

DEVELOPMENT OF AN INFORMATION DISPLAY SYSTEM FOR UAS OPERATIONS IN NORTH DAKOTA

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Outline:

- Background
- GPAR-RMS Simulation Architecture
- GPAR-RMS Information Display Systems
- GPAR-RMS Architecture
- Subsequent Work
- Conclusion
- Questions



Background:

UND is working to identify more than 13,000 square miles of airspace within the state of North Dakota suitable for all manner of unmanned aircraft system (UAS) operations without the need for implementation of temporary flight restrictions or an on-board sense and avoid system.

With funding provided by the US Air Force (contract number FA4861-06-C-C006) UND is developing a ground-based radar system capable of detecting low observable aircraft such as sailplanes and hot-air balloons while developing the software to optimally display the information to operators of UAS.

The system will serve as a proof of concept for a ground-based mitigation strategy for UAS operation.



Background (cont):

The system must be portable to allow the interim mitigation strategy to facilitate UAS research and development outside restricted airspace.

Due to the safety critical nature of the system, a reasonable effort must be made to ensure it will be reliable.

Aside from the technical challenges of designing, developing and verifying a real-time systems such as this, we must also design a system that either is or can be made compliant with DO-178B/C (ie UNIX/Linux, C/C++, OpenGL).

The displays must also conform to MIL-STD-1472F (Department of Defense Design Criteria Standard: Human Engineering).

All displays are 24 in (61 cm) “wide” displays (1900x1200 pixels).



Background (cont):



Unmanned Aircraft



RADAR



ADS-B Transceiver



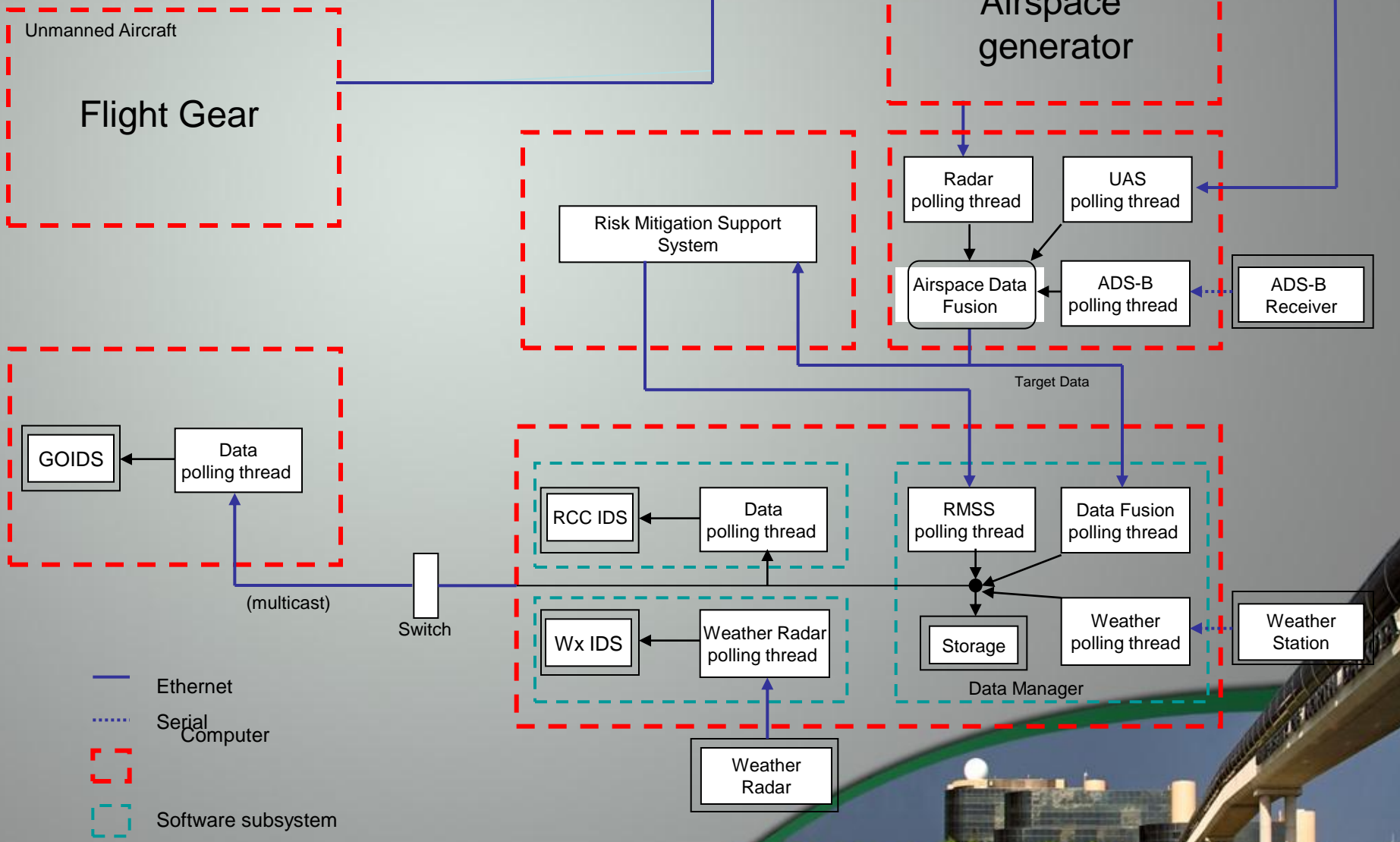
Command Center



Weather Station



GPAR-RMS Simulation Architecture:



Information Display Systems (RANGE CONTROL CENTER / RCC-IDS):

Applications Places System 11:15 AM

UAS GPARS Range Control Center

WEATHER INFORMATION

Last Update...
 Temperature... 73°F / 23°C
 Pressure..... 29.26 inHg
 Wind: N

Speed 0 mph
 Gust 0 mph

Direction 353 degrees

DISPLAY LEGEND

- Fixed Wing
- Rotary Wing
- Military
- Balloon
- UAV
- Commercial
- Unknown

Aircraft altitude is annotated in feet MSL:

6530

OPERATIONAL RISK

AIRCRAFT DATA

Longitude.... -97° 40' 52"
 Latitude.... 47° 57' 33"
 Altitude.... 825 MSL
 Air speed.... 70 knots
 Heading..... 180 degrees
 Tail number.. N204ND
 Aircraft.... Light Aircraft

OVERLAY CONTROLS

Velocity Vectors <input checked="" type="checkbox"/>	Risk Circles <input checked="" type="checkbox"/>
Obstructions <input type="checkbox"/>	Road Map <input checked="" type="checkbox"/>
Airports <input checked="" type="checkbox"/>	MDA Areas <input type="checkbox"/>
Hazards <input type="checkbox"/>	UAV Areas <input type="checkbox"/>

RADAR VIEW CONTROLS

Up & Left	Up	Up & Right
Left	Center	Right
Down & Left	Down	Down & Right
Zoom In	No Zoom	Zoom Out

06/07/2010 @ 16:15:25 UT

0 2 4 Miles

Information Display Systems (WEATHER & HEALTH MONITOR):

Applications Places System 11:04 AM

UAS Visualization group - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://range_control_center/

UAS Visualization group

National Weather Service Enhanced Radar Image Loop
Grand Forks, ND Radar

Go to: Standard Version Local weather forecast by "City, St" City, St Go Radar Status Message

Adjacent Radars: MVX

Short Range Images
Reflectivity: Composite Loop Base Loop
Velocity: Storm Relative Loop Base Loop
Rainfall: 1-Hour Total Loop Storm Total Loop
Long Range Images
Reflectivity: Base Loop
U.S. Views
Reflectivity: National Loop Alaska Loop Hawaii Loop Guam Loop Puerto Rico Loop
Radars by State
Additional Info: Radar FAQ Downloading Images Mobile Users GIS Users KML Doppler University Color Blindness Tool Credits

Base Reflectivity
10:15 AM CST Fri Jan 15 2010
National Weather Service WSR-88D Image from: MVX 01/15/2010 18:15 UTC (10:15 AM CST)

Warnings: Tornado Severe Thunderstorm Flash Flood Special Marine

Animation Speed AutoUpdate is Off Refresh

Topo Radar Counties Rivers Highways Cities Warnings Legend

Applet AniS started

Terminal UAS Visualization group - Mozilla Firefox

UAS GPARS System Management

SEIISOR STATUS

Status	Sensor	Last checked
█	Radar #1	Last update time
█	Radar #2	Last update time
█	Radar #3	Last update time
█	ADS-B	Last update time
█	GCS	Last update time
█	Weather	Last update time

SERVER STATUS

Status	Server	Last activity
█	Main Server	In Use
█	Backup Server	Idle
	Storage	<div style="width: 100%; height: 10px; background-color: blue;"></div>

SYSTEMMESSAGES

Warnings & Messages

SYSTEMCLOCK

Current time

BAROMETER CALIBRATION

7	8	9	Backspace
4	5	6	
1	2	3	
0	.	Enter	

10245.7

Information Display Systems (GROUND OBSERVOR / GO IDS):

UND AEROSPACE GPARS UAS 2D Prototype.

WEATHER INFORMATION

Current time.. 01/15/2010 @ 17:03 UT
 Last Update... 12/31/2009 @ 23:59 UT
 Temperature... -1.66 F / -18.70 C
 Pressure..... 29.13 inHg
 Humidity..... 68.70%
 Wind:

Speed 0.67 mph Gust 0.45 mph
 Direction 180.00 degrees

DISPLAY LEGEND

	Fixed Wing		Balloon
	Rotary Wing		UAV
	Military		Commercial
	Out-of-range		Unknown

Aircraft are color coded and annotated based on relative Proximity and Orientation:

	Neutral		Climbing
	Warning		Level Flight
	Conflict		Descending
	Unknown		Above UAV
			Below UAV

AIRCRAFT DATA

Longitude.. -97.19092
 Latitude... 47.95265
 Altitude... 1367.0 ft
 Air speed... 56.5 knots
 Heading.... 274.9 degrees
 Tail number: NUV001
 Aircraft: UAV

RADAR VIEW CONTROLS

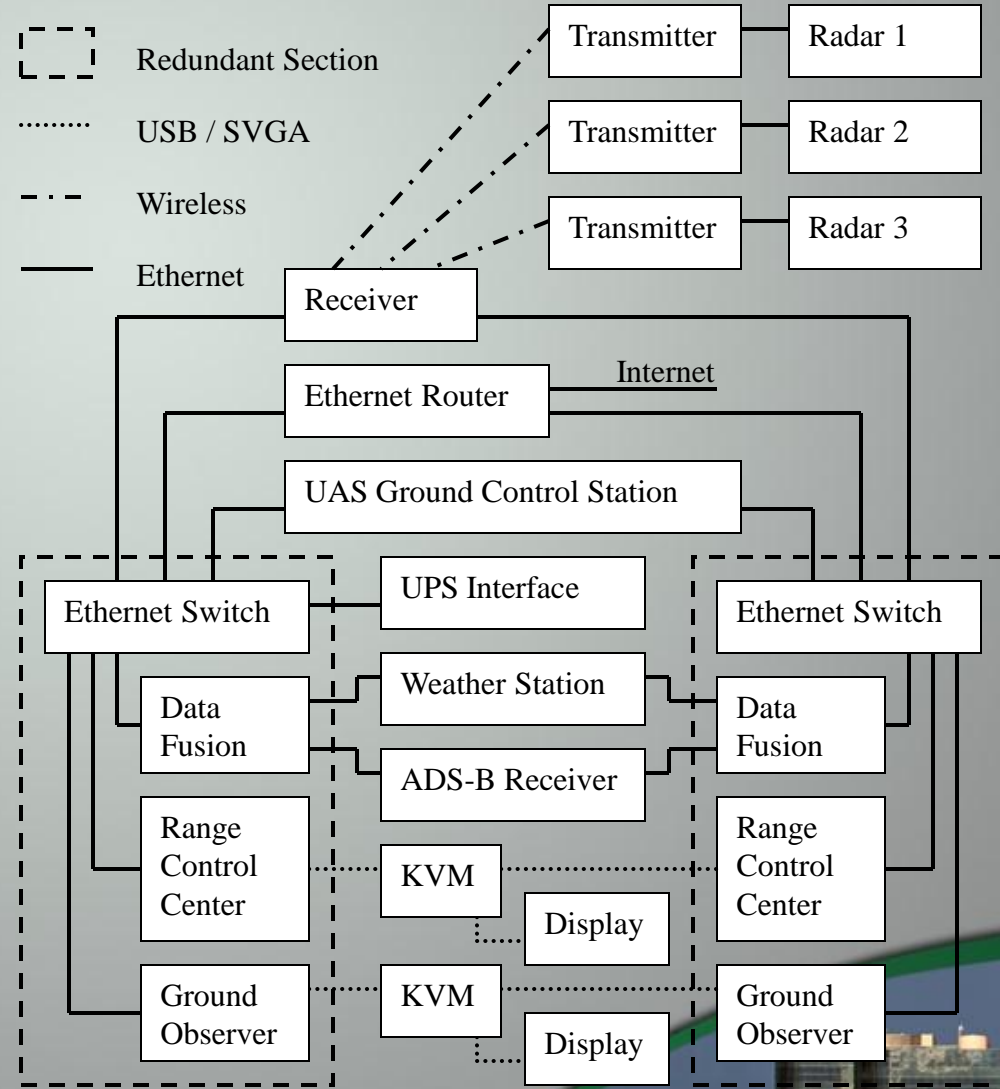
RANGE:

UAS UP:

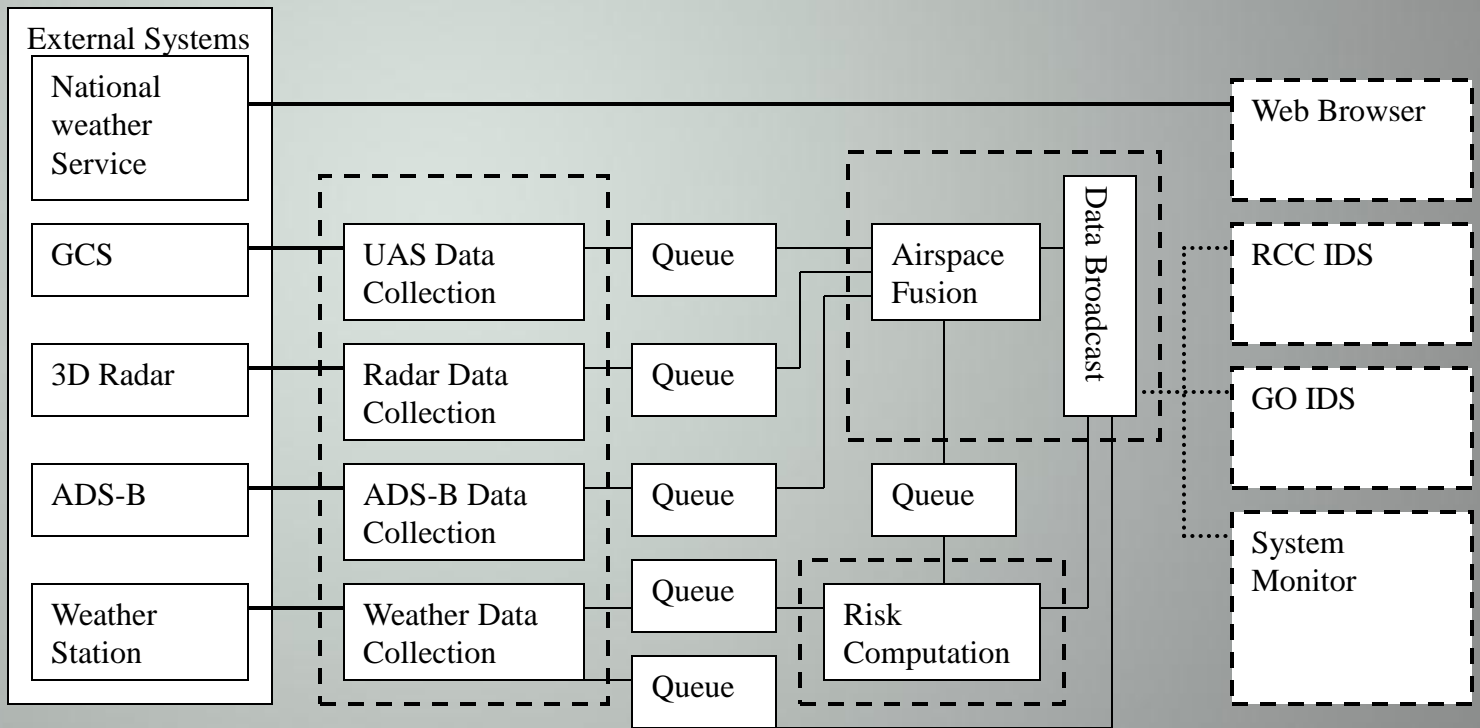
VELOCITY VECTORS:

RISK CIRCLES:

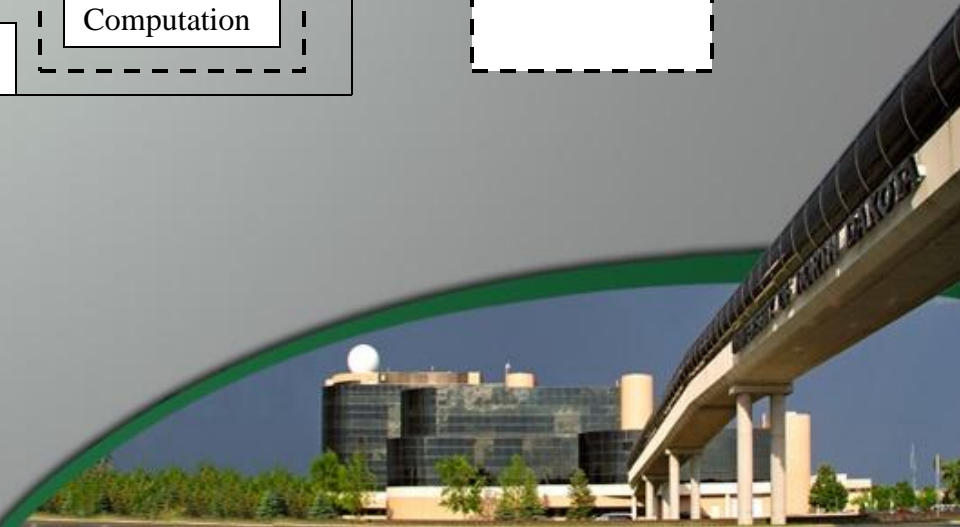
GPARG-RMS Architecture:



GPAR-RMS Architecture (cont):



- TCP Connection
- UDP Connection
- [- - -] Process



Conclusion:

Research that was not fully completed:

- Human factors testing of the displays.
- System fault tolerance and formal verification of the software.
- ADS-B spoofing of bird flocks.
- Radar interface.



Subsequent Work:

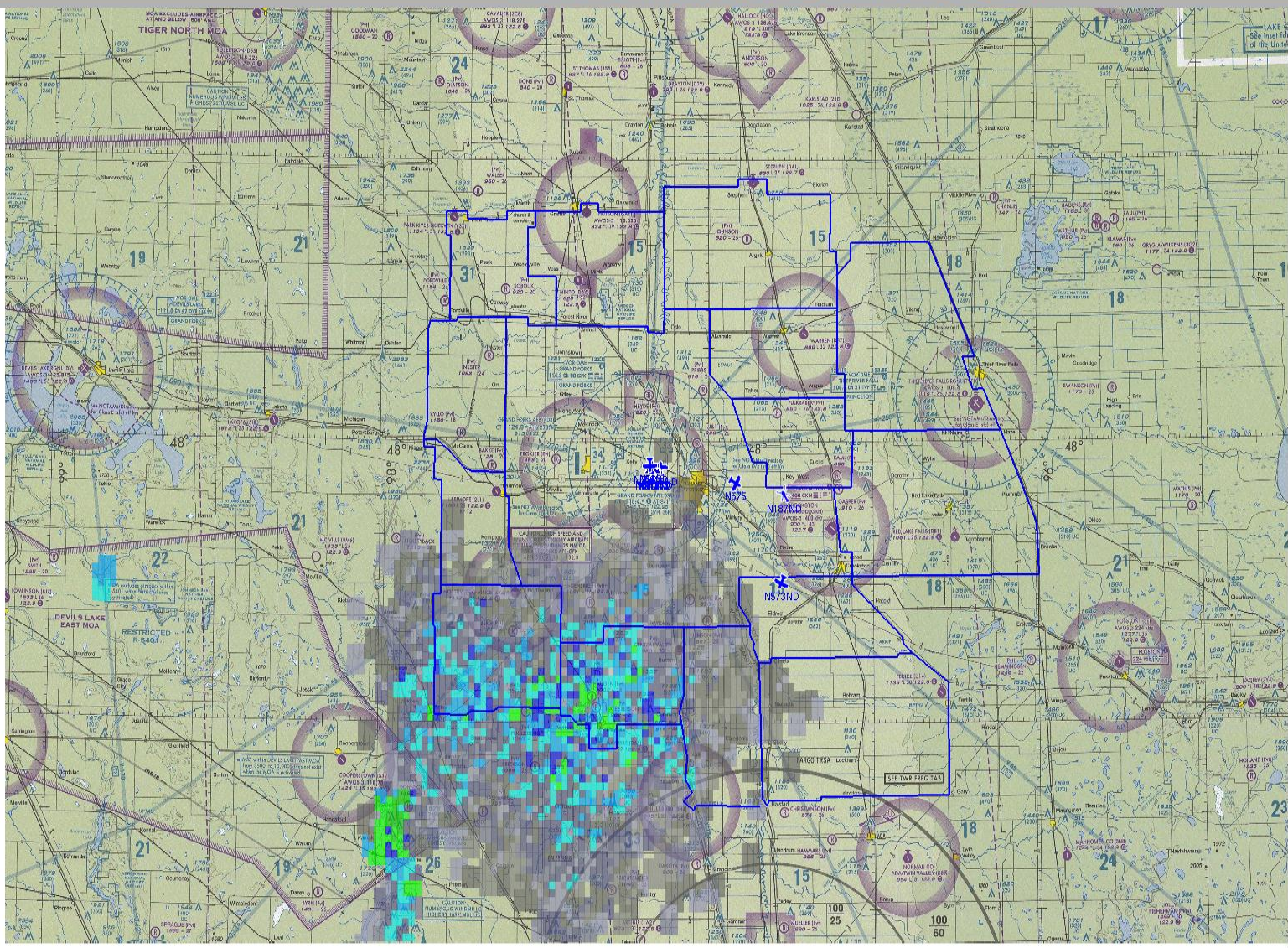
AADS (Airport Aircraft Display System) – At the request of the Aviation Department, the Computer Science UAS team rewrote the RCC-IDS software to support airport operations. To date, three of these displays have been installed to support aircraft and helicopter flight operations at UND.

IAA (Incident Awareness and Assessment) – Aerospace is looking into the development of a civilian equivalent of a Distributed Common Ground System. Such a center would foster research into new Intelligence, Surveillance and Reconnaissance (ISR) technologies as well provide such service to civilian agencies during times of emergencies.



Airport Aircraft Display System (AADS):

UND AADS (Aerospace Aircraft Display System) - Build Version 1381 (on file_server)



AIRCRAFT DATA

Altitude.....1559 feet MSL
 Heading.....213 degrees
 Ground speed....58 knots
 Tail number.....N573ND
 Latitude.....47° 45' 5"
 Longitude.....-96° 46' 48"

OVERLAY CONTROLS

- Section Map
- Doppler Radar
- Practice Areas

MAP CONTROLS

Zoom In No Zoom Zoom Out

← ↑ ↗

← Center →

↙ ↓ ↘

TRANSPARENCY CONTROLS

- Section Map +
- Doppler Radar +

AIRCRAFT SEARCH

Atmos. Pressure: 08:26 AM 09/16/11
 Doppler Radar: 08:27 AM 09/16/11
 ADS-B: 08:28 AM 09/16/11



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