Interagency Field Test & Evaluation
An Introduction

This work is sponsored by DOE, DOD, DHS, and FAA under Air Force Contract #FA8721-05-C-0002. Opinions, interpretations, recommendations and conclusions are those of the authors and are not necessarily endorsed by the United States Government.

Wind Turbine/Radar Interference Defined

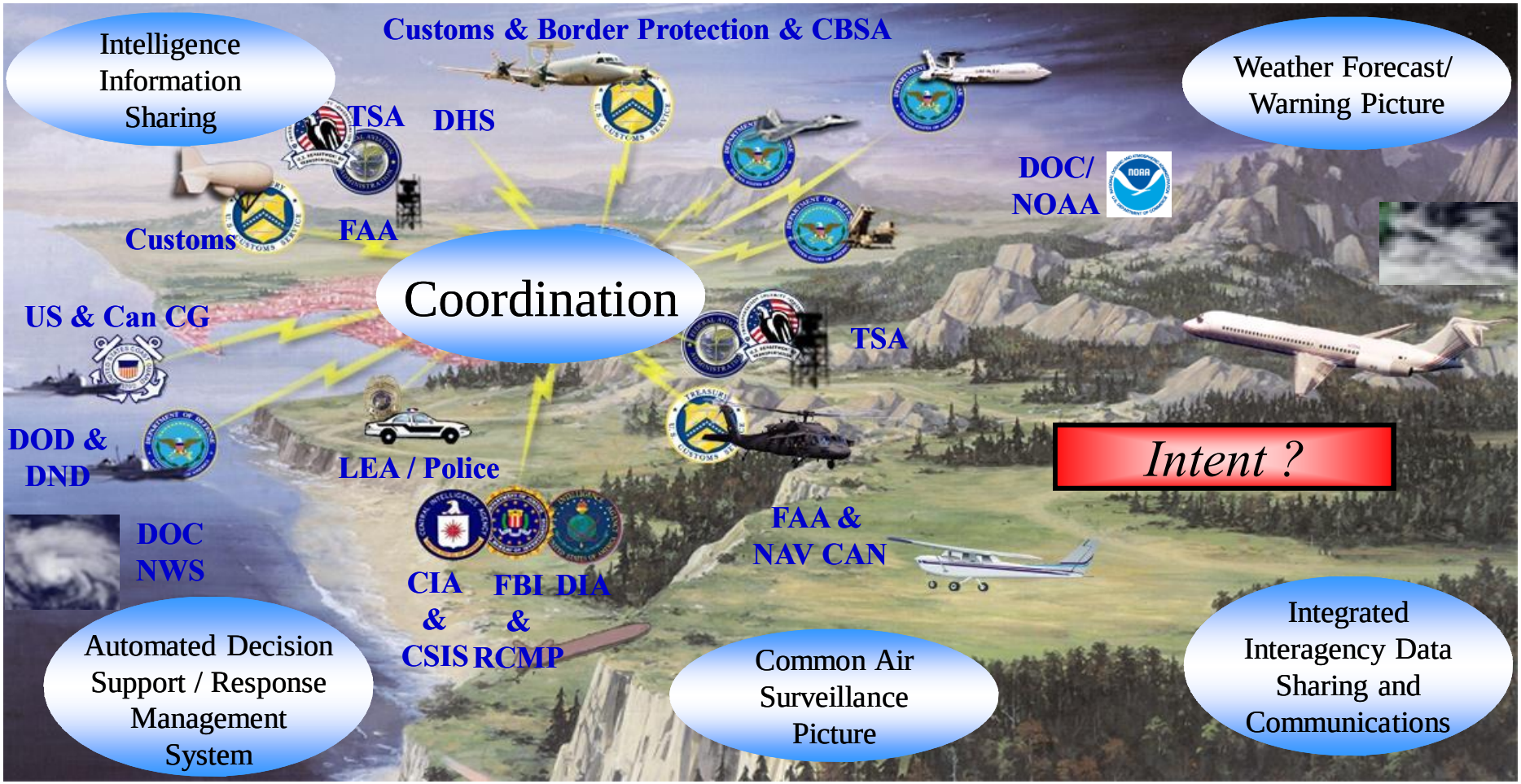
Wind turbines have been proven to interfere with radar operations (Air Traffic Control, Aerospace Surveillance, Air Defense, Weather, etc.). The impairments caused by wind turbines on radar span a range from creating clutter and reducing detection sensitivity to obscuring potential targets (among others). These effects on radar systems can inhibit target detection, generate false targets, interfere with target tracking, and impede critical weather forecasts.

This Interagency Team is Committed to Eliminating Wind Turbine/Radar Interference as a Barrier to Wind Energy Development

Outline

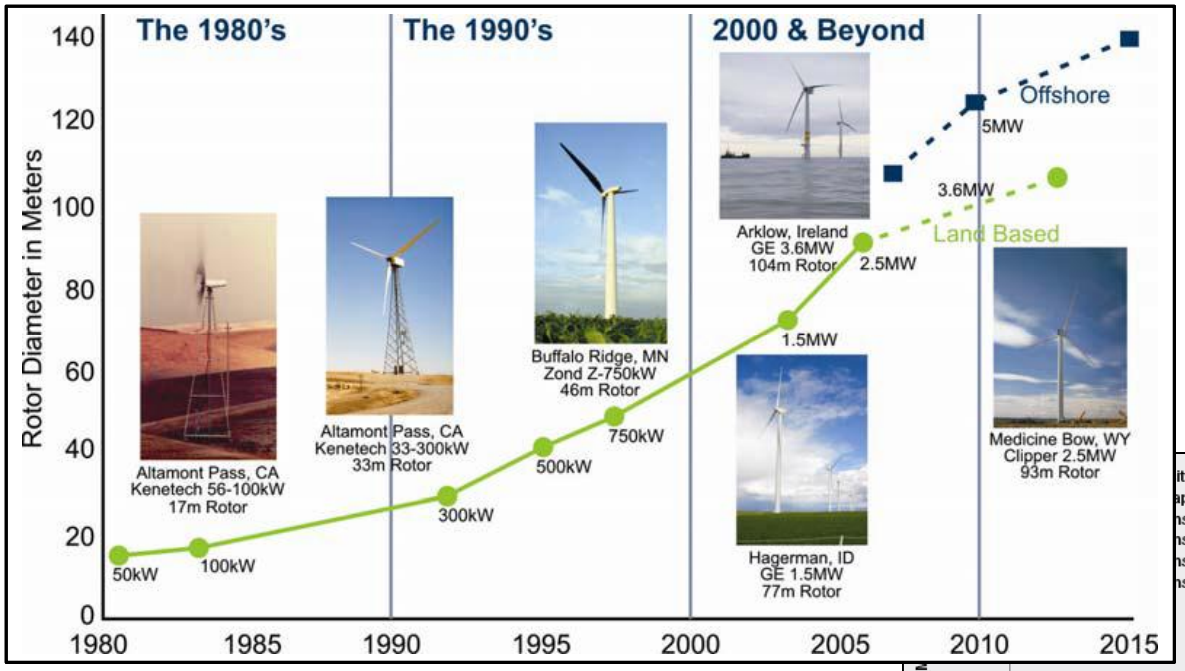
- Background
- Program Overview
- Field Tests
- Conclusions
- Questions

Surveillance Radars Are Key Enablers



Success = Maximized Interagency Partnership

Wind Turbine Trends

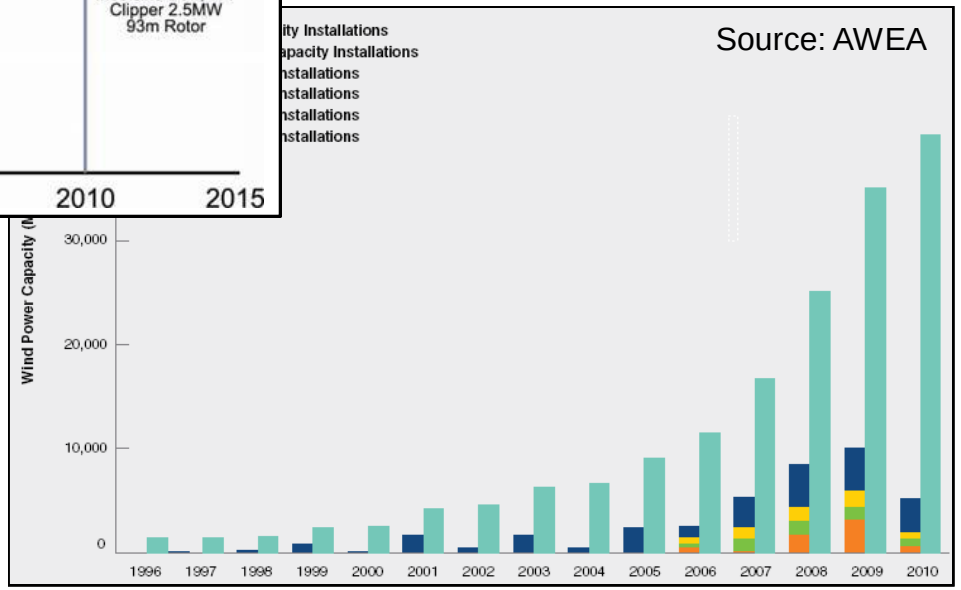


Source: DOE
"20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply"

Growing in Size…

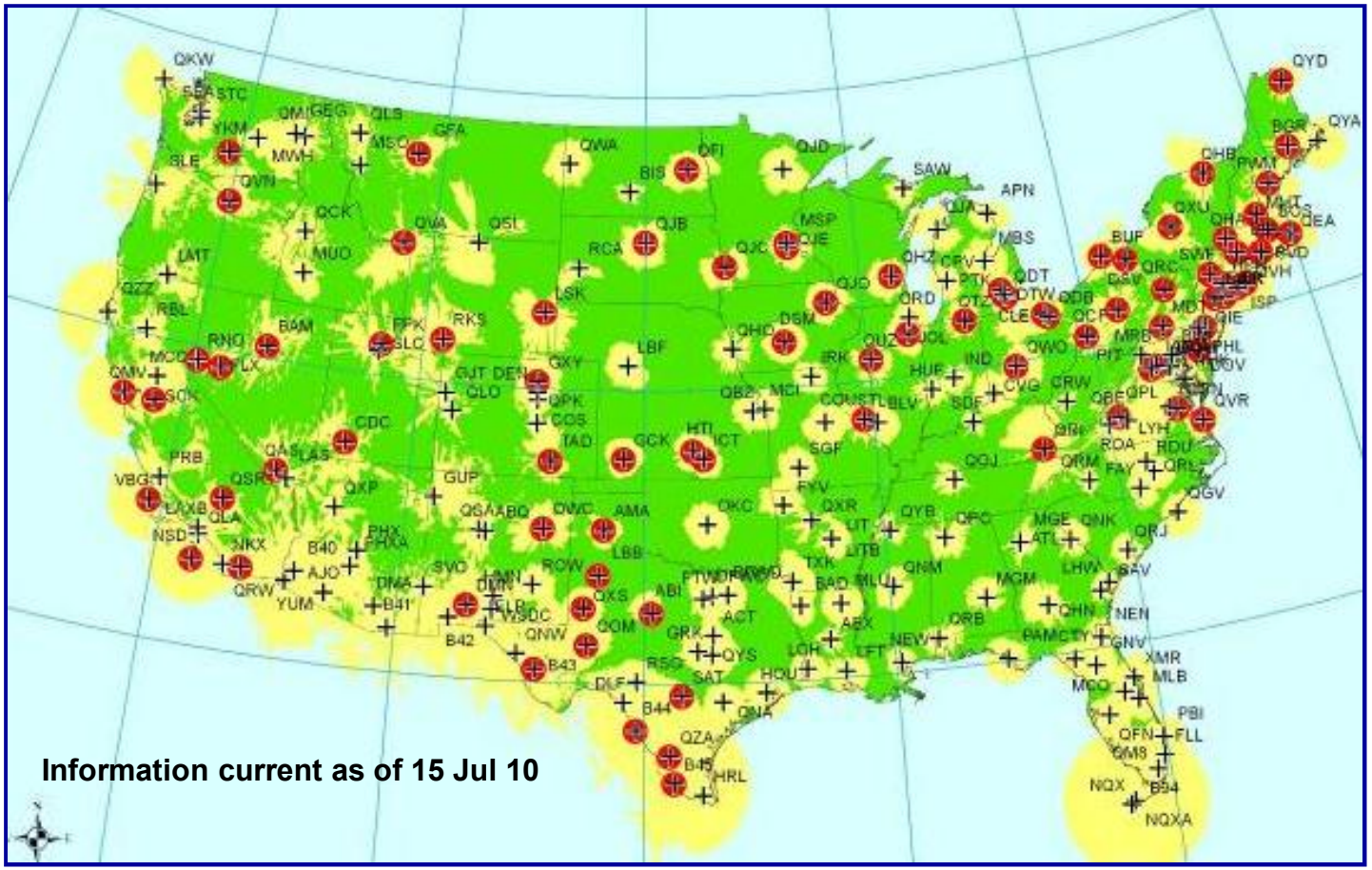
100 Meter Blades
Now in Development

…Growing in Number



Wind Energy / Radar Challenges Overlap

Of 214 total radars here, 83 of the sites (or 39 %) already had Wind Turbines within Radar Line-of-Sight (RLS)



Wind Turbine Impacts

Turbines are growing in size and number

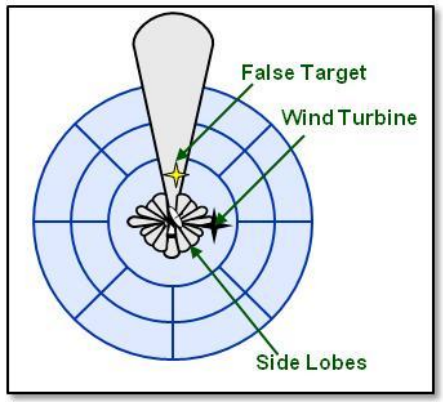
- Tip speeds over 225 mph
- Blades more than 50 m long
- Wind farms with 100s of turbines

Impacts on Radars:

- Decreased Sensitivity (P_D)
- False Targets (P_{FA})
- Corrupted Track Quality

Raises Concerns for:

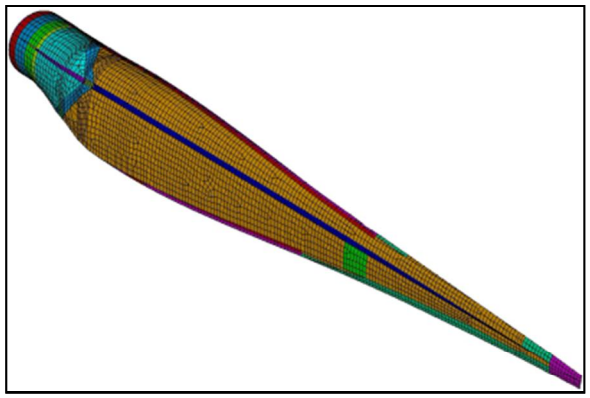
- Flight Safety
- Homeland Air Security
- Weather Operations



What Can We do to Mitigate the Impacts?

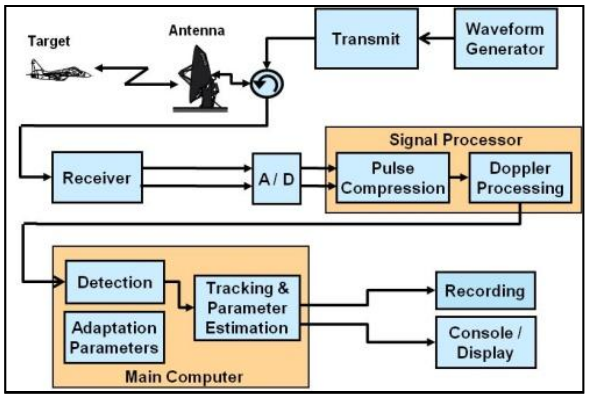
Industry Proposed Mitigation Options

Reduced Signal Turbines



Replacement Radar

Radar Upgrades



Wind Farm Siting

Augmentation Radar

C2/Automation Upgrades

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Formation of IFT&E Program

- **DOE and DOD co-sponsored a interagency workshop in September 2010; stakeholders identified 26 unique research opportunities**
- **The National Security Staff Sub-Interagency Policy Committee on Air Domain Awareness facilitated interagency funding from DOE, DOD, DHS, and DOT/FAA**
- **Path forward focuses on:**
  - Testing and evaluating mature technologies in the near-term
  - Gathering data for a mission analysis to guide future investments

The IFT&E Program Team

The Federal Core

Steering Committee

DOE, DOD, DHS, FAA

Non-Voting Member

DOC/NOAA

Surveillance Needs & Radar Technology

Energy Needs & Wind Technology

Executing Labs

MIT LL

Sandia

Interagency Field Test & Evaluation Products

Enabling Partners

Wind Farm Owners/Developers, Radar Manufacturers, City, County, State, Local, Tribal, and Other Private Industry Stakeholders

Project Strategy

Problems

Requirements

Missions

Environment and Targets

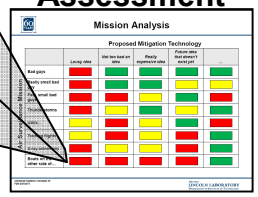
Requirements

		Mission					
		Actionable Oil	Spill Extent	Boom Status	Sensitive Areas	Affected Shoreline	Wellhead Recon
Resolution Limits (m)	High	0.06	0.3	0.06	0.4	0.2	0.06
	Low	1.3	1.9	0.3	0.8	1.3	0.3
Modality		EO, IR, MSI, HSI	EO, IR, MSI, HSI	EO	MSI, HSI	EO, MSI, HSI	EO
Coverage Area (km²)		3100	17000	120	630	230	11
Max Imaging Time (hours)		2	6	10	10	10	2

Å System Analysis

Å Field Evaluations

Assessment



Recommendations

Å **Identify Risks & Gaps**

Å **Investments & Acquisitions**

Technologies

Solutions

Capabilities

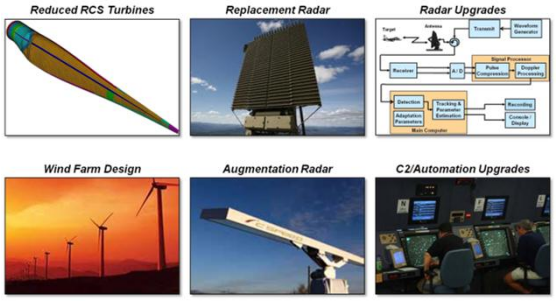
Interagency Field Test & Evaluation

Evaluate wind turbine impact and industry mitigations

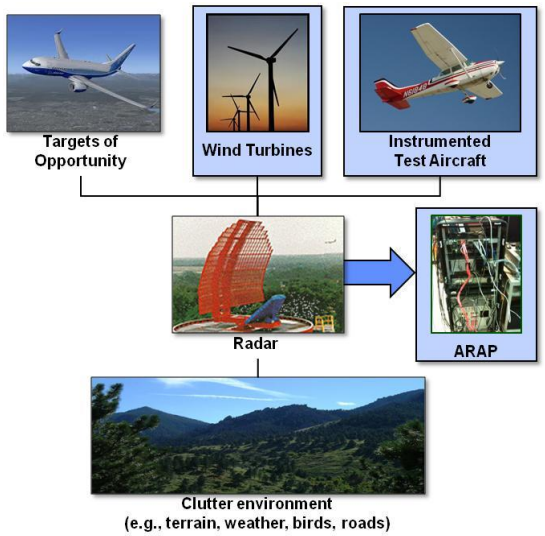
Steering Committee

DOE, DOD, DHS, DOT/FAA

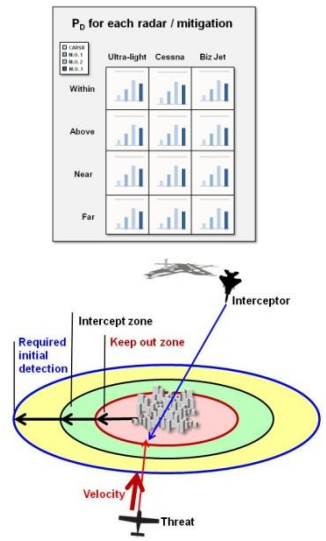
Industry Mitigations



Flight Tests & Analysis

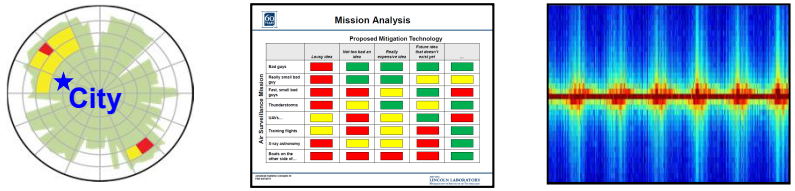


System Analysis



- Å **2-year, 3 flight campaign, jointly funded program**
  - ï **CARSR (MN), ASR-11 (TX), ARSR-4 (TX)**
- Å **Invites to selected mitigation technologies**
  - ï **Selected 11 of 16 proposed concepts to assess**
- Å **System analysis of mission impact**
- Å **Program Goals**
  - ï **Characterize impact of wind turbines on NAS radars**
  - ï **Assess mature industry-proposed mitigation technologies**
  - ï **Increase understanding for developing future mitigations options; develop a library of data**

Interagency Field Test & Evaluation Products

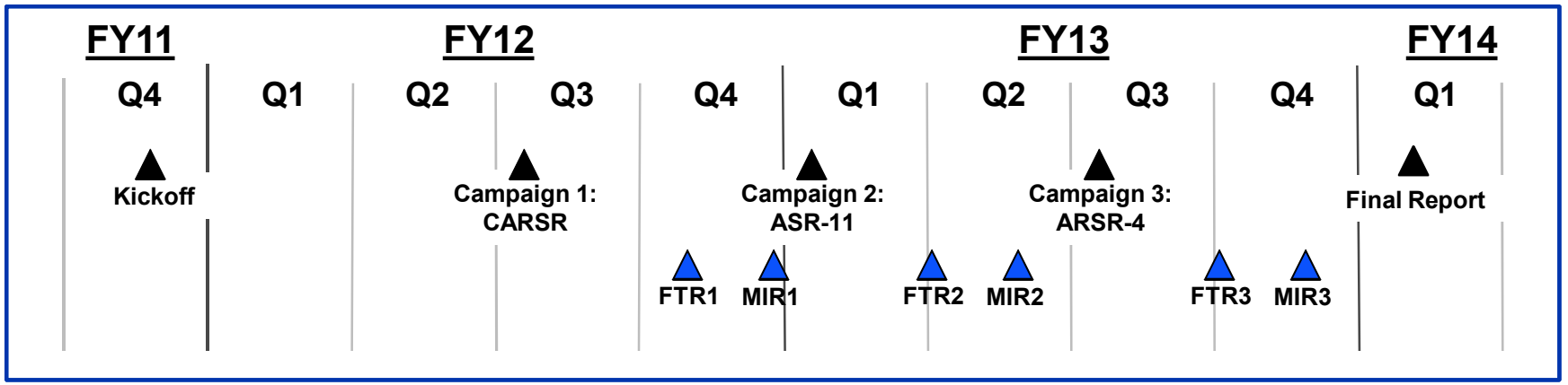


Characterize Current Impact | **Assess Proposed Mitigations** | **Data for Future R&D**

Current IFT&E Scope

- **Campaign 1: CARSR at Tyler, MN**
  - ✓ C Speed Lightwave
  - ✓ SRC LSTAR(V)3
  - ✓ Raytheon Processor Upgrades
- **Campaign 2: ASR-11 at Abilene, TX**
  - ✓ Terma Scanter 4002
  - ✓ Aveillant CH-Infill
  - ✓ BAH clutter cancelling posts
  - ✓ Raytheon Processor Upgrades
- **Campaign 3: ARSR-4 at King Mountain, TX**
  - ✓ Qinetiq
  - LM TPS-77
  - Raytheon X-band Infill
  - Sensis Saab Radar Upgrades

✓ Confirmed Participation



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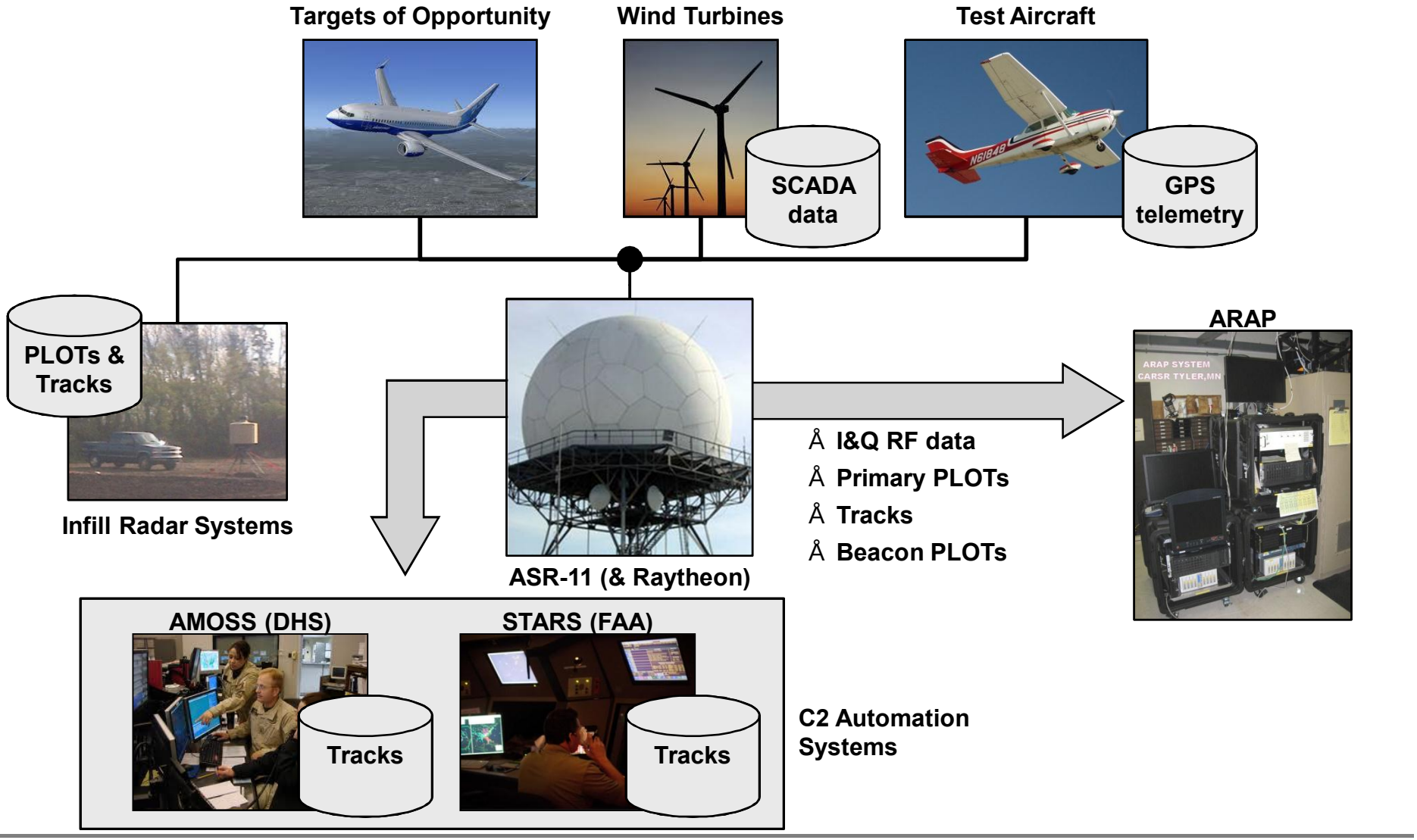
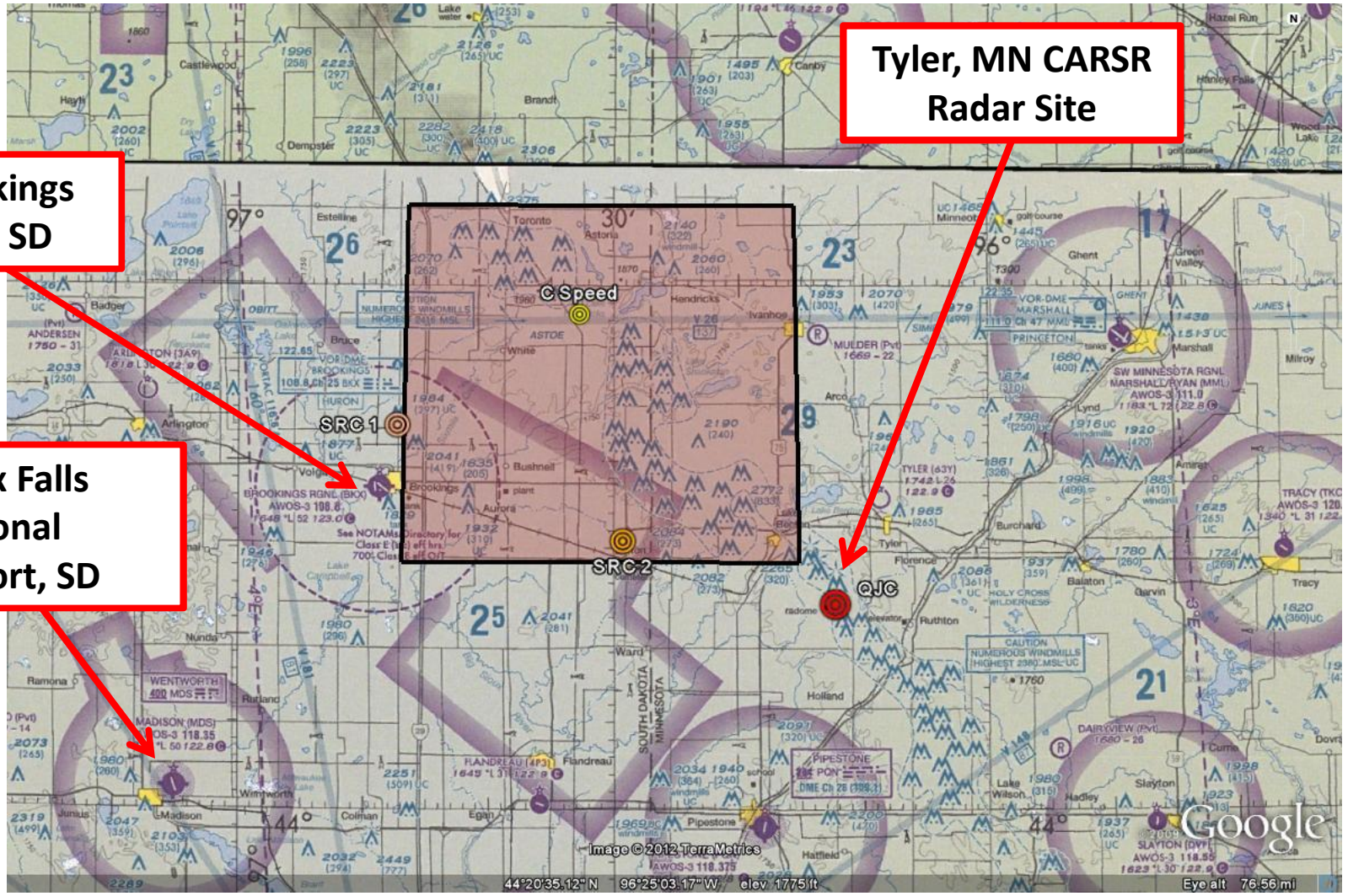
Field Test Overview

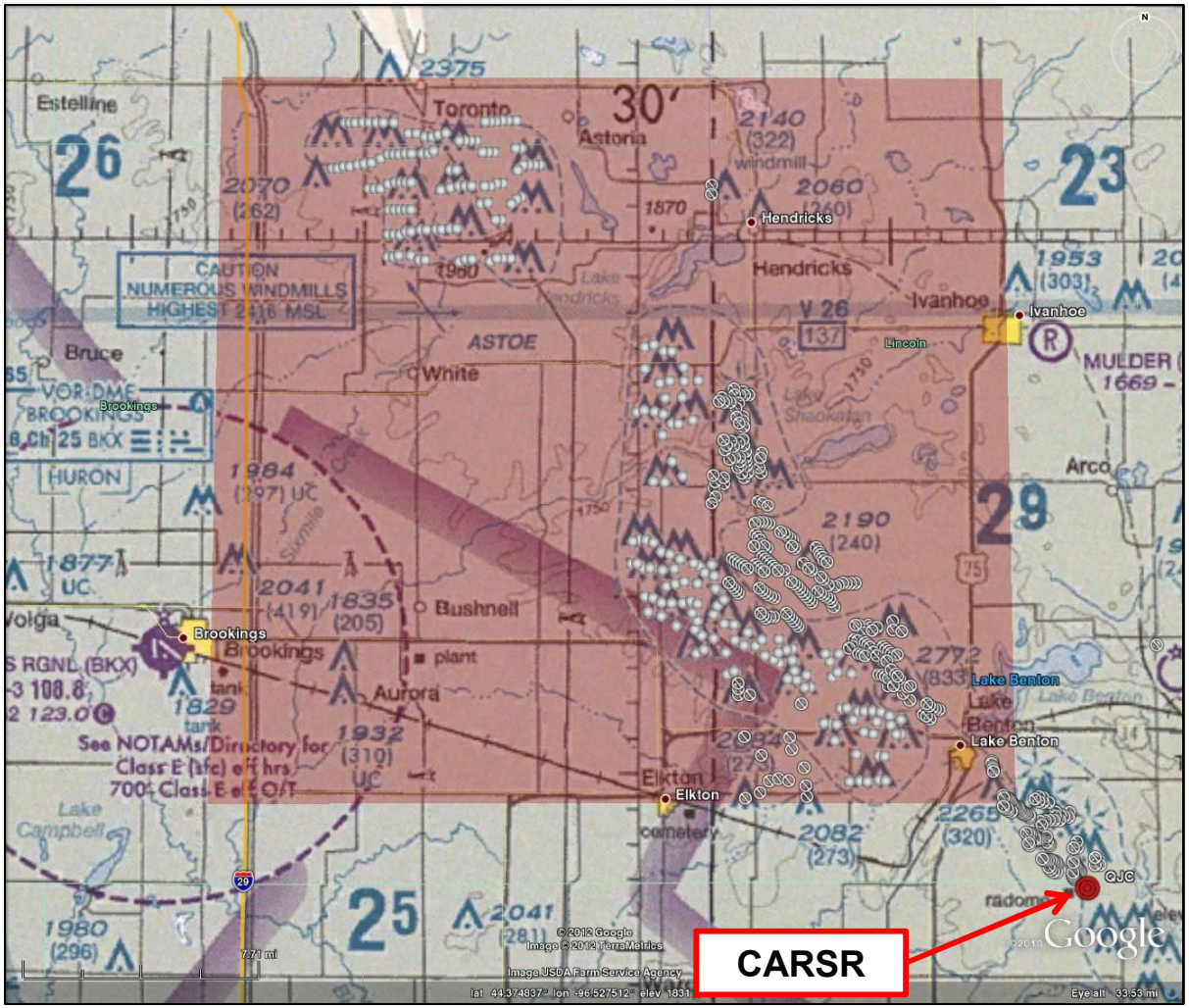


Tyler, MN CARSR (QJC) Area Orientation



QJC Vendor Surveillance Area

Red Box: Assigned Surveillance Area (22 x 22 nmi)



	Wind Turbines	*with Telemetry*
Total	**2,104**	**430**
In Line of Sight	**1,128**	**343**
In Box	**459**	**229**

IBERDROLA RENEWABLES

Xcel Energy℠

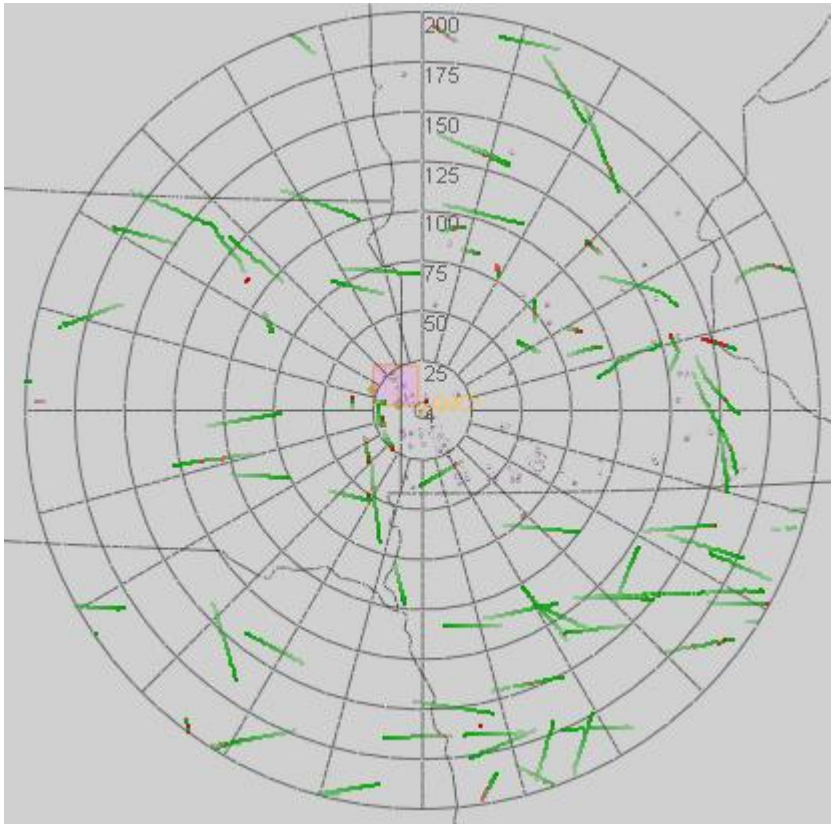
enXco An EDF EN Company

Lyon-Lincoln Electric Cooperative

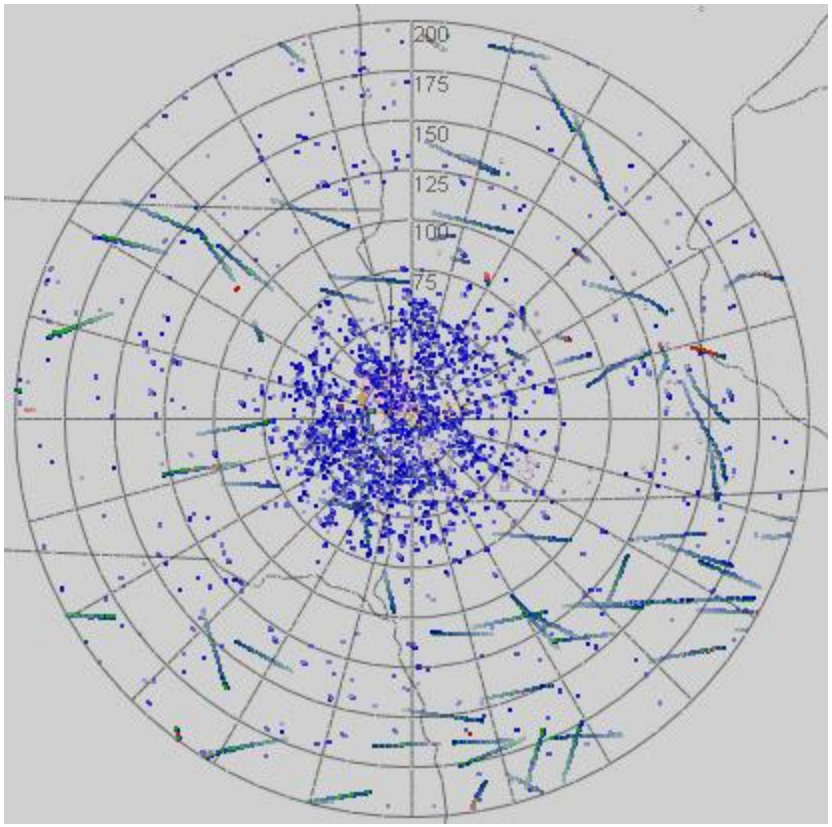
Plots from CARSR

April 24 @ 2:31:14 PM

Beacon & Reinforced Data



All Plots

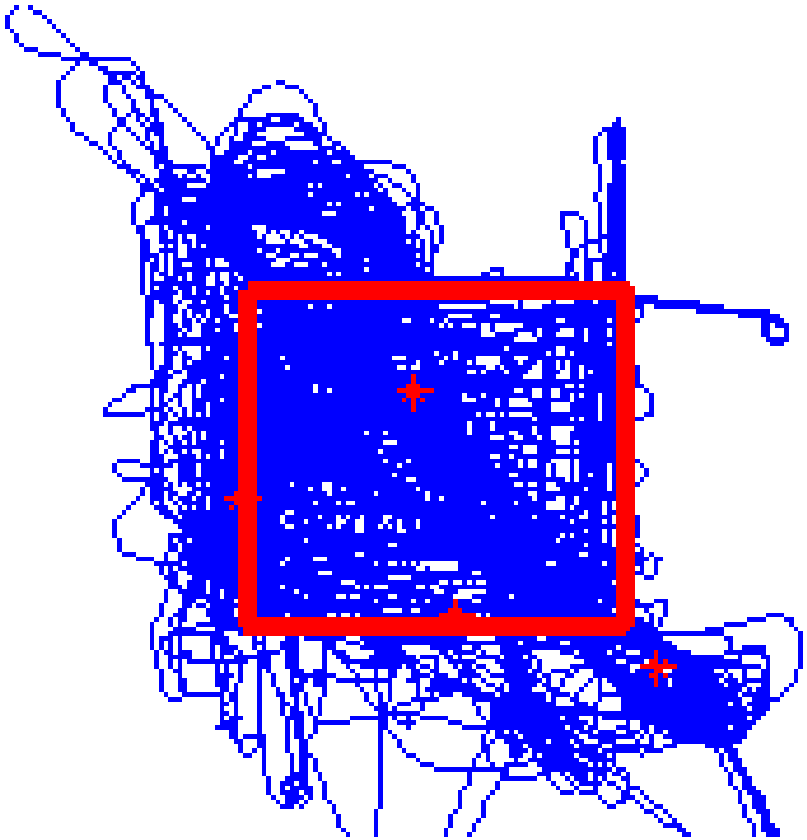


Surveillance Area Coverage Success

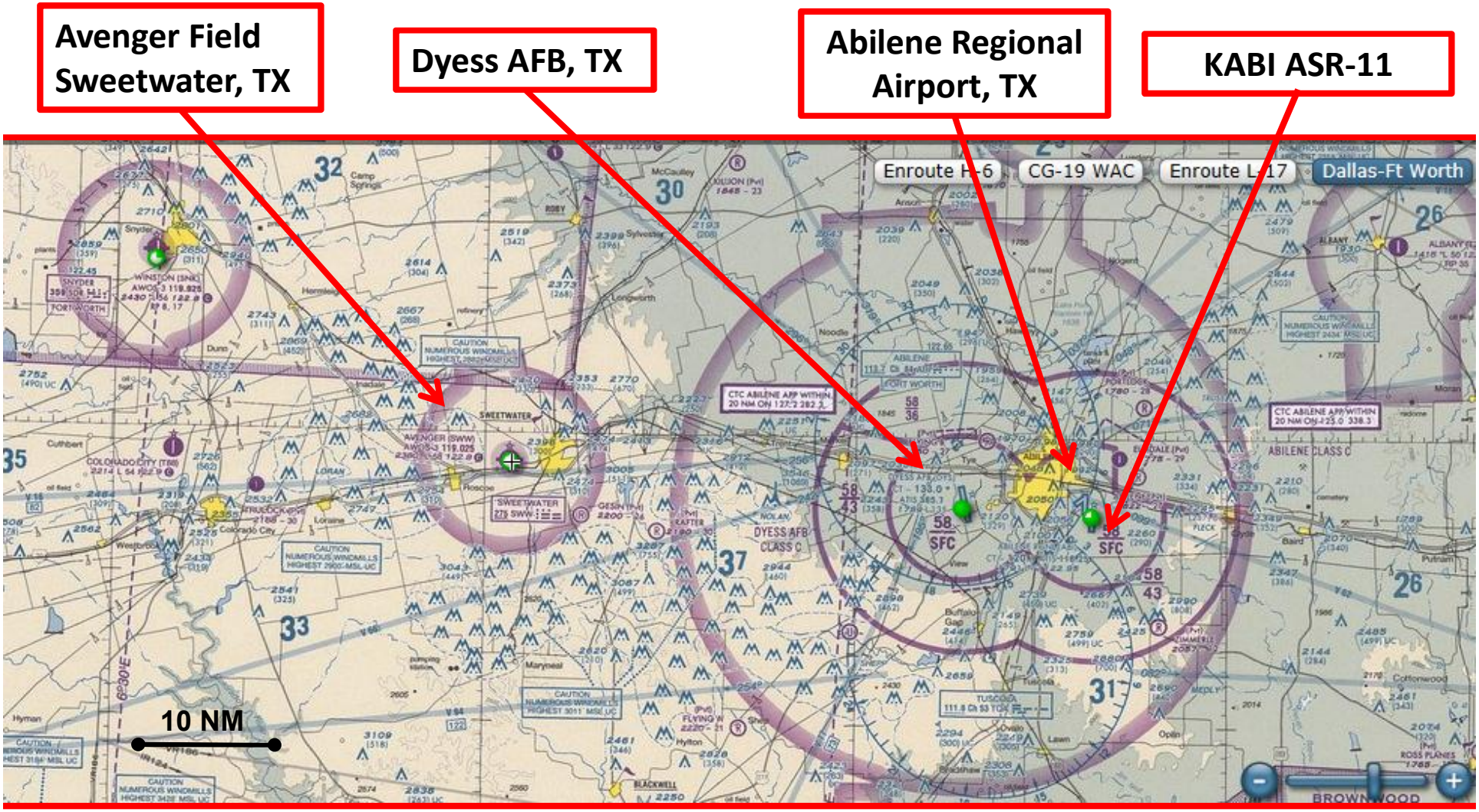
GPS

Points collected: 450000+

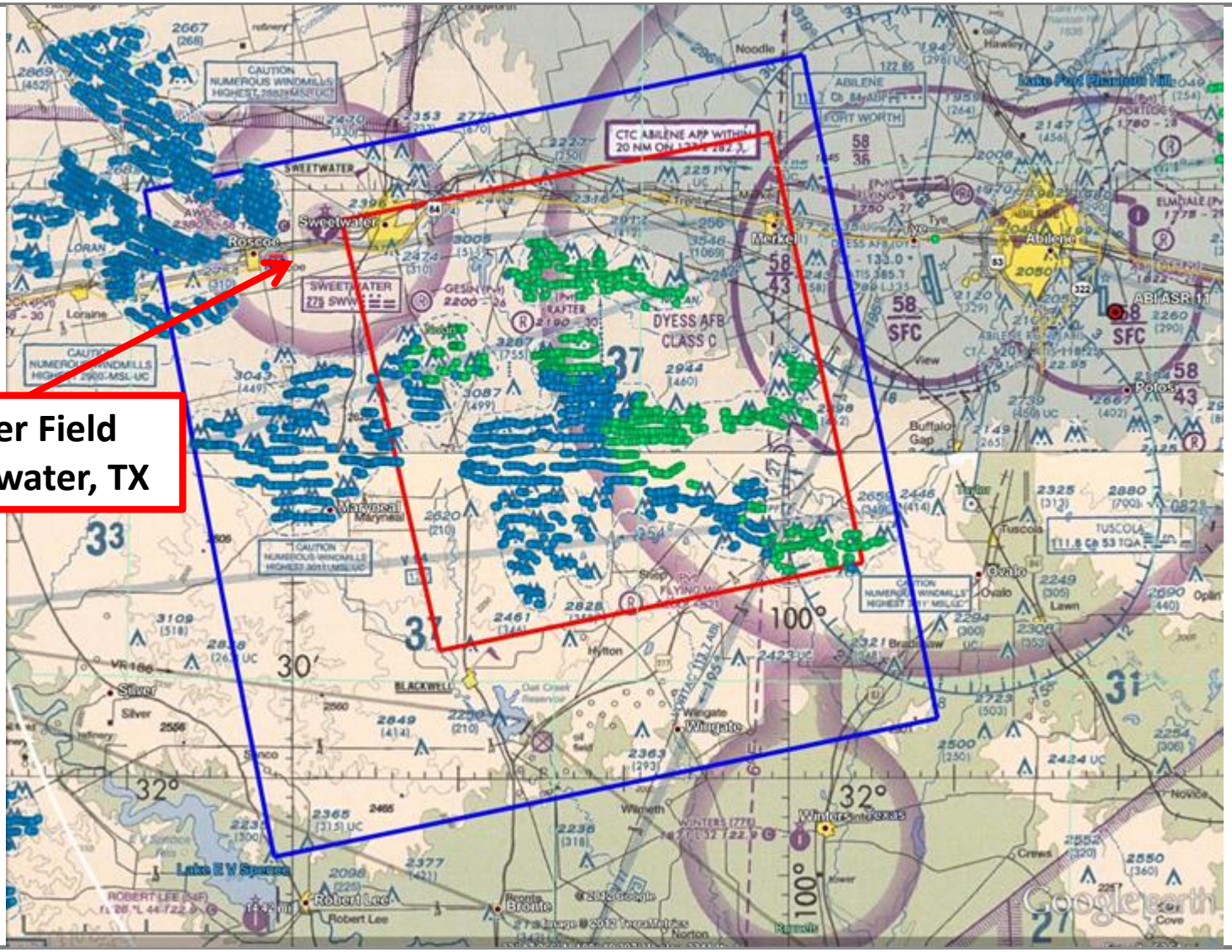
Points in test area: 250000+ (> 55%)



Abilene, TX (KABI) Area Orientation



KABI Vendor Surveillance Area



Key KABI Area Wind Farms

Plant Name	MW	Units	Type	Owner
Buffalo Gap	523.3	67	Vestas	AES Wind Generation
		74	Siemens	
		155	GE	
Trent Mesa Wind Farm	150	100	GE	American Electric Power
South Trent Mesa	101.2	44	Siemens	Babcock & Brown
Sweetwater	585.3	176	GE	
		81	Siemens	
		135	Mitsubishi	
Champion (Roscoe II)	126.5	55	Siemens	E.On Climate & Renewables
Inadale (Roscoe IV)	197	197	Mitsubishi	
Pyron (Roscoe III)	249	166	GE	
Roscoe Wind Farm	209	209	Mitsubishi	
Snyder Wind Project	63	21	Vestas	Enel North America
Lone Star I and II	400	200	Gamesa	Horizon Wind Energy
Turkey Track Energy Center	169.5	113	GE	Invenergy
Callahan Divide Wind Energy Center	114	76	GE	NextEra
Horse Hollow Wind Energy Center	738.5	293	GE	
		130	Siemens	
Hackenberry Wind Project	165.5	72	Siemens	RES Americas

Critical Wind Turbine Data Requested from Wind Farm Owners/Operators

- **Facilitating collection of wind farm data**
  - **Points of contact**
  - **Static data (for each turbine)**
    - **Turbine location (latitude, longitude, elevation)**
    - **Manufacturer, model/type**
    - **Tower height (AGL) and blade length**
    - **Materials**
  - **Dynamic data (for each turbine)**
    - **Timestamp**
    - **Yaw**
    - **Blade pitch**
    - **Blade speed (RPM)**
  - **Meteorological tower data during test**
    - **Wind speed at hub height**
    - **Wind direction**

King Mountain, TX Area Planning

TBD

Outline

- Background
- Program Overview
- Flight Testing
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Conclusions

- Wind turbines cause problems for most radars
  - Several mitigation strategies proposed
- IFT&E program established to assess alternatives
  - Field tests to gather high fidelity data
- First IFT&E flight campaign successfully completed
  - 140+ flight hours
  - 4 radar systems with >70+ hours data per radar
  - 430 wind turbines providing SCADA data
  - Analysis still being completed
- Preparing for second test in Abilene, TX (Oct-Nov 12)
- Third test schedule at King Mountain, TX (Apr-May 12)

Questions?

Contact Information

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