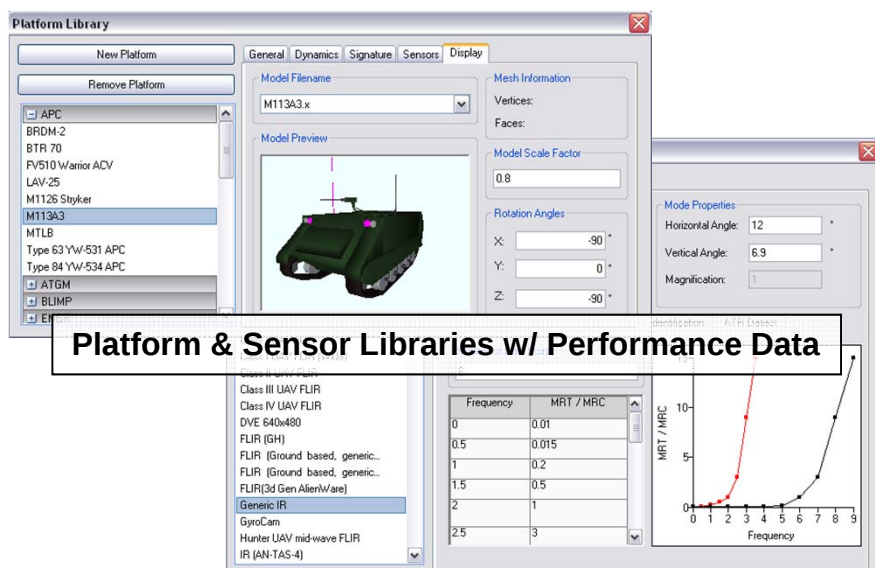
UNCLASSIFIED



Customer:
TRAC

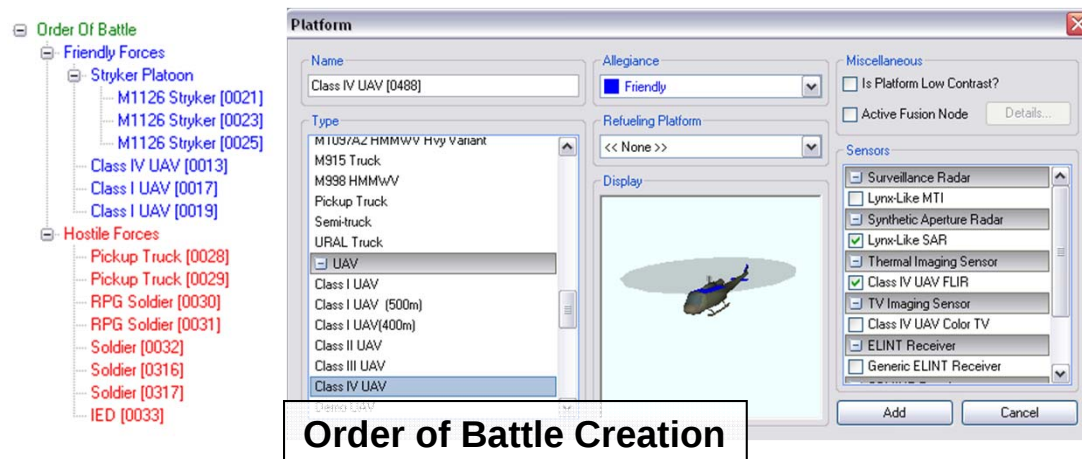
- Completed for TRAC in September 2007 as a follow-on to TRAC UAS Mix Analysis of 2006
- Analysis Goals
 - Small UAS Laser Designation targets in urban environment
 - Rotary Wing (RW) versus Fixed Wing (FW) UAS detection
- Implementation
 - FOCUS was used for all modeling and analysis
 - Two missions: laser designation and persistent surveillance
 - Three flight modes: FW, RW, P&S
- Results
 - Poor LD of moving targets in high density terrain
 - Inconsistent LD of moving targets in medium density terrain
 - Good LD of stationary targets
 - Perch-and-Stare could be the best choice for persistent surveillance
 - Surveillance of an intersection by hovering gives better performance than a circular flight path around the area

UNCLASSIFIED



FOCUS solves these problems

- Modeling of C4ISR functions using flexible architecture
- Explicit modeling of fusion processes
- Fast turn-around time-- Graphical mission tools and integrated analysis package
- System of systems analysis

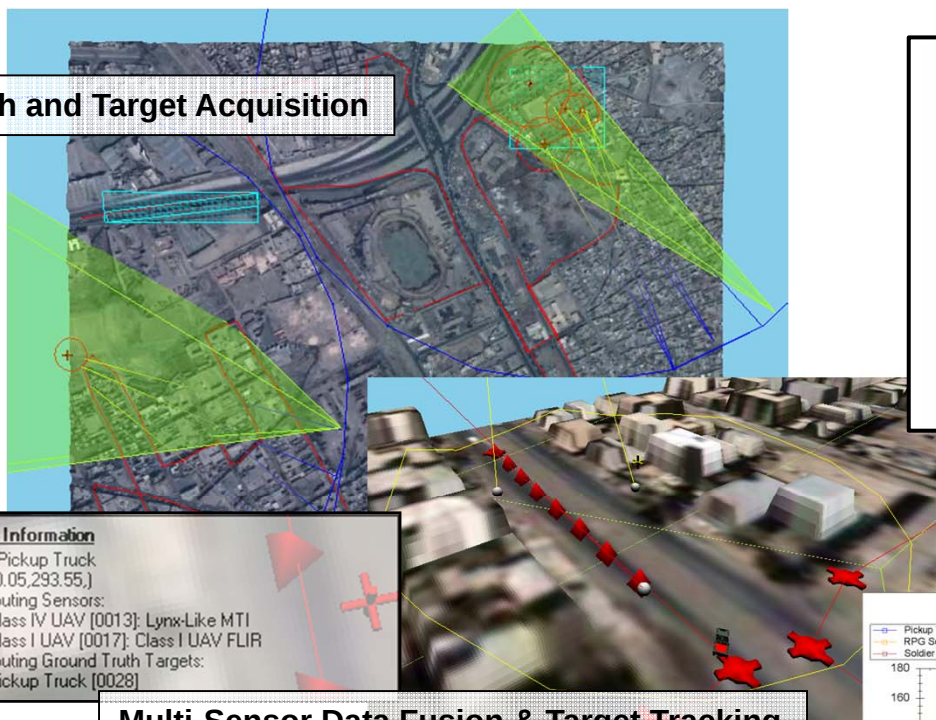


TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED

UNCLASSIFIED

Search and Target Acquisition



Track Information

Type: Pickup Truck
At: (-60.05,293.55,)
Contributing Sensors:
1. Class IV UAV [0013]: Lynx-Like MTI
2. Class I UAV [0017]: Class I UAV FLIR
Contributing Ground Truth Targets:
1. Pickup Truck [0028]

Multi-Sensor Data Fusion & Target Tracking

Other Projects

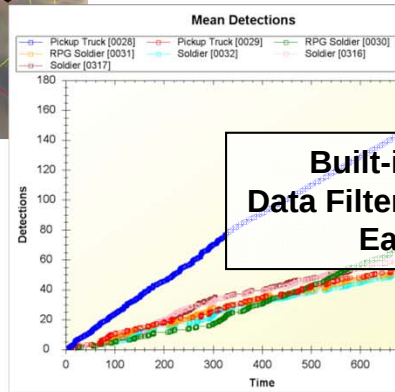
- UAS Mix Pilot Study
- Sensor Fusion Analysis
- Fusion Algorithm Test Bed

Potential Applications

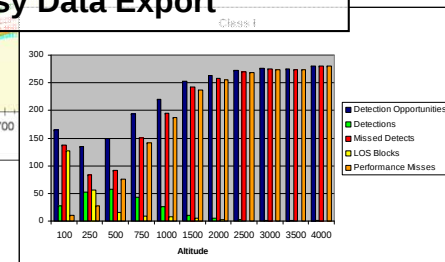
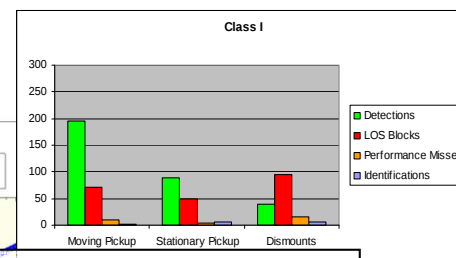
–C4ISR analysis

- Sensor mix questions
- C4ISR in urban terrain
- Collection / search strategy evaluation
- Fusion effects
- Unit behavior effectiveness
- Sensor Cueing / collaborative C4ISR

–TTP Development and Analysis



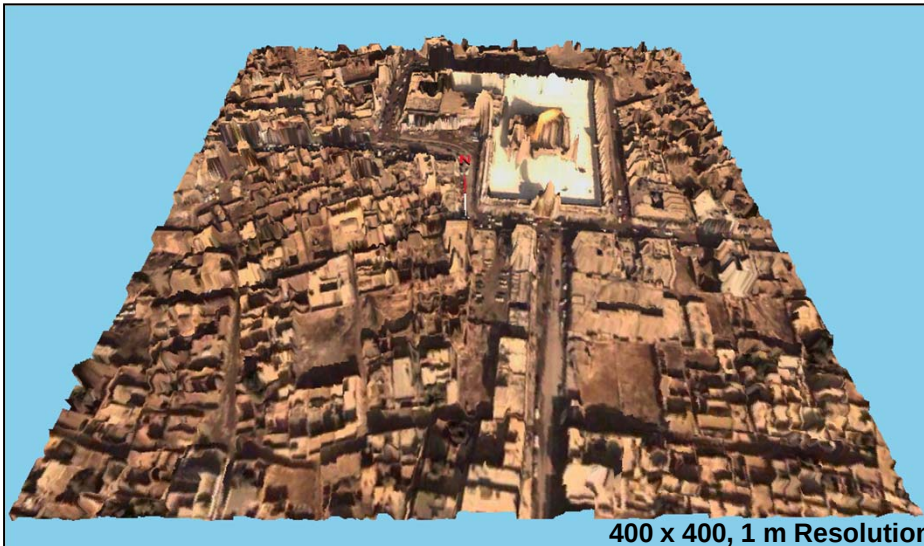
Built-in Analysis Toolkit Data Filtering & Custom Metrics Easy Data Export



UNCLASSIFIED

- **Limited Scenarios**
- **UAS Movement**
 - No jitter
 - Fixed-Wing UAS
 - Minimum turn radius used for path; circular flight path around intersection
 - Hovering UAS
 - Stays behind target when tracking; standoff when lasing
 - Hovers at a point with LOS to intersection for 5 minutes then moves
 - Perch-and-Stare
 - Edge of building, 10 m from intersection
 - Altitudes: 20 m (High Density), 10 m (Medium Density)
- **C4ISR**
 - Communications simplified
- **Sensors**
 - 3-axis mount, 2 FOVs
- **Warhead receiver**
 - Low fidelity representation
 - Horizontal safe angle
 - Assumed LOS

UNCLASSIFIED



High Density

- Samarra, Iraq
- Tall buildings (3-5 story), tightly packed
- Narrow streets with some intersecting wide avenues



Medium Density

- Fallujah, Iraq
- Low residential buildings (1-2 story)
- Narrow streets and back alleys
- Enclosed courtyards

UNCLASSIFIED

UAS Follow-On Study Run Matrix			
Laser Designation Scenario			
Run #	Target Type	Terrain	Flight Characteristic
1	Moving	High Density	Fixed-Wing
2	Moving	High Density	Rotary-Wing
3	Moving	Medium Density	Fixed-Wing
4	Moving	Medium Density	Rotary-Wing
5	Stationary	High Density	Fixed-Wing
6	Stationary	High Density	Rotary-Wing
7	Stationary	Medium Density	Fixed-Wing
8	Stationary	Medium Density	Rotary-Wing
Intersection Surveillance Scenario			
Run #	Sensor Type	Terrain	Flight Characteristic
9	IR	High Density	Fixed-Wing
10	IR	High Density	Rotary-Wing
11	IR	High Density	Perch-and-Stare
12	IR	High Density	Perch-and-Stare Wide FOV
13	IR	Medium Density	Fixed-Wing
14	IR	Medium Density	Rotary-Wing
15	IR	Medium Density	Perch-and-Stare
16	IR	Medium Density	Perch-and-Stare Wide FOV
17	TV	High Density	Fixed-Wing
18	TV	High Density	Rotary-Wing
19	TV	Medium Density	Fixed-Wing
20	TV	Medium Density	Rotary-Wing
Sensitivity Analysis			
	Altitudes	100,200,300,400,500	
	Standoff Ranges	100,200,400,500,700	
Run #	Scenario	Terrain	Flight Characteristic
21	LD Moving	High Density	Fixed-Wing
22	LD Moving	High Density	Rotary-Wing
23	Surveillance	High Density	Fixed-Wing
24	Surveillance	High Density	Rotary-Wing

Fixed Wing

Rotary Wing

Perch/Stare

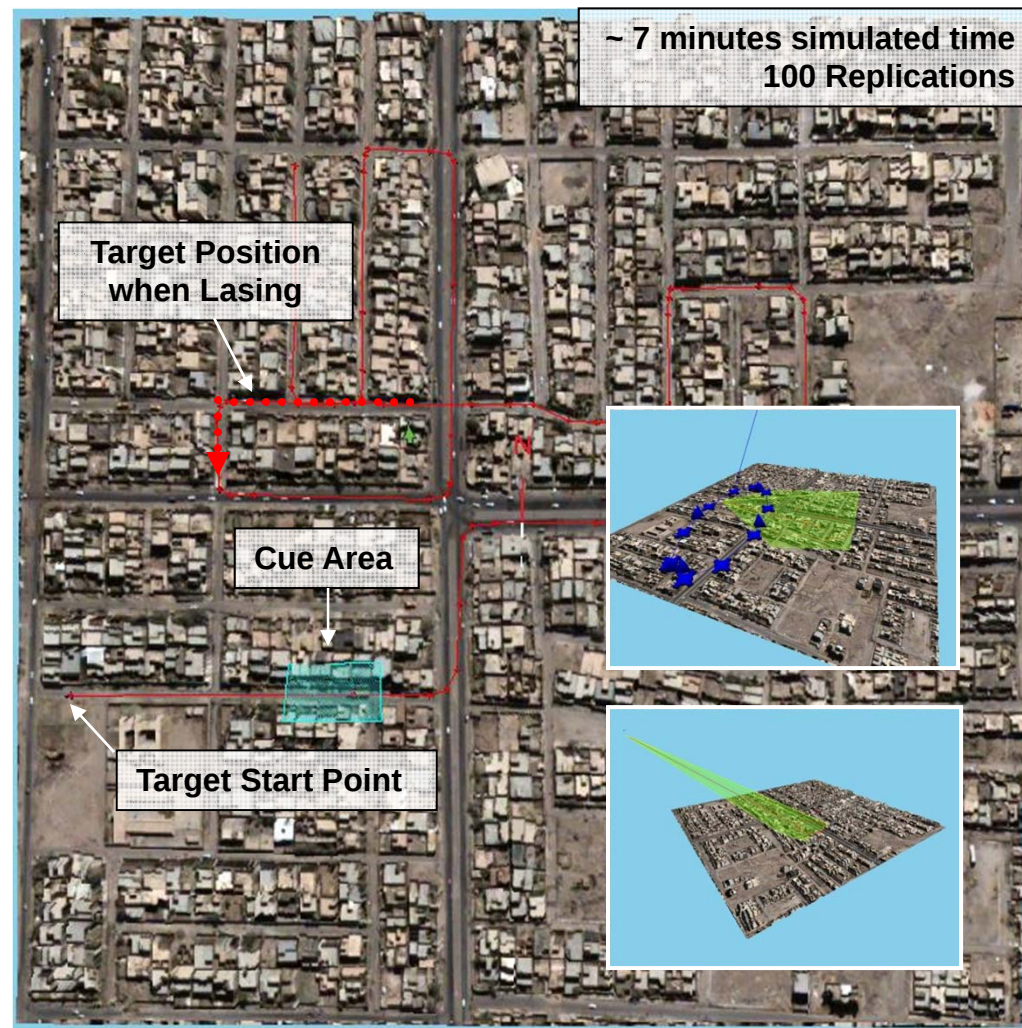
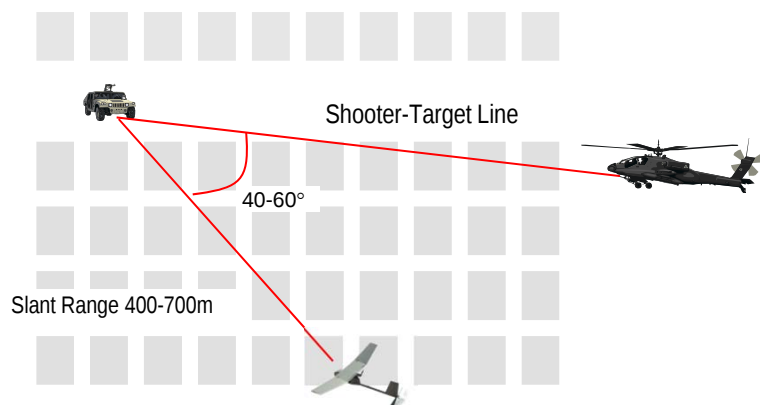
Perch/Stare
Wide FOV

UNCLASSIFIED

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED

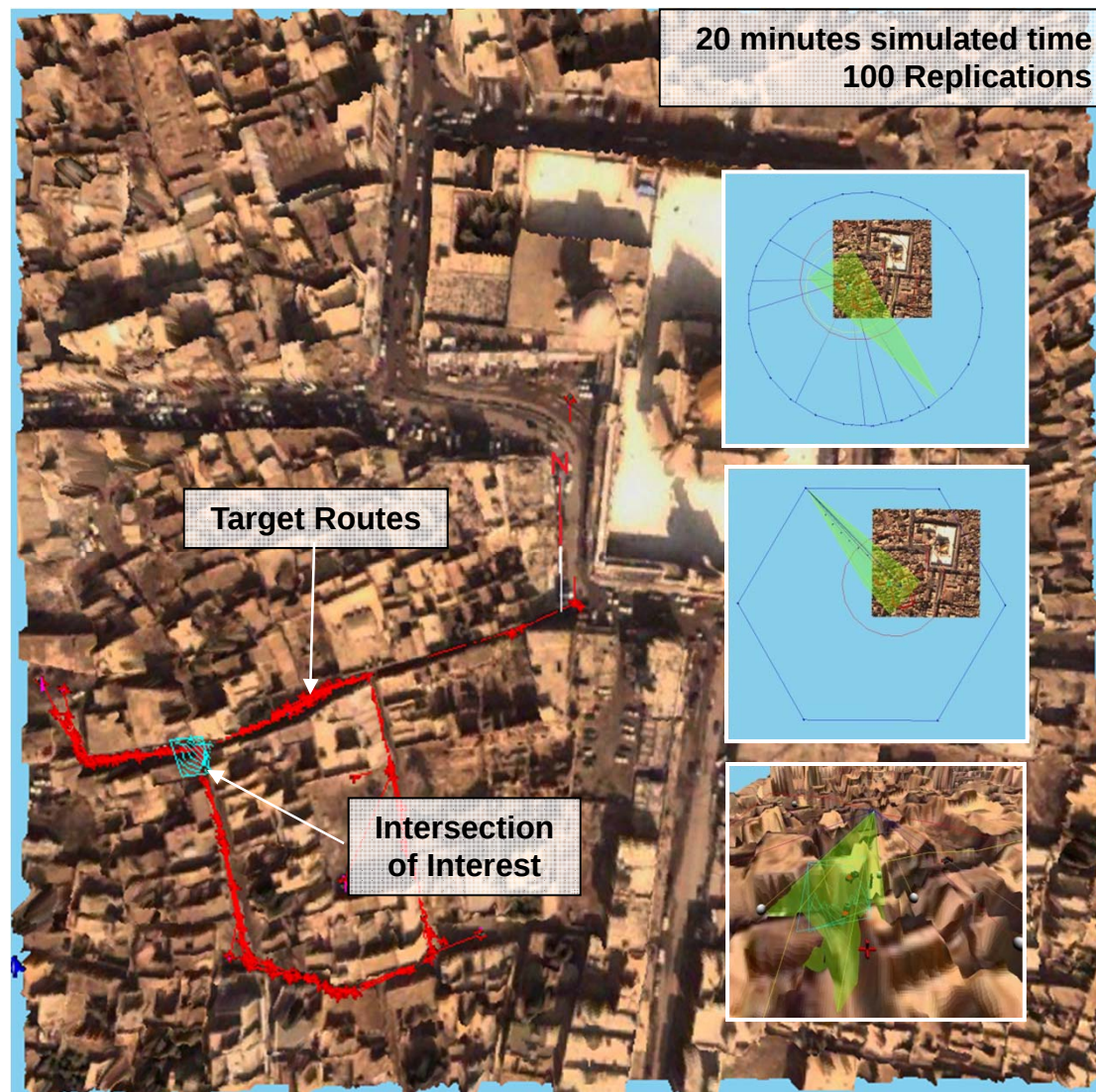
- Moving or Stationary Target
- After tracking target for 5 minutes, UAS moves into slant range while maintaining “safe angle”
- Warhead/Receiver moves toward target
- Once warhead reaches target, simulation ends



UNCLASSIFIED **TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

UNCLASSIFIED

- 20 minute coverage w/ IR or TV
- Targets circle around block
- Sensor only attempts detection at intersection
- FW UAS – circular flight path
- RW UAS – hovers at points on circle for 5 minutes
- Perch-and-Stare UAS – Fixed position at edge of building



UNCLASSIFIED **TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.**

UNCLASSIFIED

Issue 1: Can a Small UAS laser designate targets in an urban environment?

- **Moving Target**
 - High Density – LOS blocks result in unacceptable Lock-On times
 - Medium Density - Target maneuvering results in inconsistent Lock-On
- **Stationary Target**
 - Lock-On near 100% of overall lasing time for all scenarios



Stationary
Target Positions



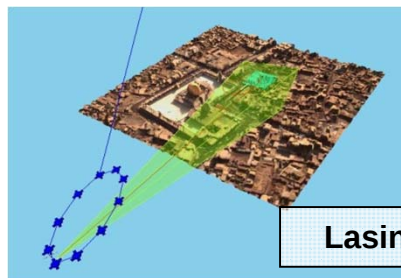
Moving Target Positions
during Lasing



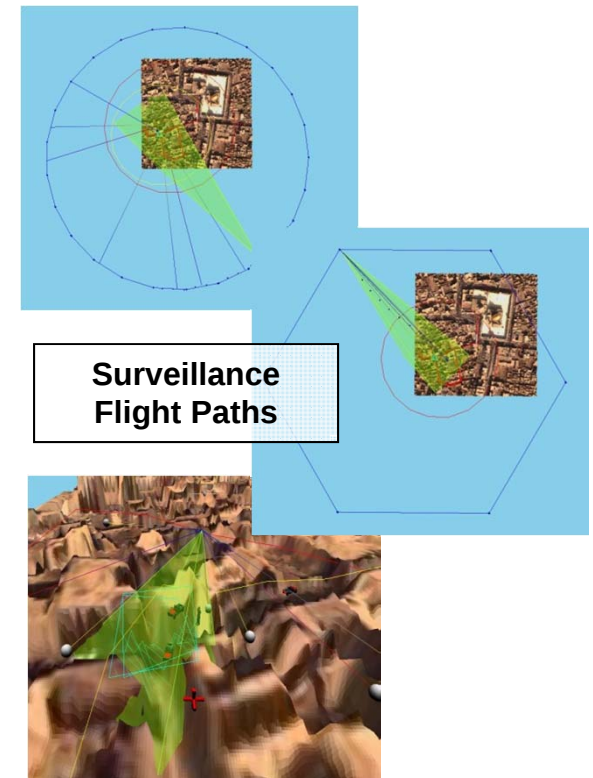
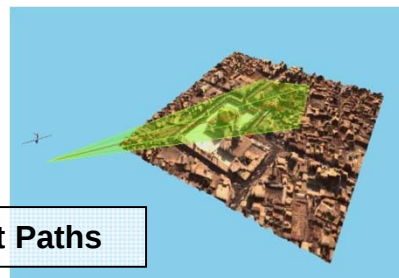
UNCLASSIFIED

Issue 2: Does a Fixed-Wing UAS provide better acquisition performance than a Rotary-Wing UAS?

- **Laser Designation**
 - Similar results for both FW and RW cases
 - LOS blocks caused by constrained movement
- **Surveillance**
 - High Density – hovering can increase acquisition performance
 - Medium Density – FW and RW UAS perform equally well
 - Perch-and-Stare Operations, when given an appropriate sensor, increases performance in High Density Environments

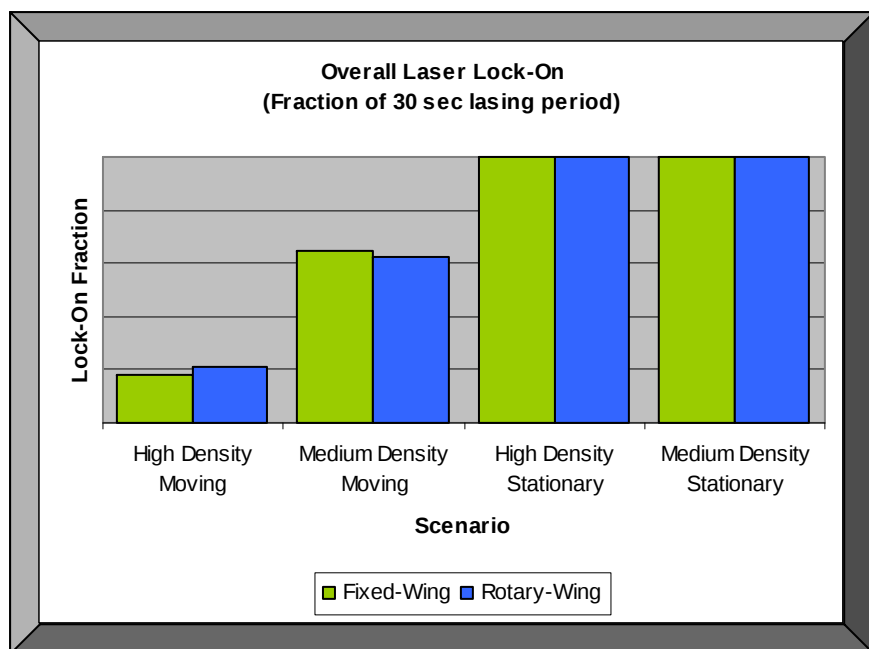


Lasing Flight Paths



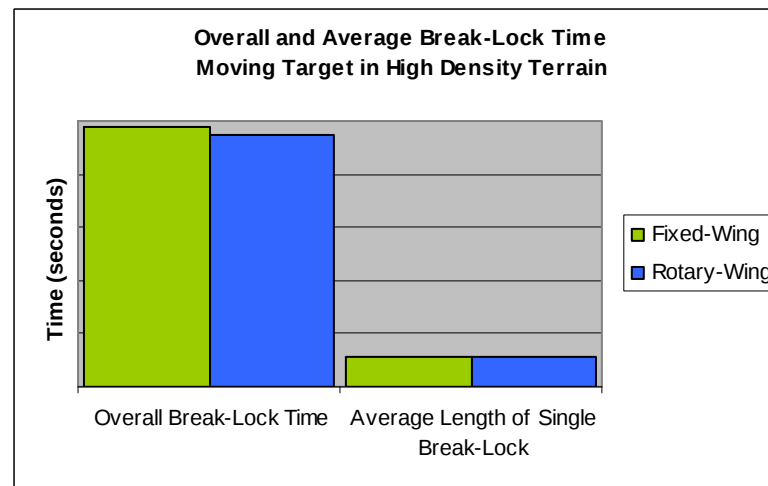
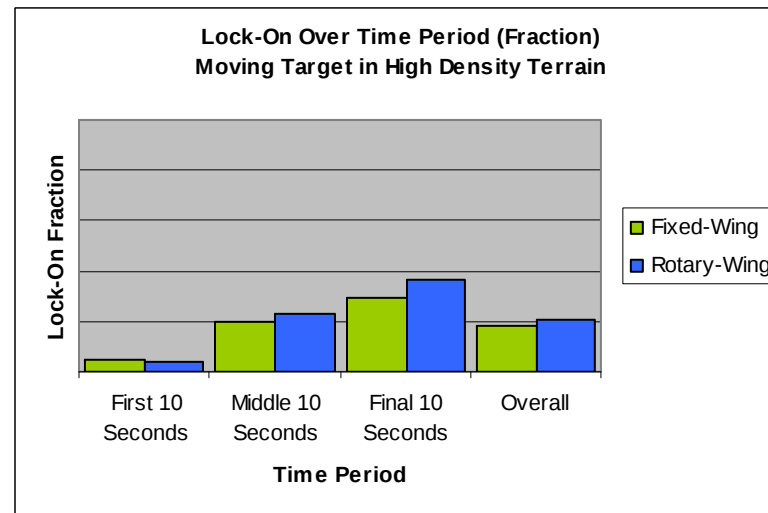
UNCLASSIFIED

Overall Lock-On Results



- Similar performance for FW and RW UAS
- Moving Target – laser rarely keeps a continuous lock on the target due to LOS blocks

Moving Target / High Density Terrain In Depth Results

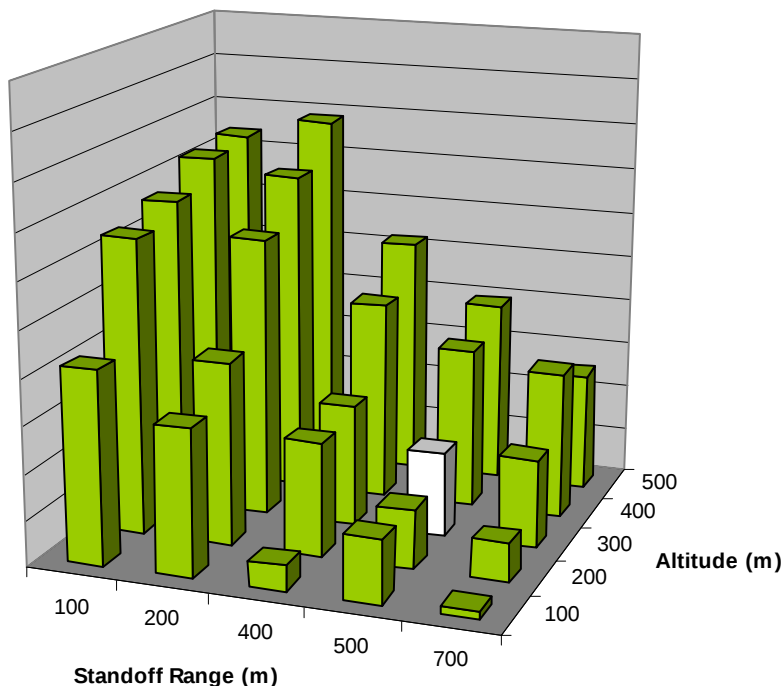


UNCLASSIFIED

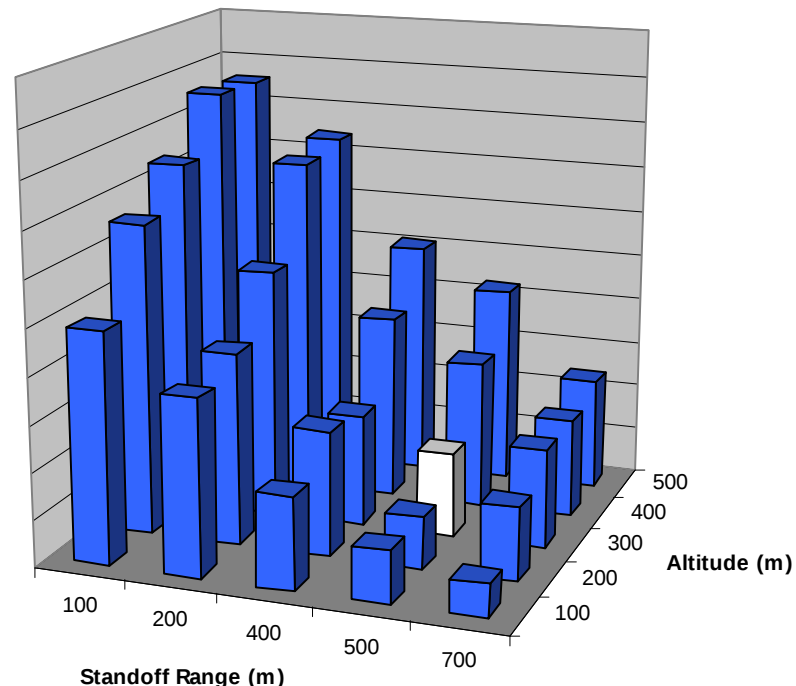
TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED

Fraction of Lock-On ~ Overall Lasing
FW SUAS vs. Moving Target in High Density Terrain



Fraction of Lock-On ~ Overall Lasing
RW SUAS vs. Moving Target in High Density Terrain

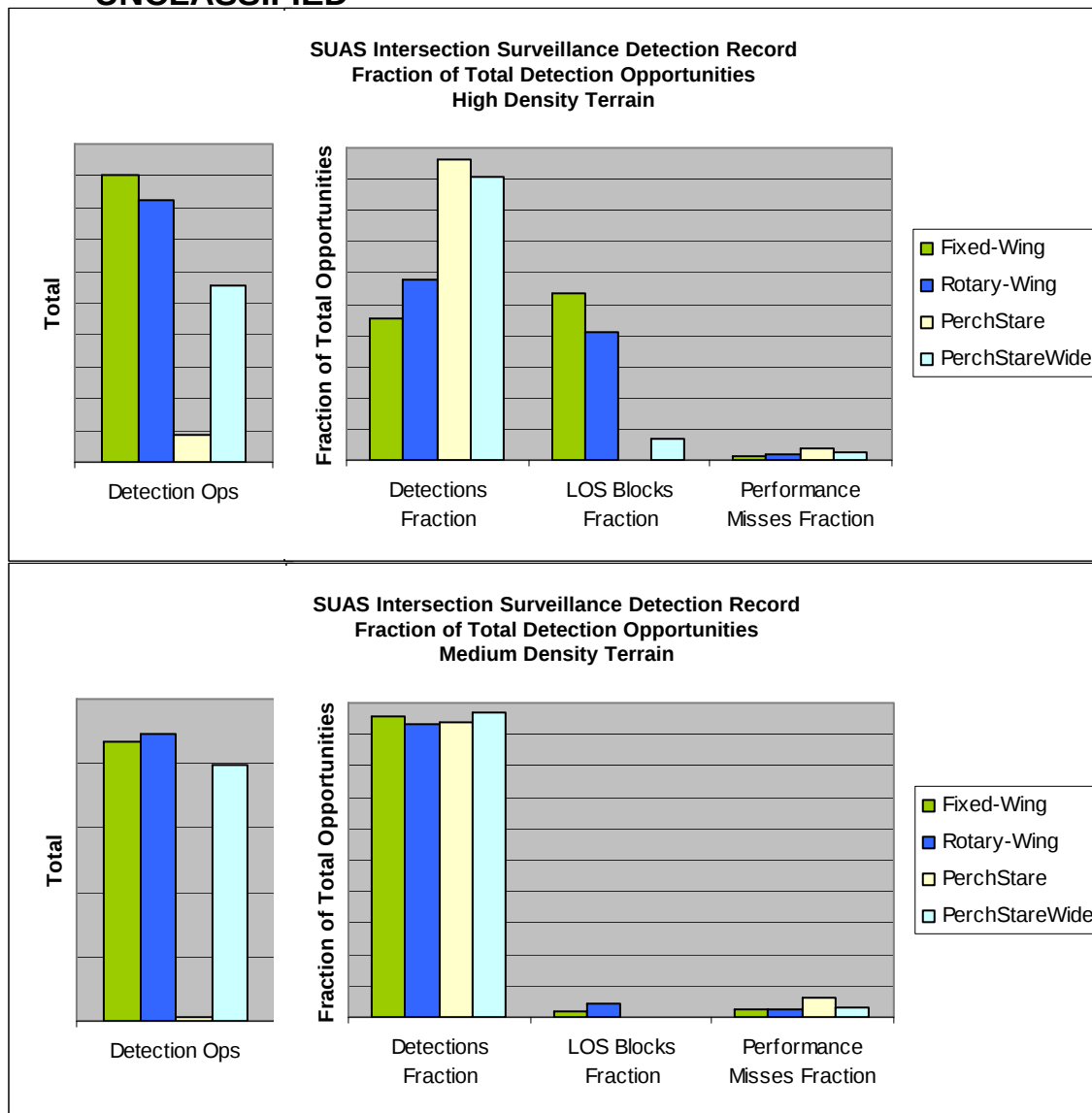


The probability of Lock-On success increases with an increase in altitude and/or decrease in ground standoff range

☐ Operational Parameters

UNCLASSIFIED

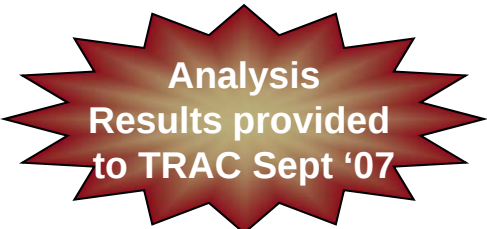
- **High Density Terrain**
 - Hovering UAS performance exceeds Fixed Wing
 - Determining Factor: LOS
 - Perch-and-Stare given wider FOV outperforms flights at operational altitude
- **Medium Density Terrain**
 - Hovering and Fixed-Wing UAS perform equally well
- **Perch-and-Stare**
 - Poorly performs due to the size of the FOV (low Ops)
 - Footprint shrinks as UAS is closer to ground level
- **TV Sensor gives similar results to IR Sensor**



UNCLASSIFIED

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

UNCLASSIFIED



Analysis
Results provided
to TRAC Sept '07

- **Conclusions**
 - Small UAS has extreme difficulty lasing moving targets in high density urban environments
 - Lasing moving targets in medium density terrain is possible but not certain
 - Lasing of stationary targets is not an issue given LOS
 - Perch-and-Stare may be the best choice for surveillance of a point or intersection
 - Surveillance of an intersection by hovering gives better performance than a circular flight path around the area
- **Next Steps**
 - TRAC will use this data in conjunction with Soldier interviews on the operational ability/benefits of the FW and RW Small UAS when compiling the final report
 - Both parts of study will be combined into a final report
 - Examine additional scenarios and more detailed missile engagements



Questions/Comments?



UNCLASSIFIED