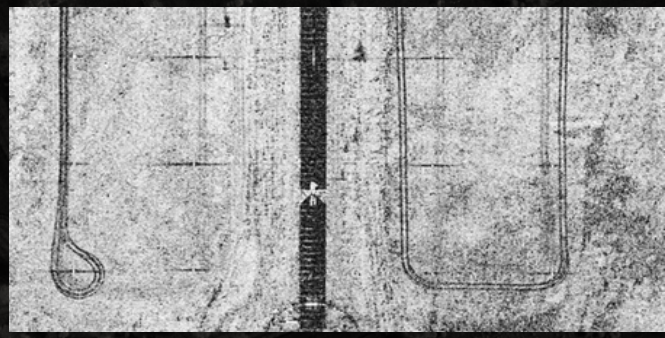
SAND2017-12593PE





Overview of Synthetic Aperture Radar at Sandia National Laboratories

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Sandia Airborne ISR: www.sandia.gov/radar/

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2014-XXXXP

U.S. DEPARTMENT OF ENERGY | NNSA

Governance of Sandia Laboratories

Sandia Corporation

- AT&T: 1949–1993
- Martin Marietta: 1993–1995
- Lockheed Martin: 1995–2017
- National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc.: 2017-present
- Government owned, contractor operated
- FFRDC: Federally funded research and development center

Purpose Statement

Sandia develops advanced technologies to ensure global peace

NW Mission & Sandia SAR Evolution

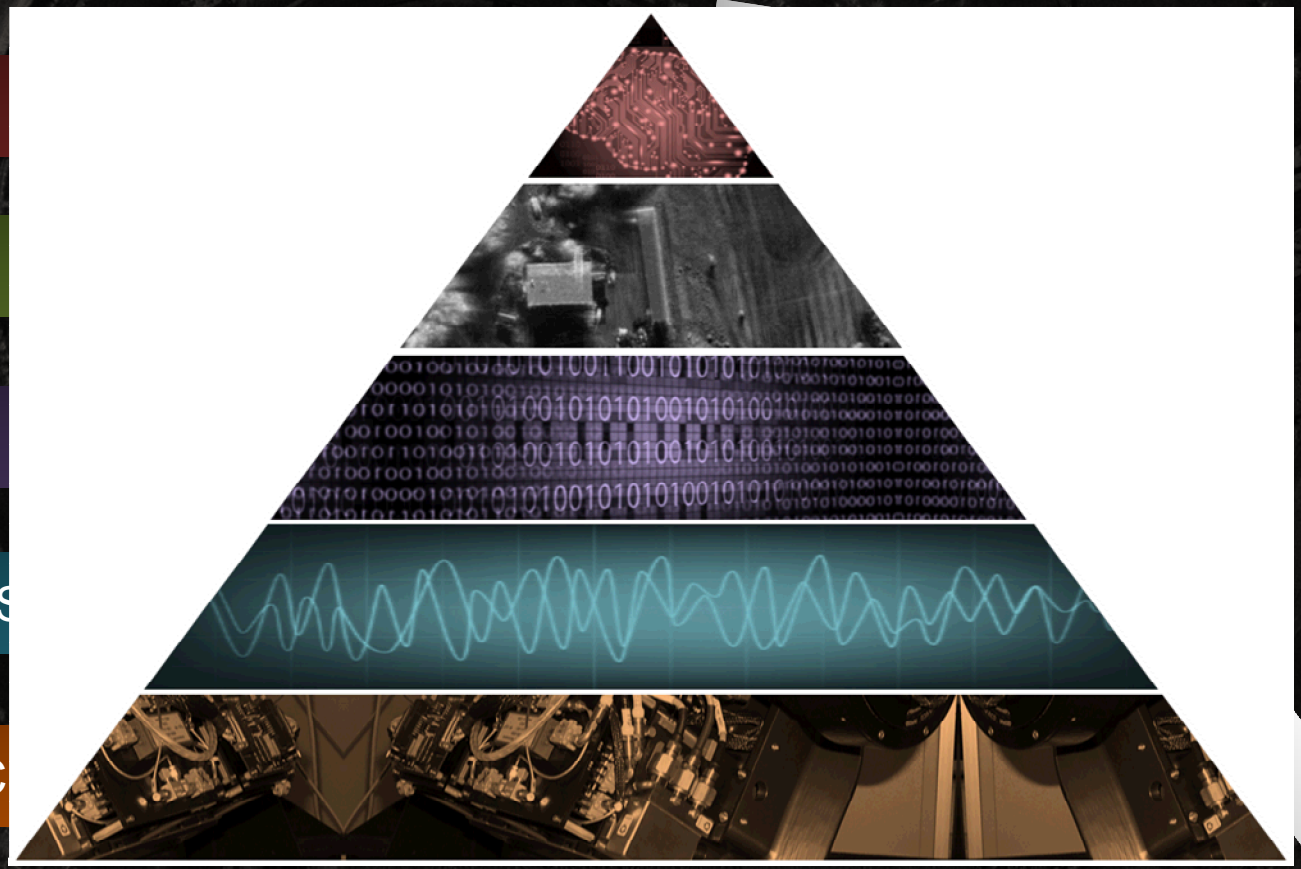
SNL SAR Overview

- Pathfinder Airborne ISR Solutions
- Real World Applications
- Complete Mission Solutions
- Multi-Mode Functionality
- SAR Resolution Matters
- Radar Change Product Image: Coherent Change Detection
- Advanced Capabilities
- SAR R&D Testbed
- Rethinking Search
- Human Factors
- Next Generation SAR
- Working with Sandia
- Summary

Airborne ISR at Sandia

Provider of system solutions across the entire Intelligence, Surveillance and Reconnaissance (ISR) architecture

DECISION MAKER



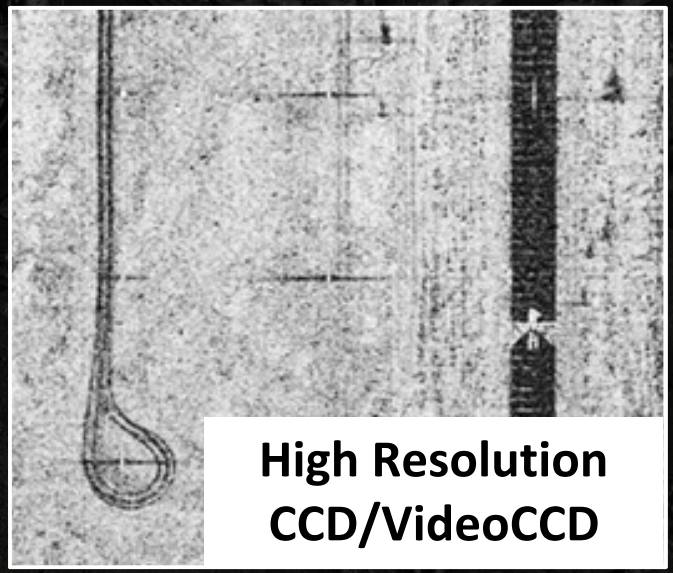
PHYSIC

Pathfinder Airborne ISR Solutions

3+ decades of experience delivering pathfinder SAR solutions for complex, critical and urgent national security problems (FFRDC)

- All Weather, Day or Night
- High Resolution, Optical-like
- On-board and Real-time Processing
- Flexible platform and TPED configuration

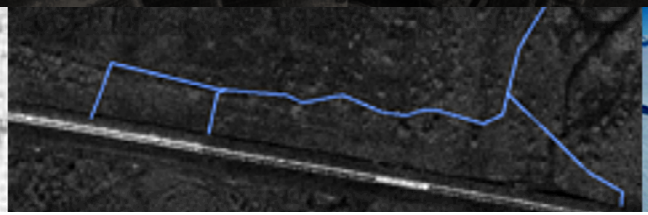
High Resolution SAR/VideoSAR



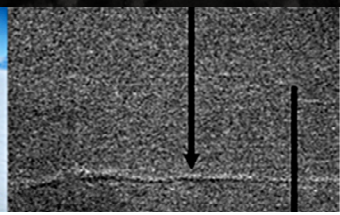
High Resolution CCD/VideoCCD

Real World Applications

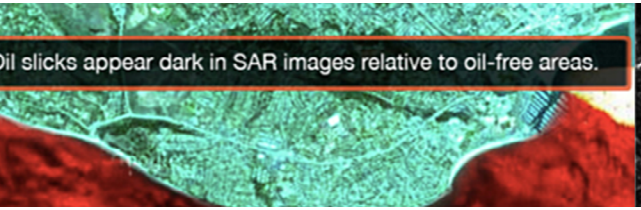
Coherent Change Detection



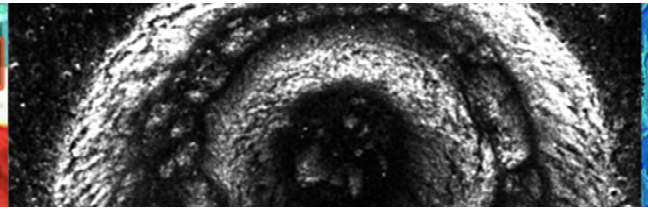
Facilities and Border Protection



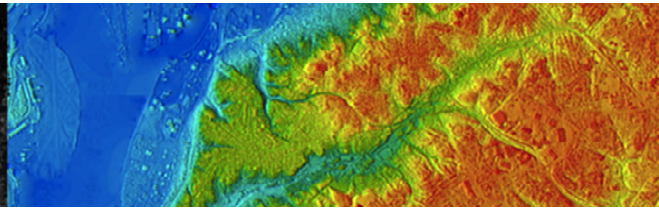
Crevasse Detection



Environmental Monitoring



Earth Sciences

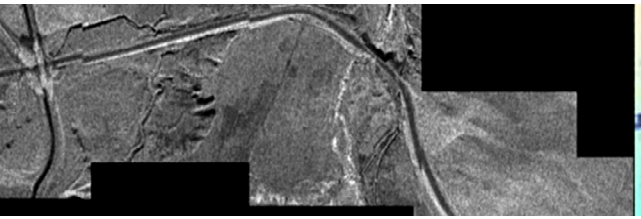


High Res. Terrain Elevation Mapping

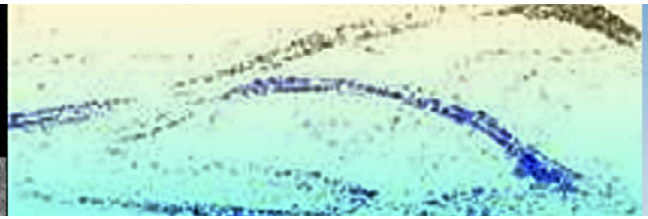
Maritime & Littoral

Tracking

S&R and Targeting



C-IED & Route Reconnaissance



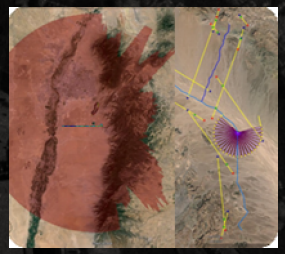
Patterns of Life

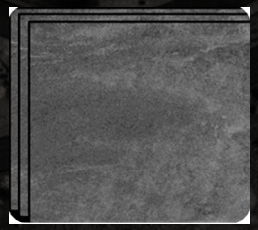
Precision Guidance

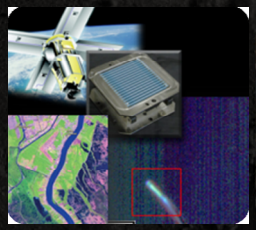
Since 1997, Sandia radars have been used to address critical problems in all geographic areas

Complete Mission Solutions

- Provider of end-to-end solutions that leverage physics, engineering, and data and information science to support national security decision making
  - **Mission Engineering**
    - Pre-Mission Analysis & Flight Planning
    - Highly customized TTPs and CONOPs
    - Continuous performance assessments
    - Analyst Training in SAR phenomenology
  - **Real-time Processing**
    - Real-time Delivery of Multiple Image Products to Analysts
    - Image Formation
    - Change Detection Products
    - Transmission of Real-time Products
  - **Advanced Sensor Exploitation**
    - Predictive Intelligence
    - Human Factors
    - Advanced Exploitation Techniques
  - Analyst Training

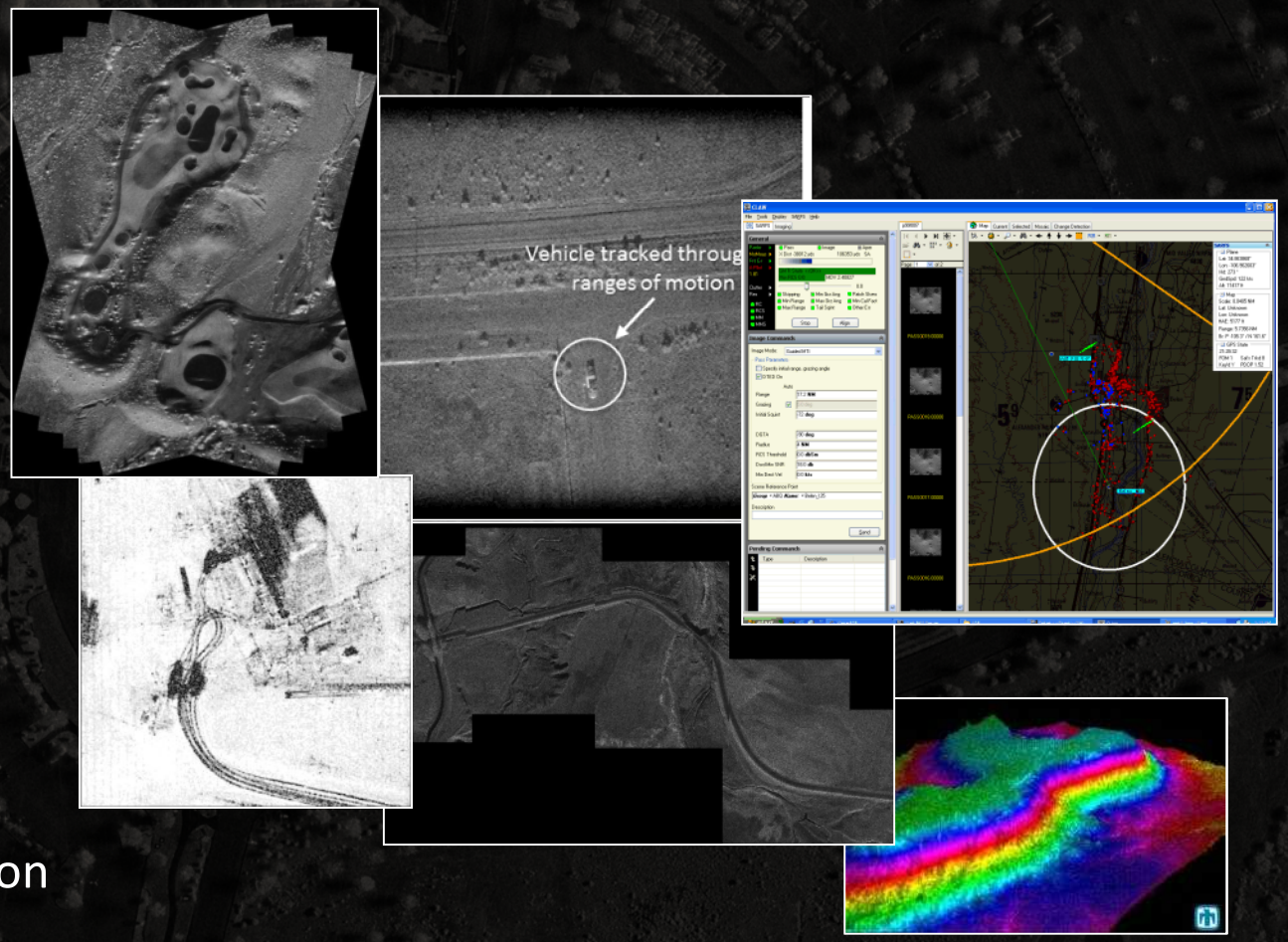







Multi-Mode Functionality

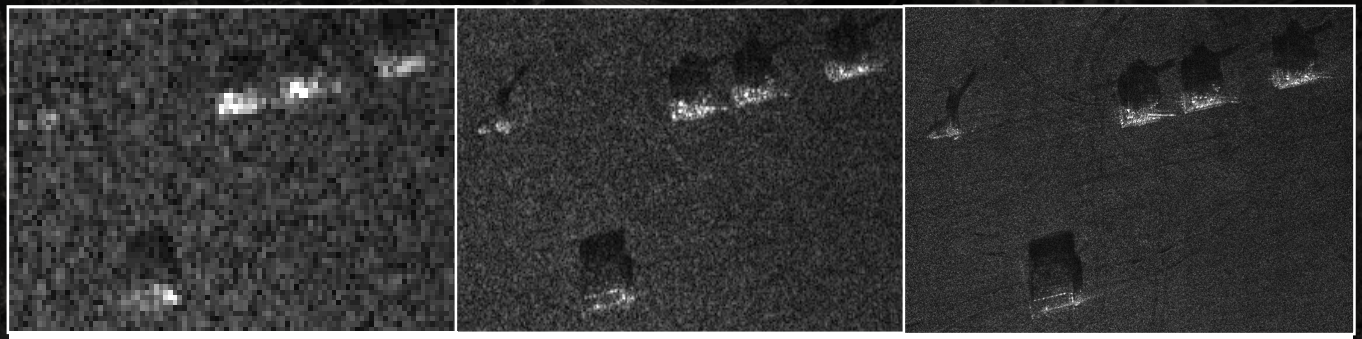
- Spotlight
- SpotDwell
- Circle
- Stripmap
- Arbitrary Stripmap
- CCD/NCP
- IFSAR
- VideoSAR/VICTR
- GMTI/DMTI
- Wide Area Search
- High Range Resolution



As new radar modes are developed they can be integrated into existing Sandia radars during product improvement phases without redeveloping the entire system

SAR Resolution Matters

- More “pixels on target” results in a more optically literate image for analysis
- Better facilitates accurate target identification
- Further improves capability of modes such as Coherent Change Detection (CCD) that exploit phase change

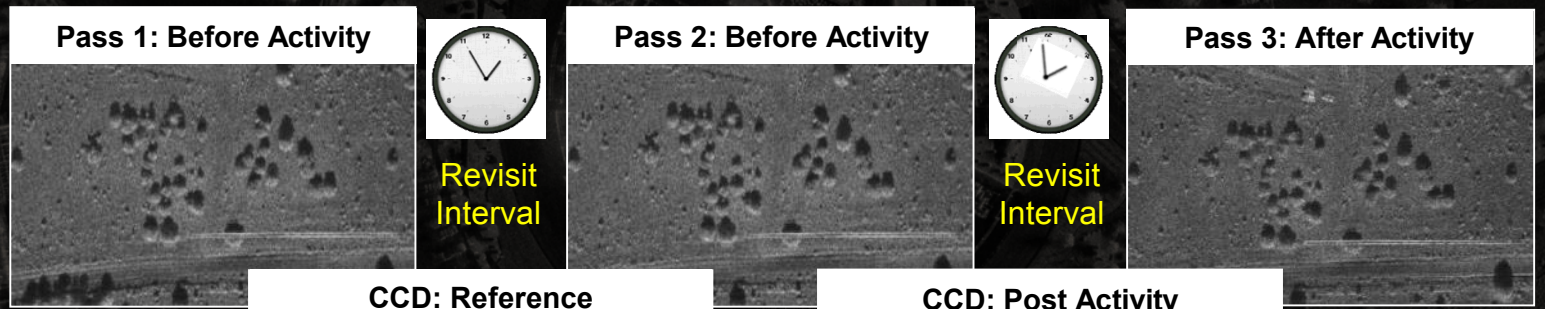


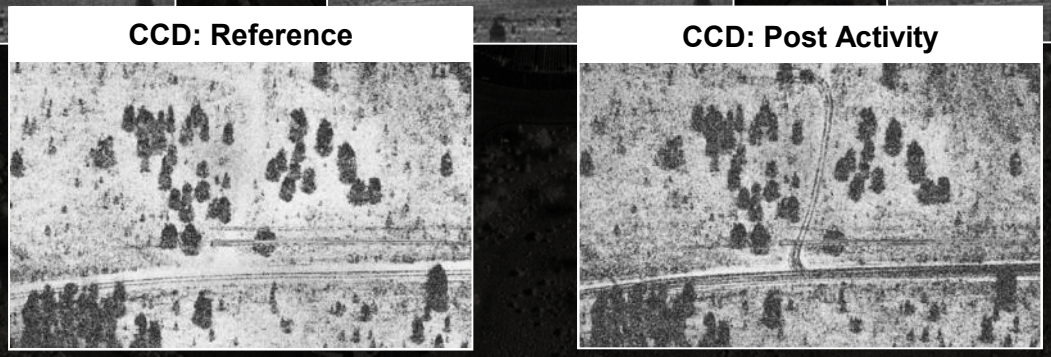
12” resolution	6” resolution	4” resolution

Radar Change Product Image: Coherent Change Detection (CCD)

Coherent change detection (CCD) is a sensitive technique for identifying subtle differences that occur in a ground scene between two SAR passes

- Can highlight arrival of new objects, removal of objects, agricultural activity and other changes
- Widely used for non-persistent surveillance, maintains a history of change

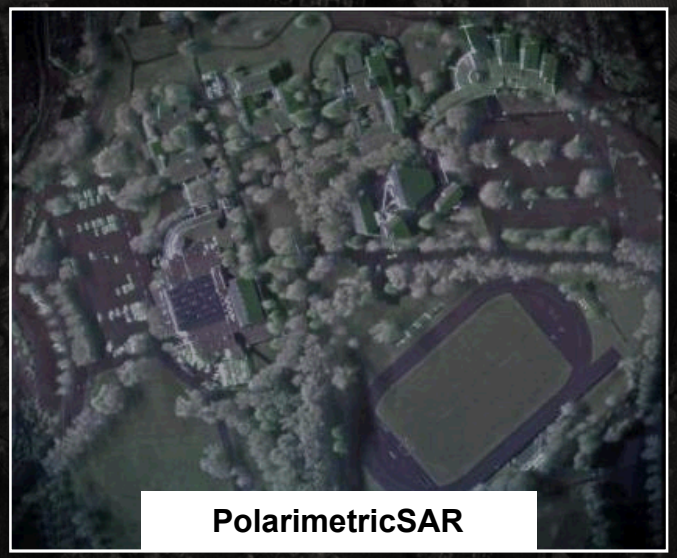




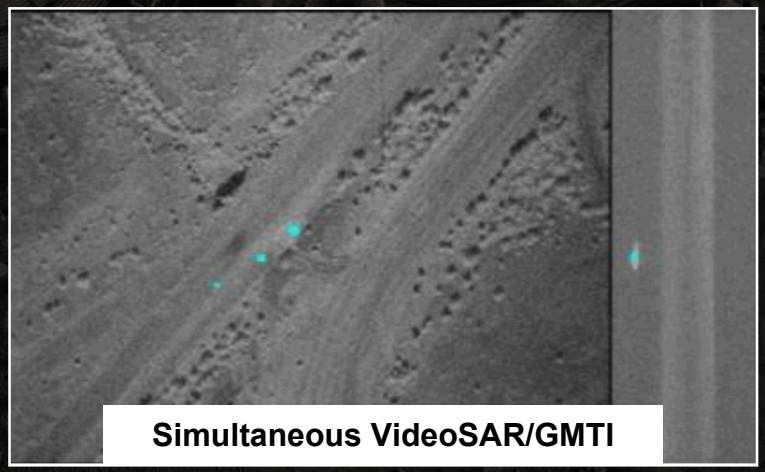
WHITE = high coherence
BLACK = low coherence

Advanced Capabilities

- Multiple channels with the same instantaneous bandwidth.
- Multiple phase centers – sum and difference yield clutter suppression and increased ability to track targets.
- Polarimetric SAR (HH, VV, HV, VH channels) yields additional information around scattering phenomena.



PolarimetricSAR



Simultaneous VideoSAR/GMTI

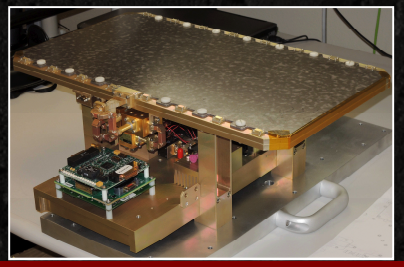
FARAD – SAR R&D Testbed

- An in-house, high-performance, multi-mode airborne radar capability for the continued advancement of SAR ISR capabilities
- FARAD works in accord with R&D efforts, both internal and external, to provide advanced radar airborne data collection and exploitation assets to facilitate specific research goals
- FARAD provides a “testbed laboratory”/research tool set that can be widely utilized in support of internal R&D, new program development, and collection of nationally-important data products.

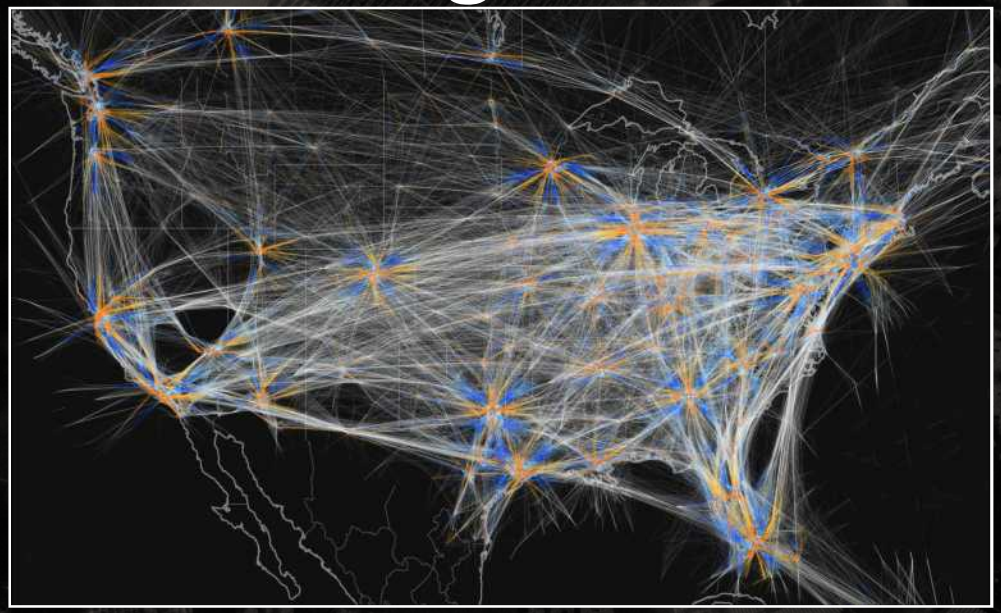
DeHavilland DHC-6 “Twin Otter” research aircraft operated for Sandia by Twin Otter International

Examples

- **X-Band**: Fully polarimetric
- **Ku-Band:** Quad-phase-center planar antenna
- **Ka-Band:** Dual-phase-center planar antenna



Rethinking Search

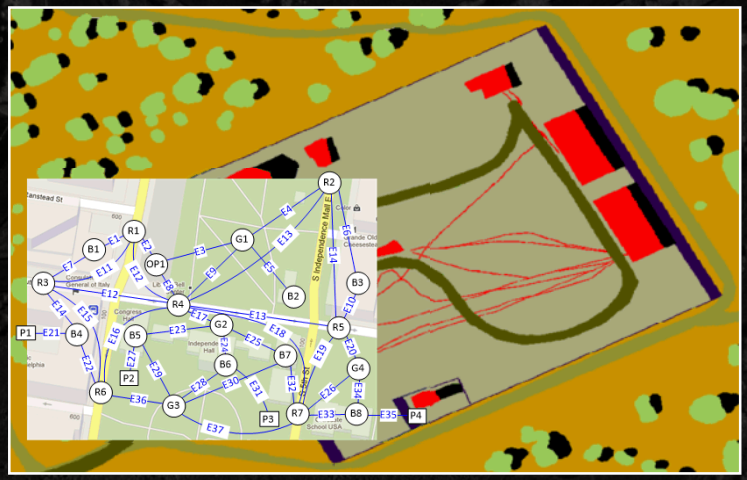


Rethinking traditional GIS and geospatial search.

- Compact, efficient representations of features extracted from sensor data
- Sensor agnostic capability for multi-INT feature relationships in time and space
- Predictive and forensic analysis

Rethinking patterns in motion.

- Geometric and temporal trajectory analyses – changing dots to tracks to *trajectories*.
- Geospatial-temporal relationships – i.e., identifying things like co-travelers.



Decision Makers and Analysts care about "what", "where", and "when".
Where is it going? Where has it been? What's the relationship? What's changed?

Human Factors Issues Permeate ISR

- Human-system integration remains the weakest link in the analytics research-development-deployment process
  - Human factors requirements may not be adequately addressed in acquisitions process.
  - As a result, situation awareness and general ergonomics may not be optimal for the TCPED cycle
  - Sandia is investing in its understanding of the Human-Machine Interface (HMI) in efforts to deliver optimal PED solutions.

Next Generation Radar

- Multi-Mission RF Architecture
  - Flexible operations in complex electronic environments
  - Multi-Channel Depending on Application
  - Simplified RF Frontend
  - Digital processing at full instantaneous bandwidth of radar
- Applications in Addition to Radar:
  - COMMS
  - SIGNALS (agile waveforms)
  - A2AD (sense, analyze, respond)
- Emerging high-speed digital COTS hardware
  - Decreased hardware costs
  - High-performance, real-time processing for multiple missions will be required.

Working with Sandia

- Technology Partnerships
  - http://www.sandia.gov/working_with_sandia/technology_partnerships/index.html

Working with Sandia

- In process: access to high resolution SAR datasets
- University Partnerships
  - http://www.sandia.gov/working_with_sandia/technology_partnerships/universities/index.html
- Careers/internships
  - http://www.sandia.gov/careers/students_postdocs/index.html

Thank You!

www.sandia.gov/radar/

BACKUP

SUMMARY

SANDIA VIDEOS

- Sandia's presentation at 2016 USGIF Symposium: https://vimeo.com/169916541
- Sandia's YouTube Channel
- Sandia's Remote Sensing and Surveillance Technologies: https://www.youtube.com/watch?v=7L_L6CmFPg4&feature=youtu.be

Thank You!

www.sandia.gov/radar/