



# Mobile GPS Payload

Virtual Design Review 1

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Team 17



FAMU-FSU COLLEGE OF ENGINEERING  
MECHANICAL ENGINEERING

# Introduction

Taylor Davis  
Administrative Lead

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Sponsor Liaison



Michael Connell  
ME Lead

Travis Bruner  
Webmaster & Financial  
Lead

Ricky Gal  
ECE Lead



# Background

Sponsor:

- Space Vehicles Directorate,  
Air Force Research Lab  
(AFRL)
  - Dr. Madeleine Naudeau – Principal Investigator, Advanced GPS Technologies Program (AGT)



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# AFRL

- Dedicated to leading the discovery, development, and integration of warfighting technologies for our air, space and cyberspace forces.
- Space Vehicles Directorate
  - Kirtland AFB, New Mexico



# AGT

Goal: to plan, manage, and execute Positioning, Navigation, and Timing (PNT) portfolio that will advance the state-of-the-art of GPS and future PNT payloads.

2012

AGT is established.

2019

Component testing of next generation PNT equipment.

2020

Live sky testing of equipment.

2021

Integration of PNT components into full payloads.



# Project Brief

- AGT would like to mobilize their current lab and new equipment to allow for range and live sky testing.
- Plan to attend various military test exercises.
- Lab will support multiple operators and test stations.



# Project Scope

Project  
Description

Key Goals

Markets

Assumptions

Stakeholders

Design a mobile GPS lab for AFRL with the capability to test components of a position, navigation, and timing payload. The design will be cost effective, user friendly, and as simple as possible.



# Project Scope

Project Description

Key Goals

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Stakeholders

**Self-Sufficient**

Design a self-sufficient mobile GPS lab.

**Equipment Safety**

Ensure equipment isn't harmed during transport or testing.

**Ergonomics**

Make interior design ergonomic for operators.

**Cost**

Keep overall design costs low.

**Complete Design**

Provide AFRL with a final design that can be used to build the mobile lab.





# Project Scope

Project Description

Key Goals

Markets

Assumptions

Stakeholders

## Primary

- AGT

## Secondary

- Military and civilian research labs
- Medical labs
- Emergency response units
- Educational labs



# Project Scope

Project Description

Key Goals

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The design can include commercial products.

**Commercial Products**

Most test equipment comes from the existing lab.

**Preexisting Equipment**

Given weights and dimensions are estimates.

**Estimated Dimensions**

A full-scale model will not be built.

**Scaled Model**

The lab technicians know how to setup all equipment.

**Technician Knowledge**



# Project Scope

Project Description

Key Goals

Markets

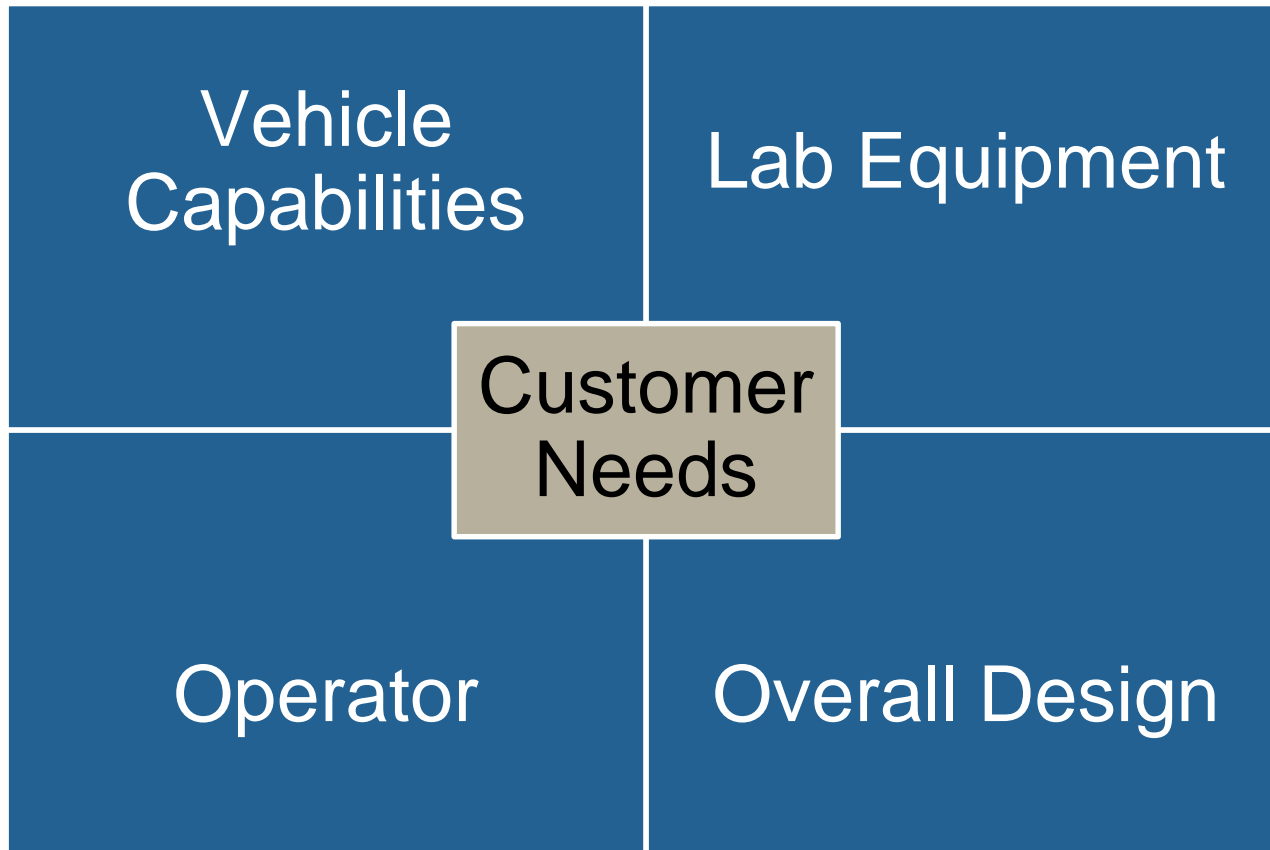
Assumptions

Stakeholders

	AGT	Dr. Naudeau	Dr. Oates	Dr. McConomy	Dr. Shih
Sponsor	X	X			
Managers		X		X	
Experts	X	X	X		
Operators	X				
General Readers			X	X	X



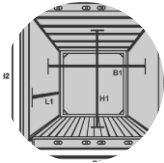
# Customer Needs



# Vehicle Capabilities



The vehicle is capable of driving on unpaved roads.



The vehicle can transport all desired equipment.



The vehicle is self-sufficient.



The vehicle has protection against intrusion.



The vehicle can withstand various climates/environments.



# Lab Equipment

Lab equipment is easily loaded and unloaded.



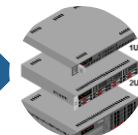
The required antennas are supported.



Lab equipment can function inside of the vehicle.



The interior can accommodate varying sizes of equipment.



Equipment is not damaged in transit.



There is proper control of ESD.



# Operator



The lab is technician friendly.



The interior conditions are ergonomic.



Operators are able to use a restroom on site.



There is ample test space.



There are workstations for multiple operators.



# Overall Design

The design minimizes operational costs.



The design is versatile.

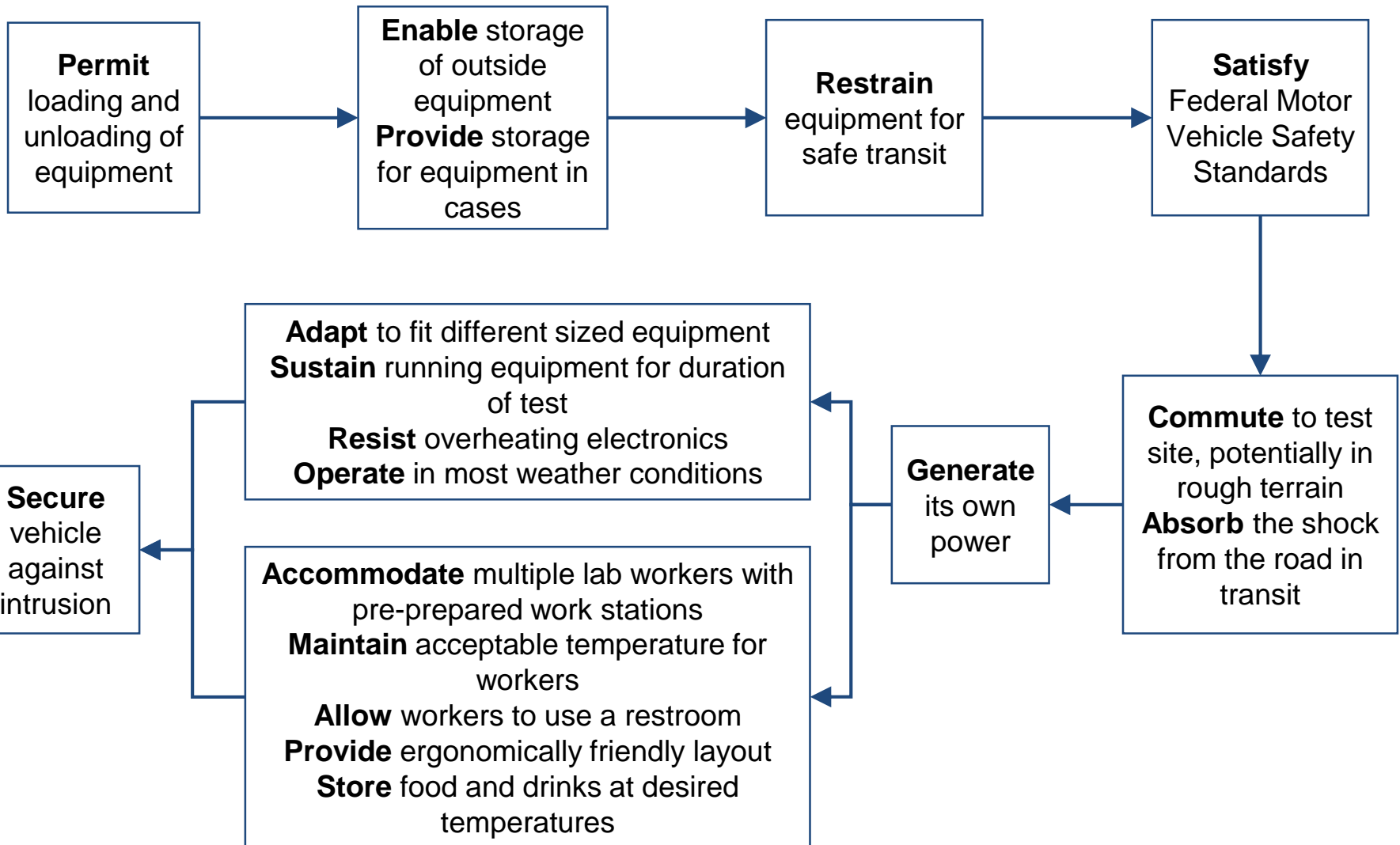


The design is reasonably priced.

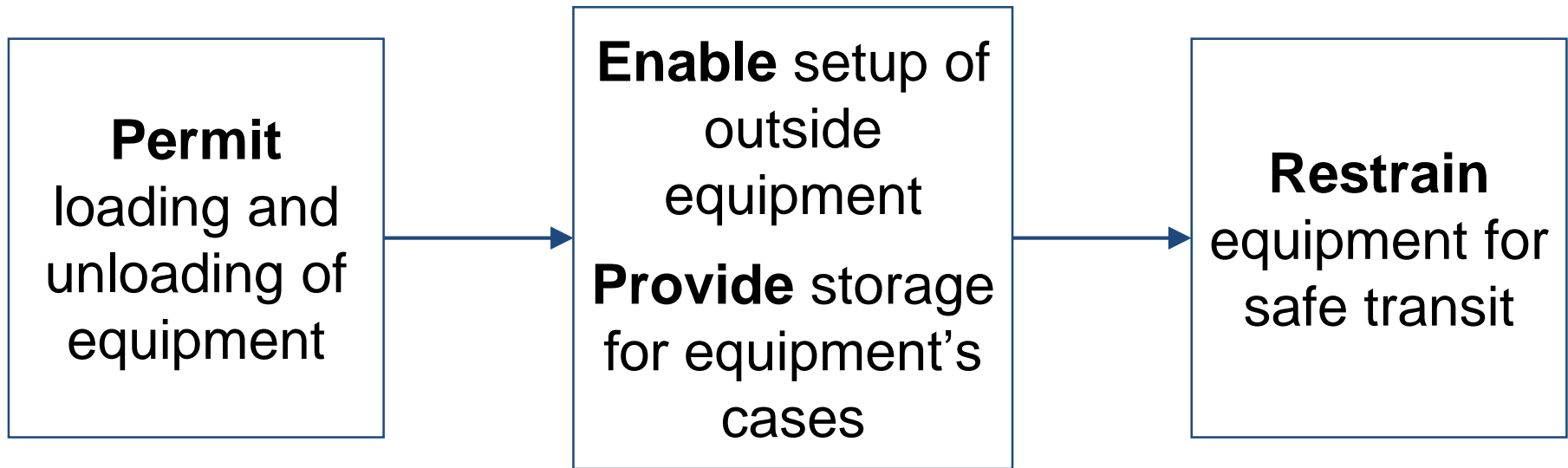




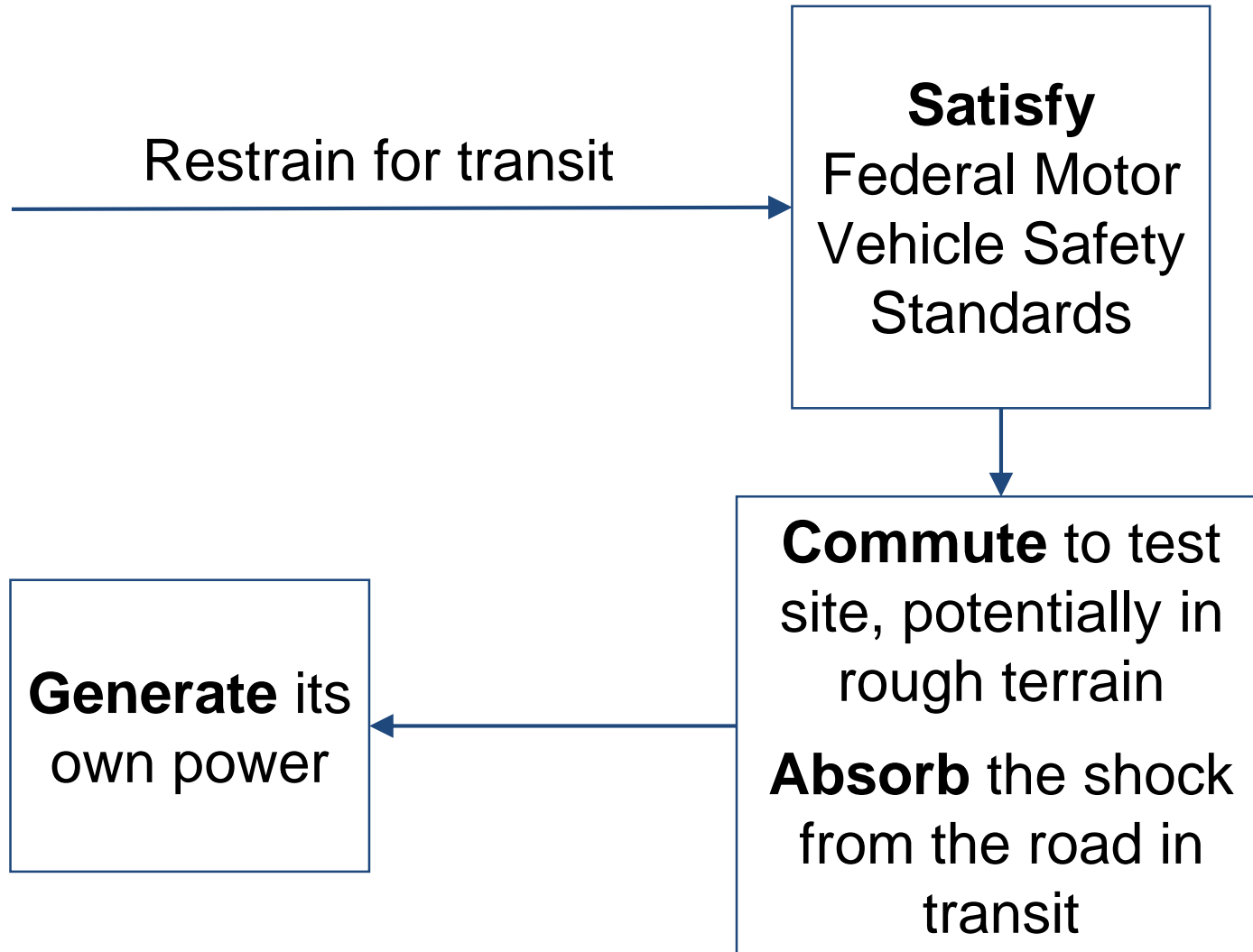
# Functional Decomposition



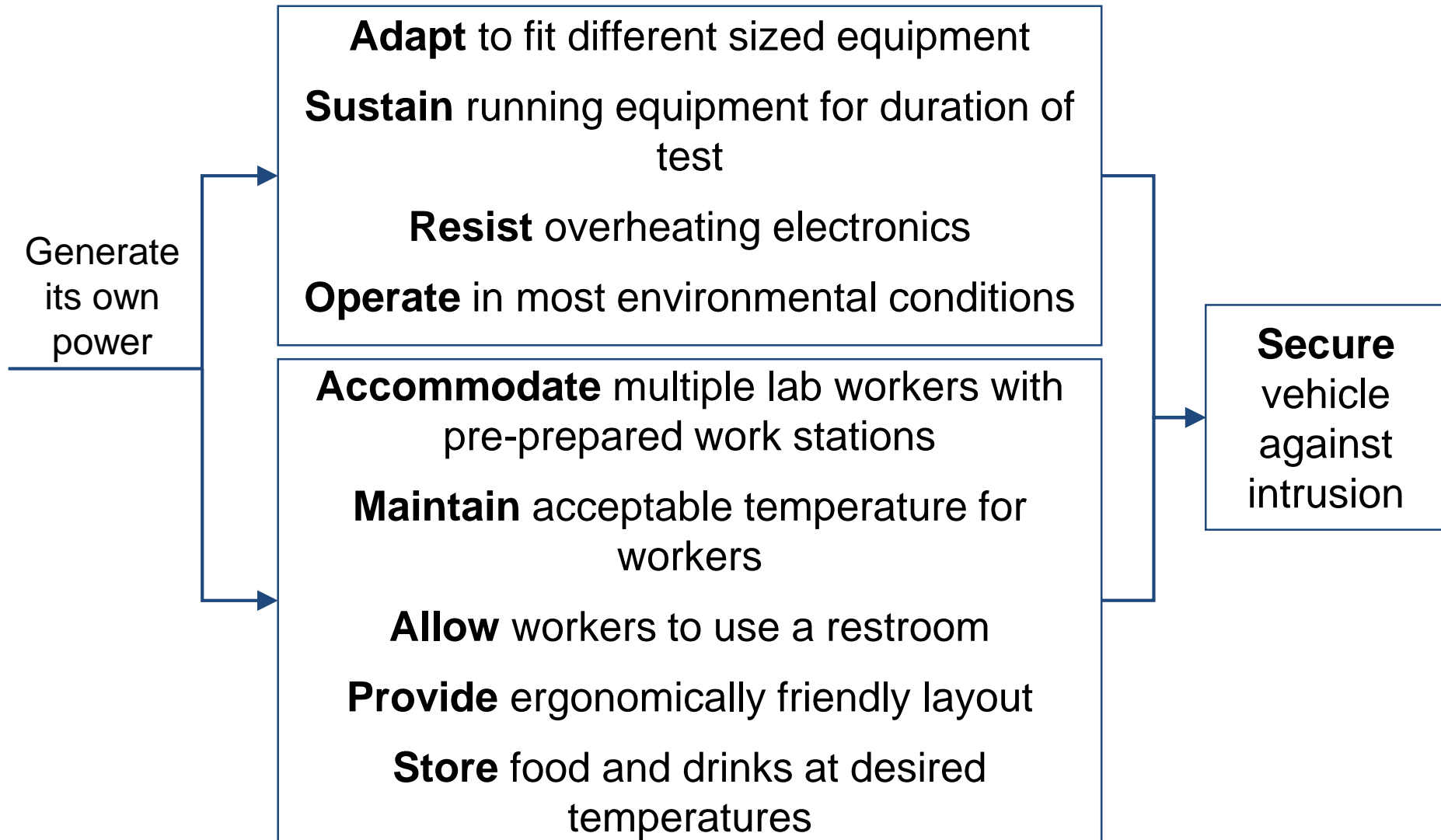
# Functional Decomposition



# Functional Decomposition



# Functional Decomposition



# Next Steps

- Establish targets
- Generate concepts
  - Vehicle Selection



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# Questions?



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# Back-Up Slides





# Acronyms

<b>GPS</b>	Global Positioning System	<b>WSMR</b>	White Sands Missile Range
<b>ME</b>	Mechanical Engineering	<b>ESD</b>	electrostatic discharge
<b>ECE</b>	Electrical/Computer Engineering	<b>FMVSS</b>	Federal Motor Vehicle Safety Standards
<b>AFRL</b>	Air Force Research Lab	<b>ORDWG</b>	On-Orbit Reprogrammable Digital Waveform Generator
<b>AGT</b>	Advanced GPS Technologies	<b>SWaP</b>	size, weight, and power
<b>AFB</b>	Air Force base	<b>DoD</b>	Department of Defense
<b>711th HPW</b>	711th Human Performance Wing	<b>GVWR</b>	Gross Vehicle Weight Rating
<b>AFOSR</b>	Air Force Office of Scientific Research	<b>NHTSA</b>	National Highway Traffic Safety Administration
<b>PNT</b>	position, navigation, and timing		



# AFRL Locations

- Edwards AFB – Southern California
- Kirtland AFB – Albuquerque, New Mexico
- Air Force Maui Optical and Supercomputing Haleakala Observatory – Maui, HI
- Ft. Sam Houston – San Antonio, Texas
- Eglin AFB – near Destin/Fort Walton Beach, Florida
- Wright-Patterson AFB – Dayton, Ohio
- Arlington, Virginia
- Rome, New York



# AFRL Directorates

Directorate	Function
711 Human Performance Wing	Human-centric warfare wing focused on research, education, and consultation.
AF Office of Scientific Research	Broad-based research into aerospace-related science and engineering.
Aerospace Systems	Fuels research, structural testing, compressor research, rocket testing, supersonic and subsonic wind tunnels, flight simulation, and more.
Directed Energy	Laser systems, high power electromagnetics, weapons modeling and simulation, and directed energy and electro-optics for space superiority.
Information	Develops information technologies for aerospace command and control, and its transition to air, space and ground systems.
Munitions	Develops, demonstrates, and transitions science and technology for airlaunched munitions for defeating ground-fixed, mobile/relocatable, air, and space targets.
Materials & MFG.	Develops new materials, processes and manufacturing technologies for us in aerospace applications.
Sensors	Leads the discovery, development, and integration of affordable sensor and countermeasure technologies for the warfighter.
Space Vehicles	Develops and transitions space technologies for more effective, more affordable warfighter missions. Primary missions: space based surveillance and space capability protection.



# Next Generation PNT Equipment

- High power amplifiers
- On-orbit Reprogrammable Digital Waveform Generators (ORDWG)
- New antenna concepts
- Supporting electronics
- Algorithms and new signal combining methods
- Satellite bus technologies for increased resiliency and lower Size, Weight, and Power (SWaP)
- Advanced cyber technology



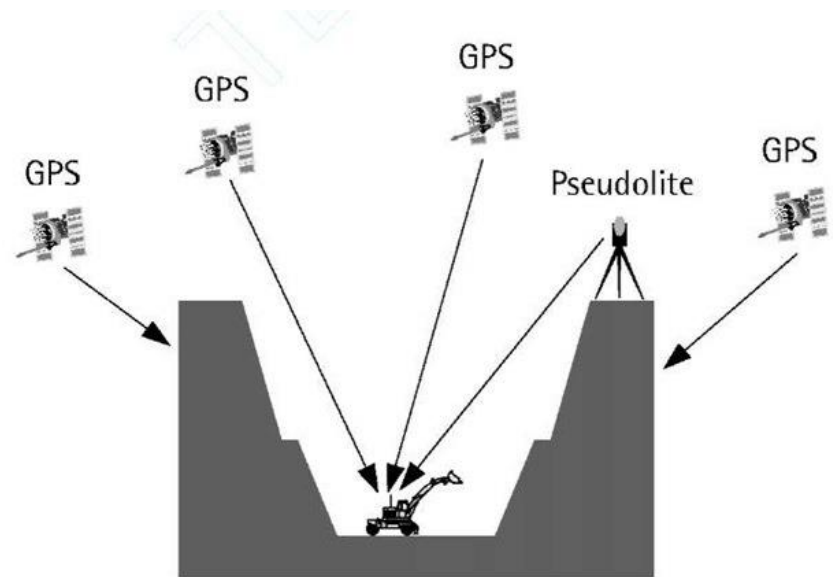
# Live Sky Testing

- Allows testing of GPS equipment in open air environment.
- Operators can test in adverse environments.
  - jamming
  - spoofing



# Pseudolite

- A word blend of pseudo and satellite.
- Function like GPS but the signals are transmitted from the ground or low flying aircraft.
- Can be used for testing or as a solution for operating in a GPS-denied environment.
- First proof of concept at White Sands, in 2011.



# NAVFEST

- 746<sup>th</sup> TS provides low-cost, realistic, GPS jamming scenarios for testing GPS-based navigation systems and training personnel in GPS-denied environments.
- DoD agencies, defense contractors, civil organizations, foreign nations.
- Drive, fly, or walk through jamming scenarios.



# Budget

- The sponsor wants the “most cost effective” design.
- Costs to consider:
  - Overall design costs
  - Operational costs
- The design budget, not including the vehicle itself, is roughly \$30,000.
- Overall design budget is roughly \$150,000.
- AGT would like us to provide a range of vehicle options depending on their capabilities, from the bare minimum to more luxurious.





# Unpaved Roads

- Design will not include analysis of vehicle performance on unpaved roads.
  - Refer to commercial vehicle performance.
  - Gross Vehicle Weight Rating (GVWR) restrictions on the vehicles will be followed.

Fuel Capacity (gal.)	150
GCWR <sup>6</sup> (lbs.)	60,660
GVWR (lbs.)	45,660
GAWR - Front (lbs.)	15,660
GAWR - Rear (lbs.)	30,000
Wheelbase	279" + tag

Weight and Measures information for Winnebago Grand Tour.



# Federal Motor Vehicle Safety Standards

- National Highway Traffic Safety Administration (NHTSA) regulations for motor vehicle performance.
  - Crash Avoidance
  - Crashworthiness
  - Post Crash Standards
- Commercially available vehicles meet these standards.



# Vehicle Selection

