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Detection via Persistence: Leveraging Commercial Imagery from Small Satellites

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PRESENTED BY

Risa Haddal
International Safeguards and Engagements Department

Co-Authors: Dennis Lee[1], John Ohlinger[2], Allison Puccioni[3], Heidi Smartt[1]

1 Sandia National Laboratories (SNL)
2 BlackSky Geospatial Solutions
3 Armillary Services LLC

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PROJECT OVERVIEW AND TECHNICAL APPROACH

Three-year collaborative exploratory effort to examine how capabilities emerging in small satellite industry (e.g., BlackSky), combined with unique nonproliferation and analytical capabilities at Sandia, can improve remote proliferation detection (PD)

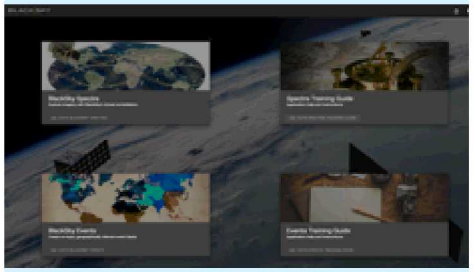
Phases I-III (2018-2020)

- Site selection
- Custom event feed development (e.g., machine learning capability using news and open source information to inform satellite tasking)
- Operational demonstration execution (30 - 60 days of collection)
  - Demo persistence through imagery collection at various revisit rates
- Increase imaging opportunities per day over time:
  - 2-4 (Phase I)
  - 4-10 (Phase II)
  - 10-20 (Phase III))
- Evaluate event feeds (e.g., correlate open source reporting with tasking and collected imagery)
- Conduct imagery analysis (change detection, pattern of life)
- Demonstrate monitoring contribution of persistent, low-cost, 1 meter (m) resolution (or <1 m) imagery to PD mission needs

BlackSky Pathfinder 1

GOALS AND CAPABILITY IMPROVEMENT

- Expand PD tools and techniques available at a fraction of the cost of current systems.



- Emerging tools include:
  - High revisit rates, rapid persistence
  - Data fusion capabilities
  - Orchestrated tipping and cueing of commercial sensors
  - Increased samplings with ability to adapt frequency
  - Unique partnerships
  - High spatial resolution at expected temporal rate of
  - ~4-20 images/day by Phase III
  - Sensor fusion
  - High definition video
  - Advanced analytics and data fusion systems
    e.g., geospatial information + reference maps +
  - Ground photos + reporting

BLACKSKY

+

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- Improve change detection
- Improve anomaly detection
- Reduce ability to obfuscate undeclared activity
- Leverage increased public accessibility to low-cost images
- Leverage expert communities to creatively approach PD challenges

RESEARCH CHALLENGE & ACCOMPLISHMENTS

Research Challenge:

- How might we approach near real-time PD by leveraging small commercial satellite assets to support and improve mission functions?

Research Questions:

- How can rapid revisit rates from small commercial satellites help achieve near real-time monitoring?
- What proliferation-indicating patterns can be detected by lower-resolution, high-revisit rates that cannot be seen with high-to-exquisite-resolution, low-revisit rates?
- How can applying autonomous data analytics such as anomaly and change detection to commercially provided data enhance or accelerate PD?
- How does the relatively arbitrary time-of-day imaging of high-revisit rates affect autonomous data analysis such as change or anomaly detection, or pattern of life?
- How can commercial satellite performance viably augment national data collection and offer sufficient capabilities, responsiveness, capacity, and cost effectiveness?

Accomplishments:

- Subcontract: 12 February 2018
- Kickoff meeting: 8-9 March 2018
- Access to and familiarization with BlackSky Platform
- Operational Demo I complete:
  - 1st collection: 15-29 May with revisit rate of 2-4 imaging opportunities/day
  - 2nd collection: 10-15 September with revisit rate of 2-4 imaging opportunities/day
- Achieved one large six-image burst in 25-hour period (1st collection)
  - Demonstrated persistent capability, including intraday imagery collection
  - Rarely, if ever, seen in commercial satellite industry before
- Developed custom automated change detection algorithm

IMAGERY ANALYSIS

Six Image Burst of Site A in 25-hour period

Sandia Automated Change Detection of Site A