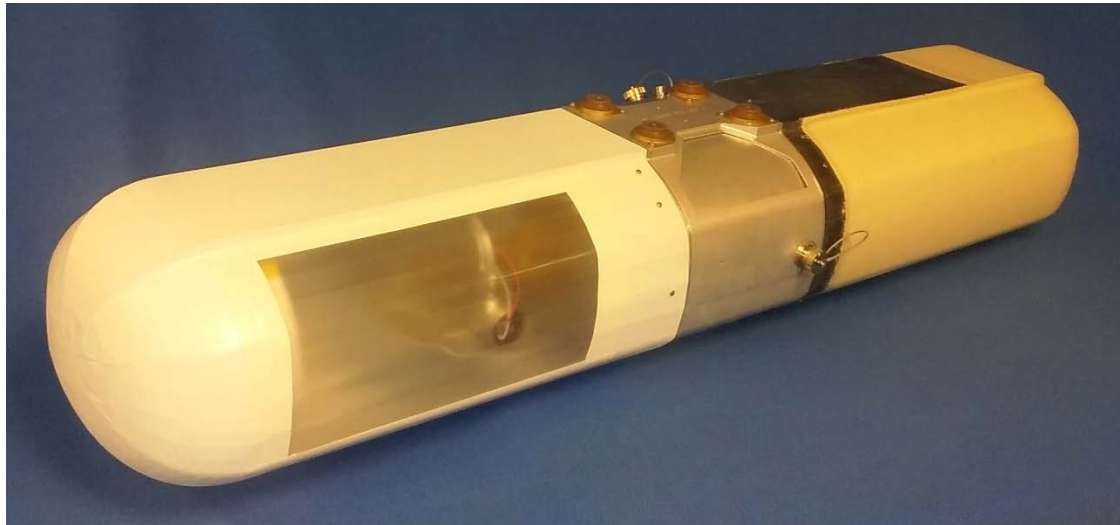


Low SWaP Airborne Gbs Pod Overview

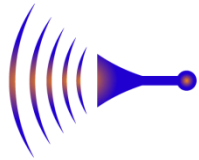


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The views, opinions, and/or findings contained in this presentation are those of the presenter(s) and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.

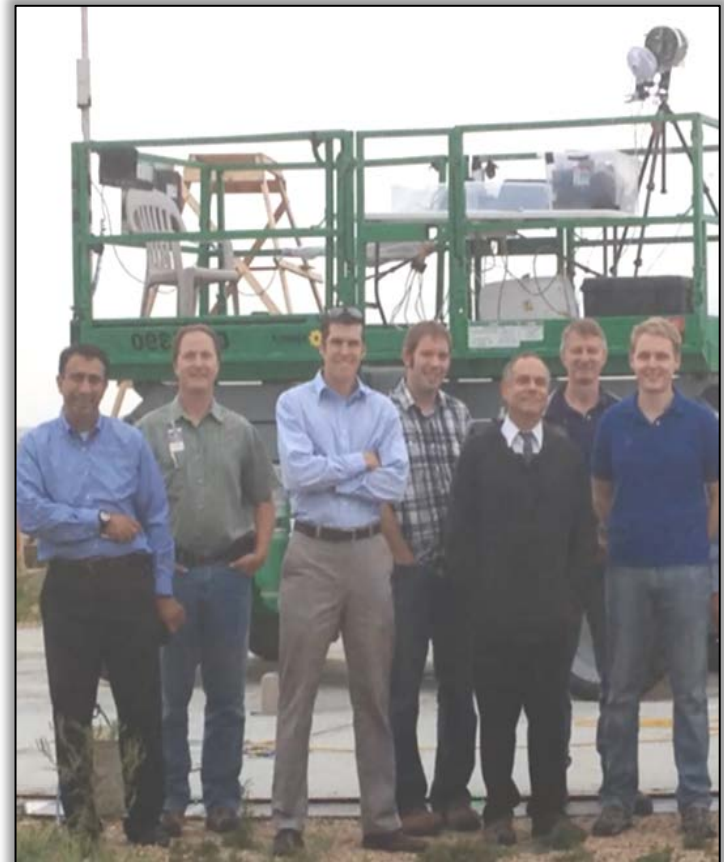
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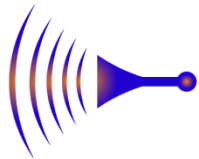
This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA)



Agenda:

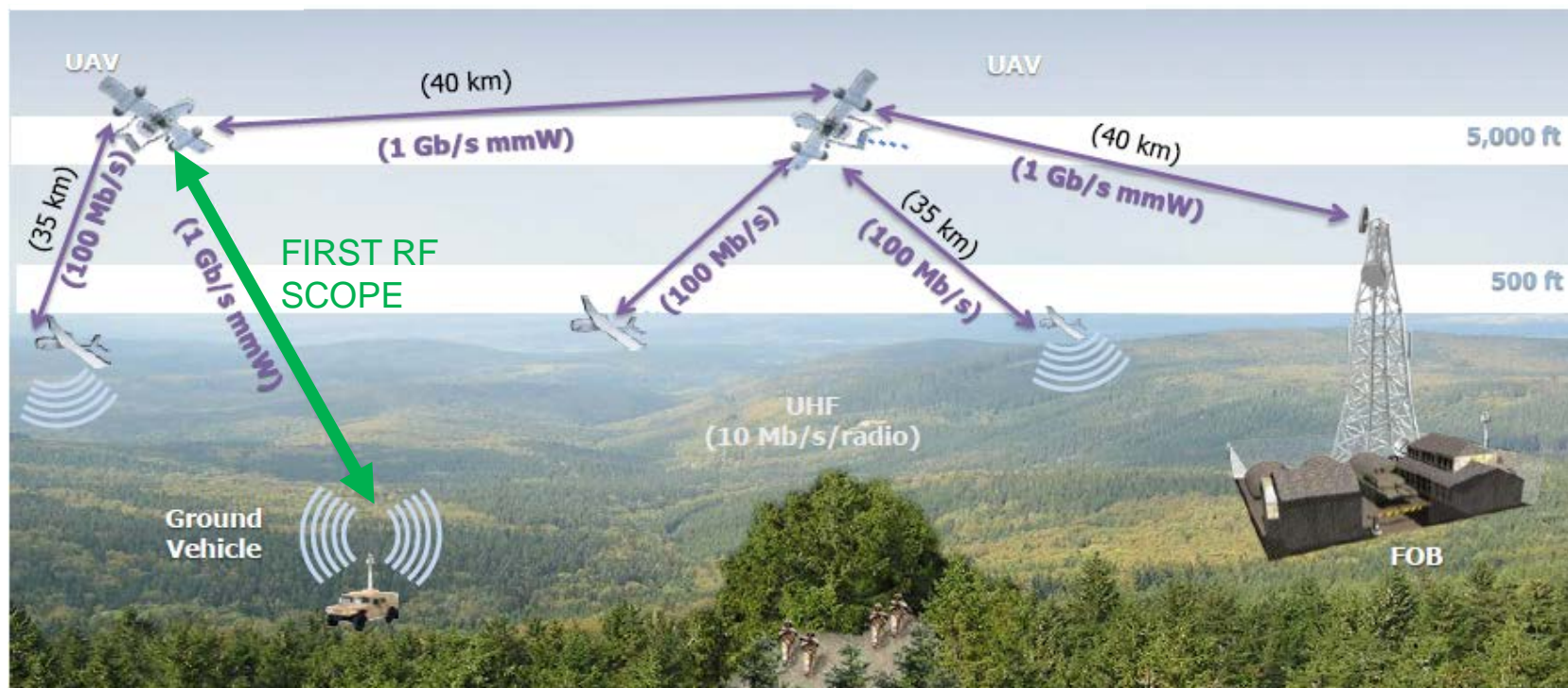
1. Introductions
2. Mobile Hotspots Program Overview
3. Phase I Demonstrations
4. Phase II Progress to Date
5. Pod Capabilities
6. Questions and discussion

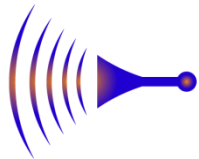




Mobile Hotspots Program Overview

- Single Point to Point Gb/s link between UAV and Mobile Ground Vehicle
- Comprised of 2 Pods with ~ hemispherical FOV = 4 Transceivers
- SWaP Requirements: 48.5 in X 9 in X 11 in ; 25 lbs. ; 350 W Peak





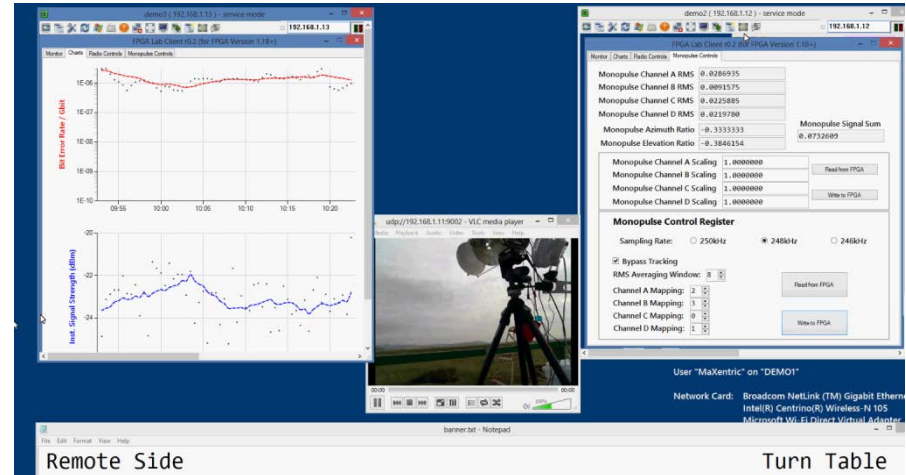
Mobile Hotspots

Phase I Overview/Accomplishments

- US ARMY/USMC Tier II UAV Compatible
- Ø 8.25" X 10" (antenna, modem, radio)
- Weight: 7.8 lbs.
- Testing in ~ 2km x 2km RF Quiet Zone
- Scissor Lifts used for multipath mitigation

Measured Performance:

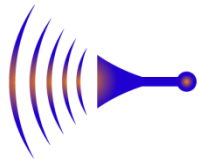
- 1 Gb/s @ <1E-6 BER at 1500m
- FDD
- Linear Polarization
- 71-76 GHz ; 81-86 GHz
- No FEC
- Pointing Acquisition and Tracking (PAT) > 7°/s
 - Using 33' Turn Table & Tripod with 3 DOF
- Passive Cooling Proven
- Tx: 15dBm Rx nf 8.2dB/7.5dB (hi/low bands)



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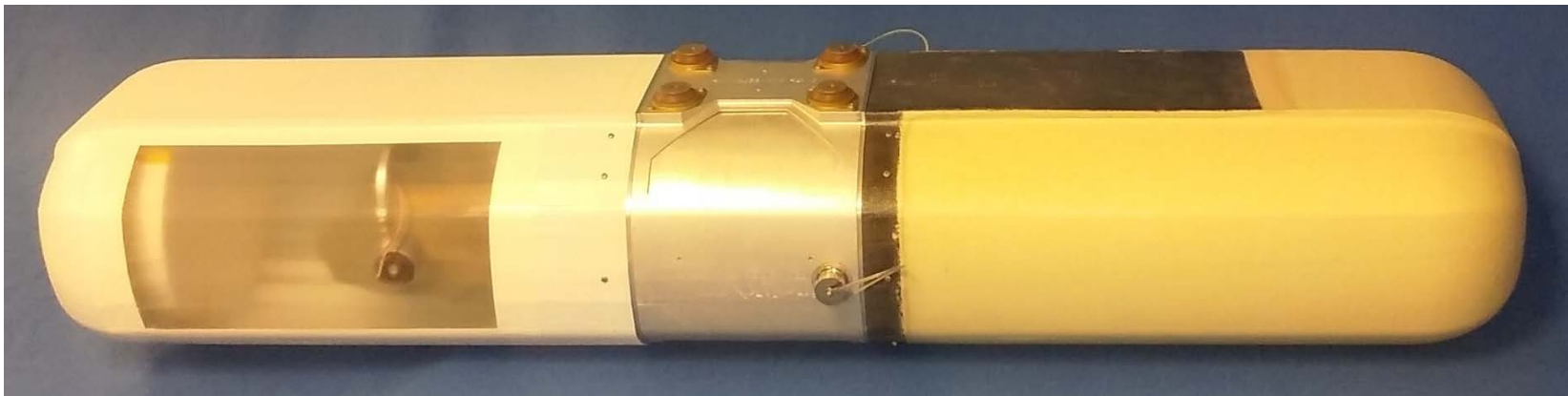
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Hotspots Phase II

Phase II Implementation (updates for phase I)

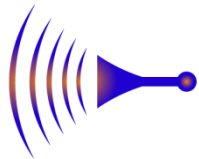
- 2 Complete Pods (2 transceivers, one central module per pod)
- Bi-directional Frequency Diverse Duplex (FDD) Pod-Pod communication
- >1Gbs while flying and driving
- Circular Polarization
- FEC
- Conformal UHF discovery antenna, discovery radio, power distribution, SBC for front/back switching
- Attitude, Heading, Reference System (AHRS) with differential GPS
- Switching between front/back transceivers (to accommodate for ~hemispherical FOV)
- Radome
- Optimized Antenna Implementation (improved gain from phase I)



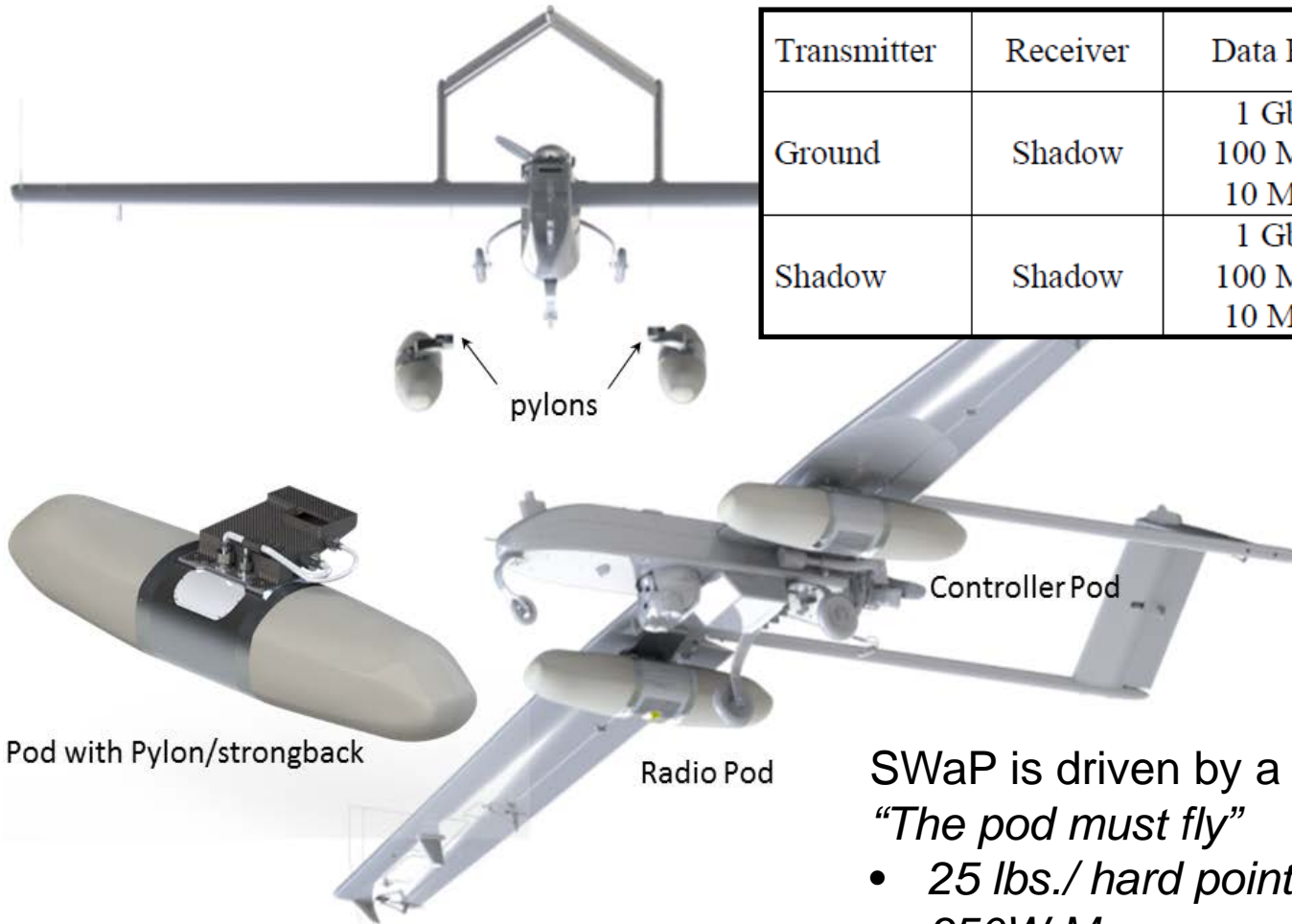
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Phase II Metrics

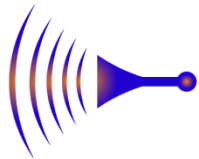


Transmitter	Receiver	Data Rate	Threshold Range	Objective Range
Ground	Shadow	1 Gb/s	40 km	50 km
		100 Mb/s	50 km	70 km
		10 Mb/s	70 km	90 km
Shadow	Shadow	1 Gb/s	40 km	50 km
		100 Mb/s	50 km	70 km
		10 Mb/s	70 km	90 km

SWaP is driven by a single requirement:

"The pod must fly"

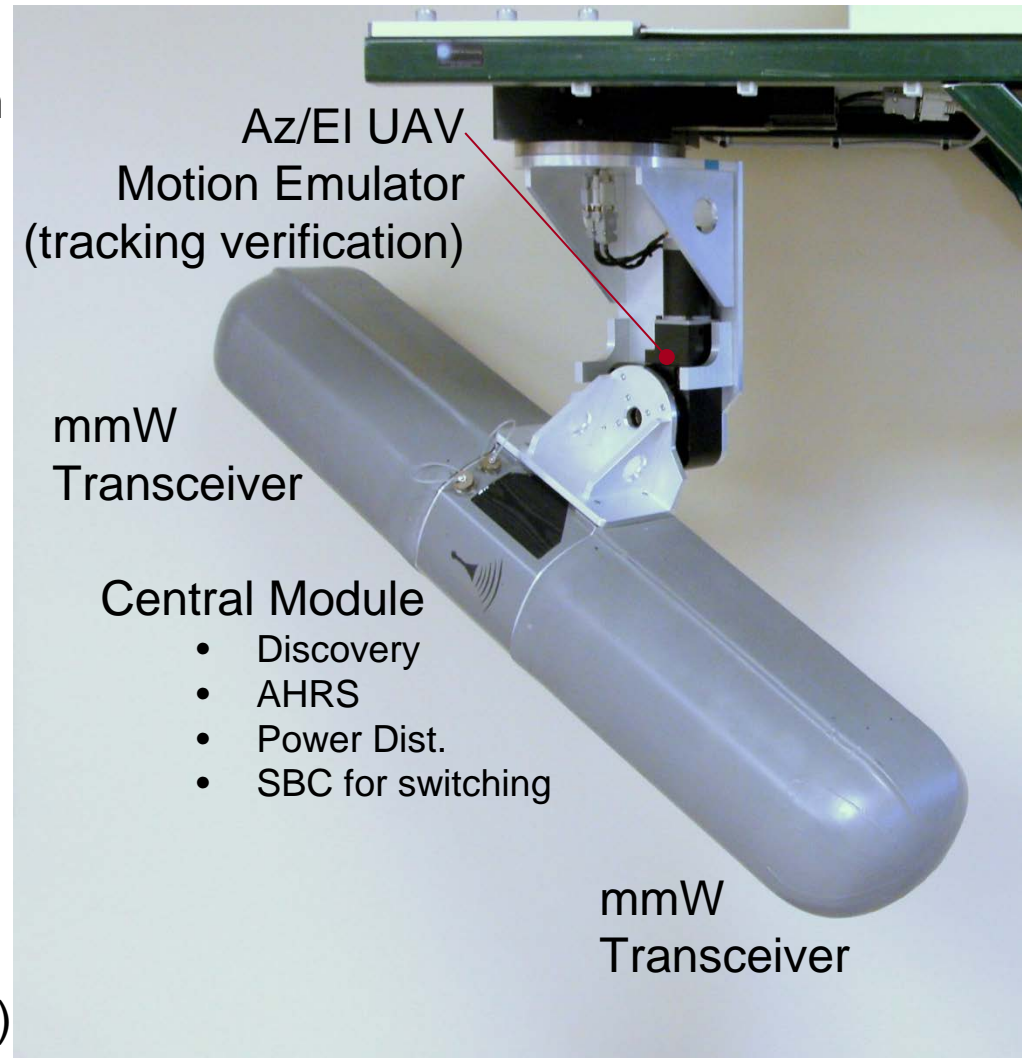
- 25 lbs./ hard point
- 350W Max
- Catapult-Launch keep outs



Pod Capabilities

Low SWaP Communications Pod

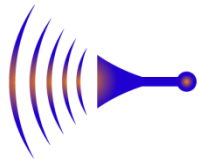
- > Gb/s FDD Transmission up to 40 km
 - 71-76 ; 81-86 GHz Circular Pol.
 - 10-100 Mb/s up to 90 km
- 48.2 in. X 8.5 in. X 11 in.
- 23.5 lbs.
- Power Consumption
 - 291 Average (Tracking)
 - 342 Peak (Searching)
 - 33W (Takeoff/landing)
- UHF Discovery
- Power Distribution (from 28V)
- Attitude Heading Reference System (AHRS) + differential GPS
- Demonstrated Tracking up to 70°/sec
- Passive Cooling (external air flow only)



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Short Range Tracking Demo June 2015 at FIRST RF



Az/EI Motion Table with
Transceiver & Link Metrics



Parking Lot Tracking Demo

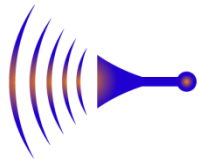
Short Range Test to verify monopulse tracking up to 50 °/sec between motion table and driving van
RSSI Remained Stable during motion
BER stayed in the 1E-6 Range



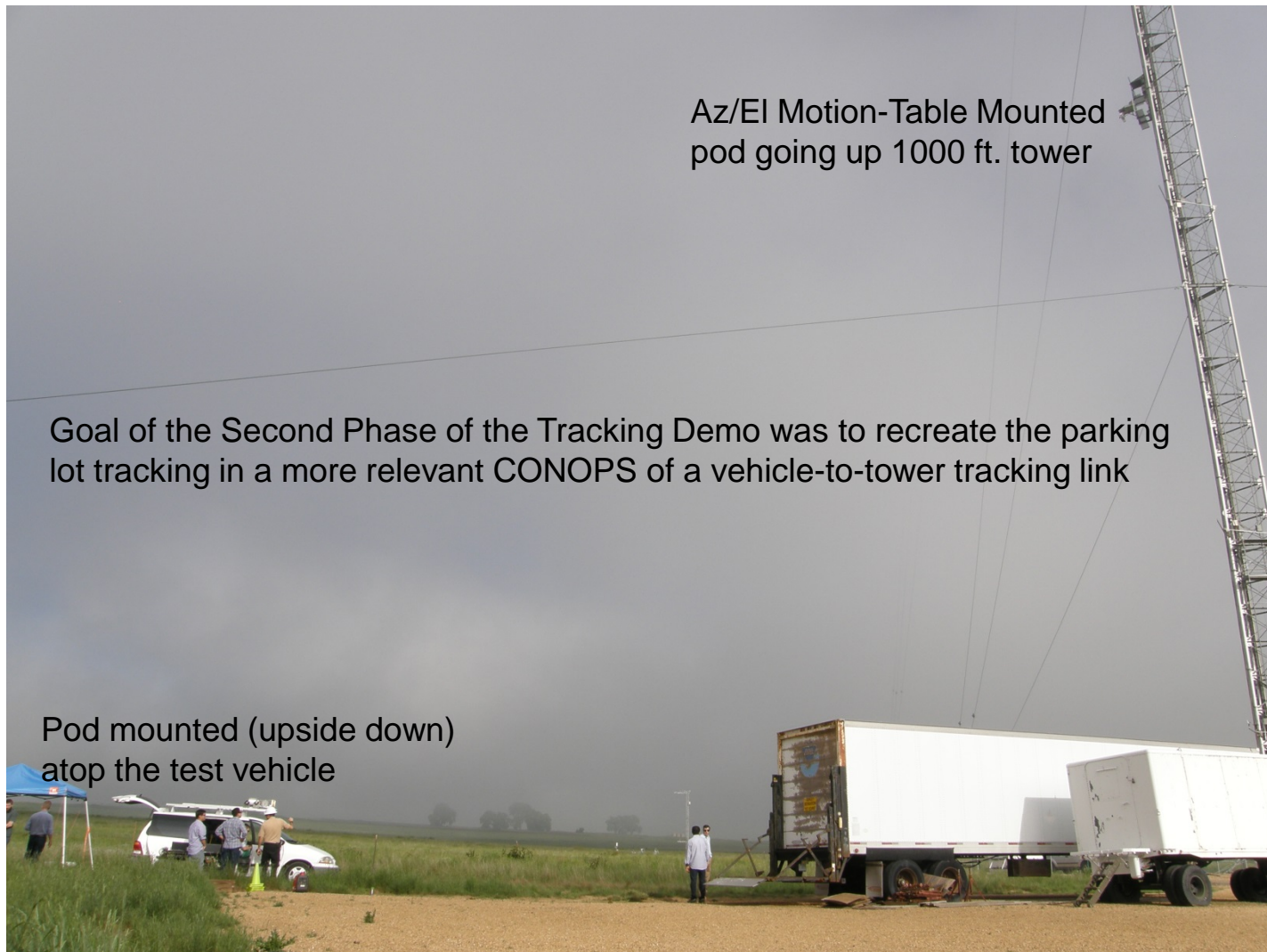
VAN with Transceiver on Roof



External fan bank to
emulate airflow from flight



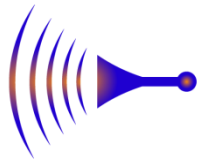
Ground-Tower Demo



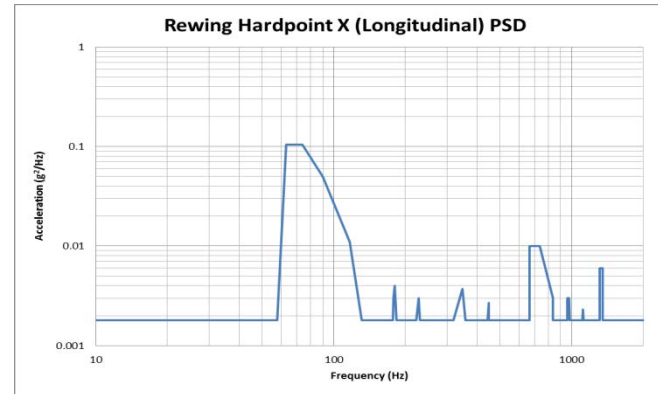
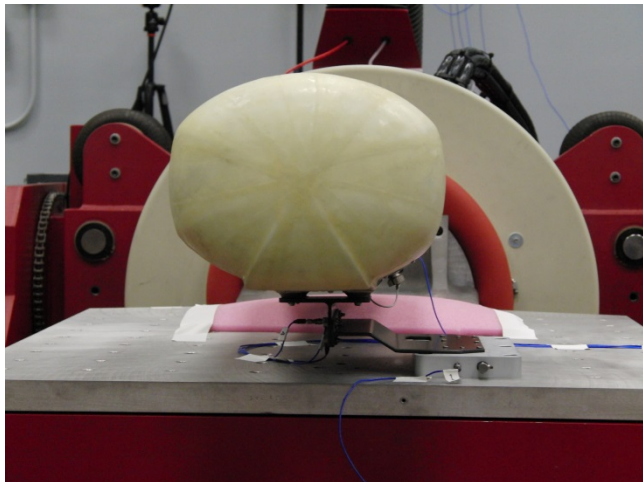
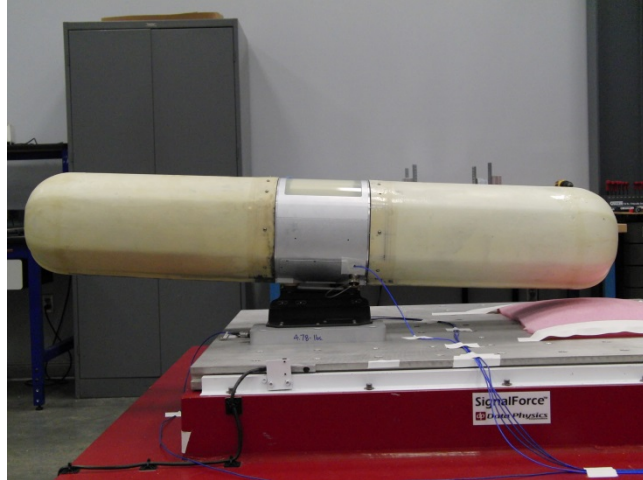
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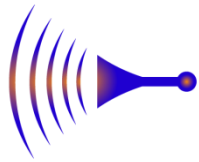
Air Worthiness Testing



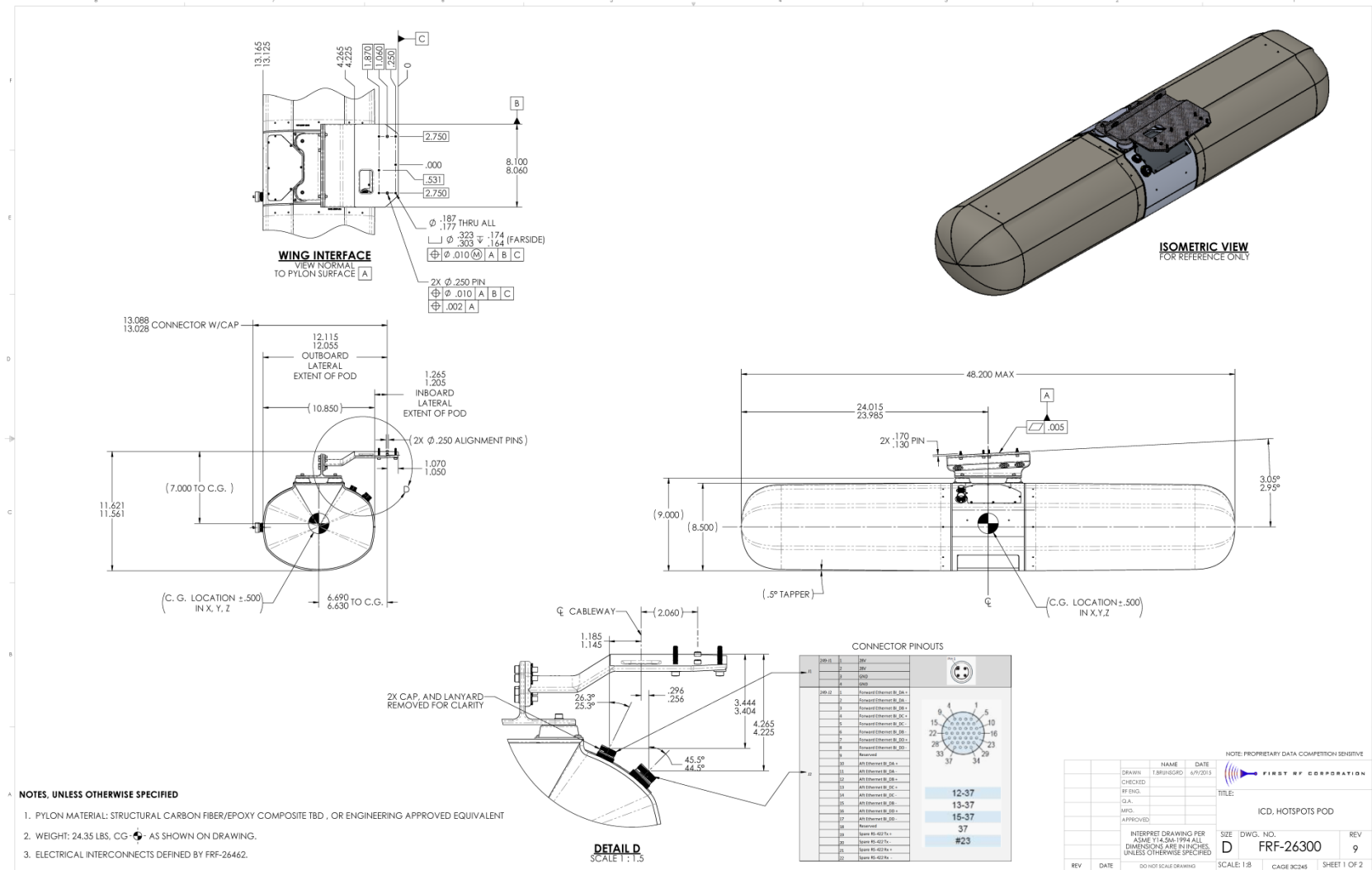
Shock & Vibration Testing Redstone Arsenal May 2015
Pod passed all Air Worthiness Tests

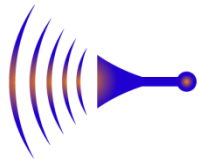
Vibration (flight/transport)
Long (axis of pod): 2.92 grms
Lat (short dim of pod): 2.13 grms
Vert (gravity vector): 3.96 grms

Shock (Landing):
+Long: 10g for 5ms
-Long: 10g for 5ms
+Vert: 5.75g for 5ms
-Vert: 4.5g for 8ms
+/- Lat: 2.75g for 55ms



Interface Control Drawing





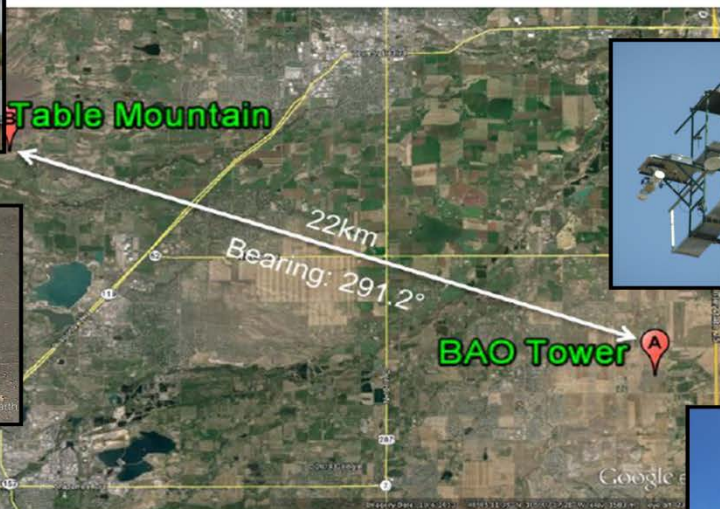
September Ground Demo



33 ft turn table



Ø 2 km Controlled
Access RF Quiet Zone

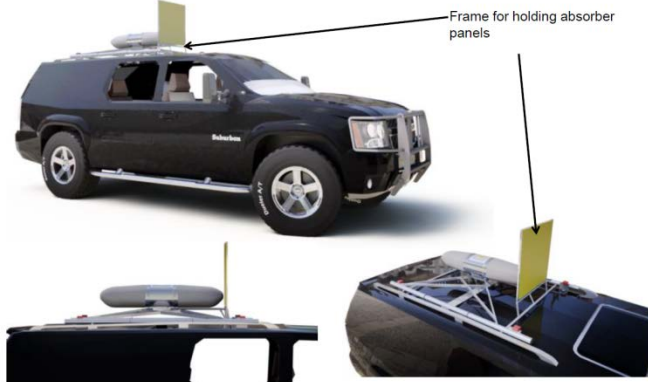


Az/EI motion
table on
tower

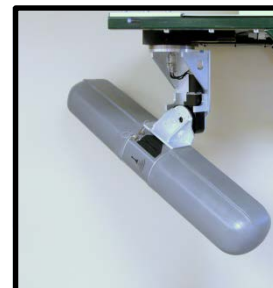


1000 ft Tower

Mobile Side driving on table mtn.
Attenuation pads to stress link > 22 km



Frame for holding absorber
panels

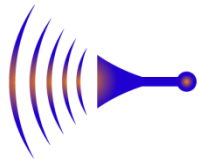


Elevated side up tower,
Attached to motion table

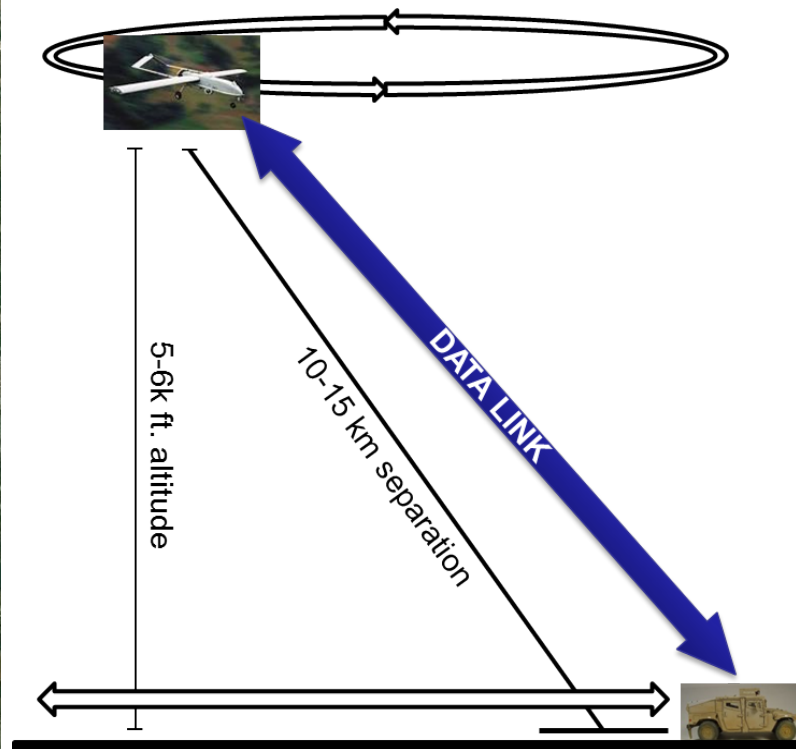
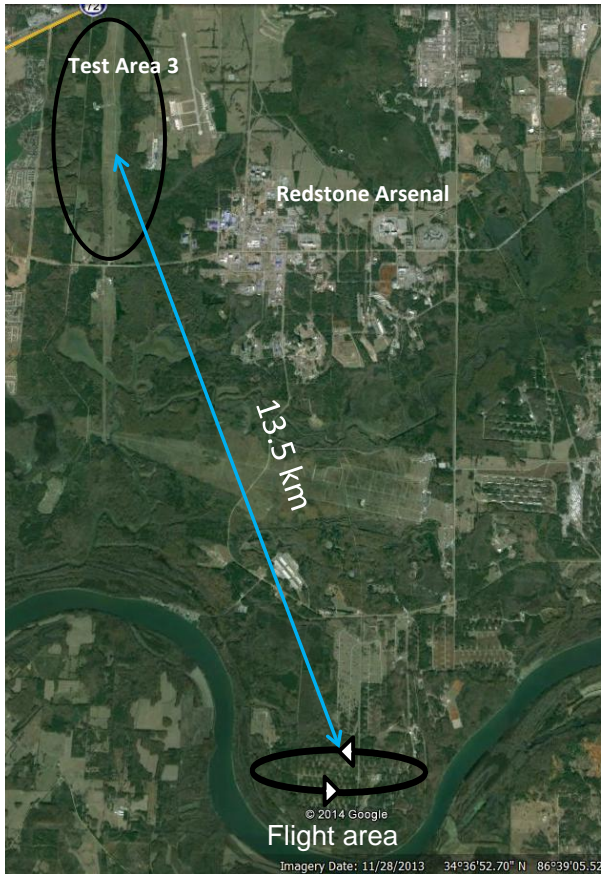
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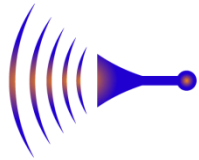
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October Flight Demo





Path Forward/Options

- Solution can be tailored to the need (open loop, con scan, monopulse)
- MHS target production pricing compatible with the Tier II UAV cost model
- FIRST RF does high volume production (largest Antenna program in the DoD)
- System is ready for transition into the commercial world – no technology gaps