



TriTech Small Business Development Center Presentations

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SPACE TECHNOLOGY MISSION DIRECTORATE



Towed Glider Air Launch System

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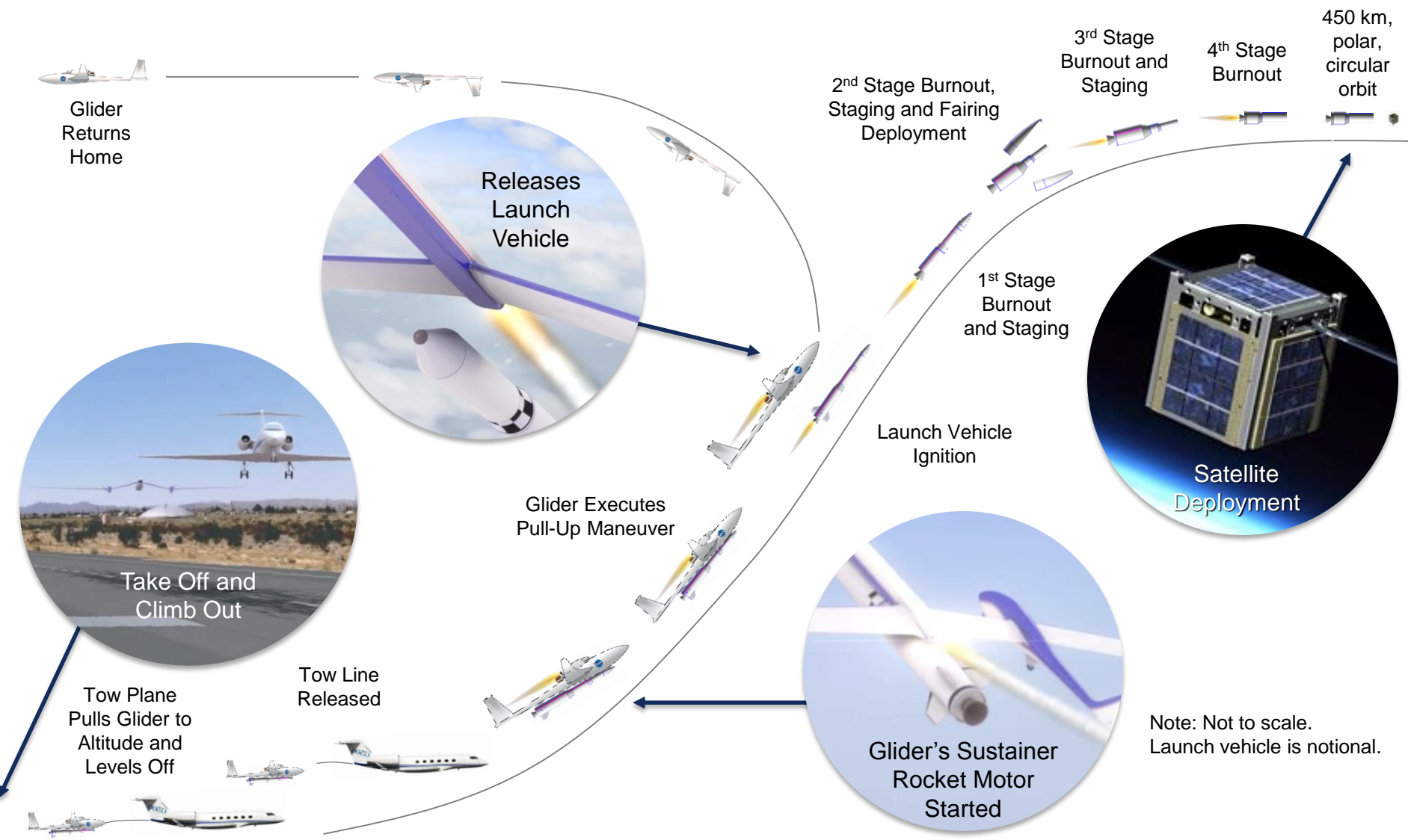
TOWED GLIDER LAUNCH PLATFORM



A remotely-piloted glider, towed by a modified business jet, releasing a launch vehicle with payload at 48K', M=0.75, up to a 70° flight path angle, safely & effectively.

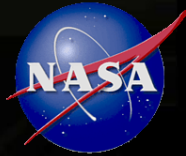


TOWED GLIDER LAUNCH PLATFORM CONOPS



Note: Not to scale. Launch vehicle is notional.

Why Towed Glider?



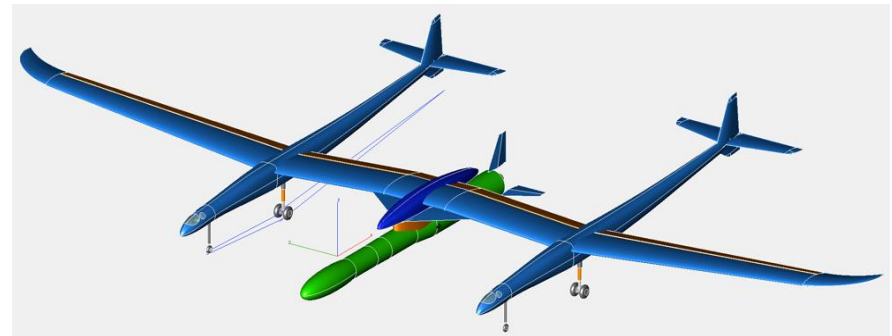
- **Performance:**
 - Pull-up maneuver provides a **30% increase** in payload performance to orbit over current air-launch approaches, up to **70% increase** over ground launch
- **Geometry:**
 - Can lift significantly larger payloads to altitude vs modifying a same size, direct carry, “conventional” aircraft for external carriage
- **Cost:** Less expensive to build, operate, and maintain than developing and building a one-of-a-kind, custom carry aircraft
 - Simple glider, devoid of expensive, complex systems
 - No hydraulics, fuel system, engines, life support, egress systems
 - Leverages the advantages of air-launching
 - No dependence on critical ground based launch facilities/assets
 - Launch operations cost is **reduced to 7%-12% of ground launch cost** at a “traditional” range
- **Safety:** Unmanned glider eliminates aircrew concerns for carrying LV
 - LV doesn’t have to be human-rated (blast proximity), nor does the glider
- **Technology:** No new technologies required, just an integration of existing, already proven technologies

Independent Concept Validation Studies



- NASA contracted with three separate entities in 2012 to study and assess the viability of the Towed Glider Air Launch System Concept

- Georgia Tech University
- SAS/Rutan Designs
- Morgan Aircraft Co.



Design Carry Efficiency: 1.85

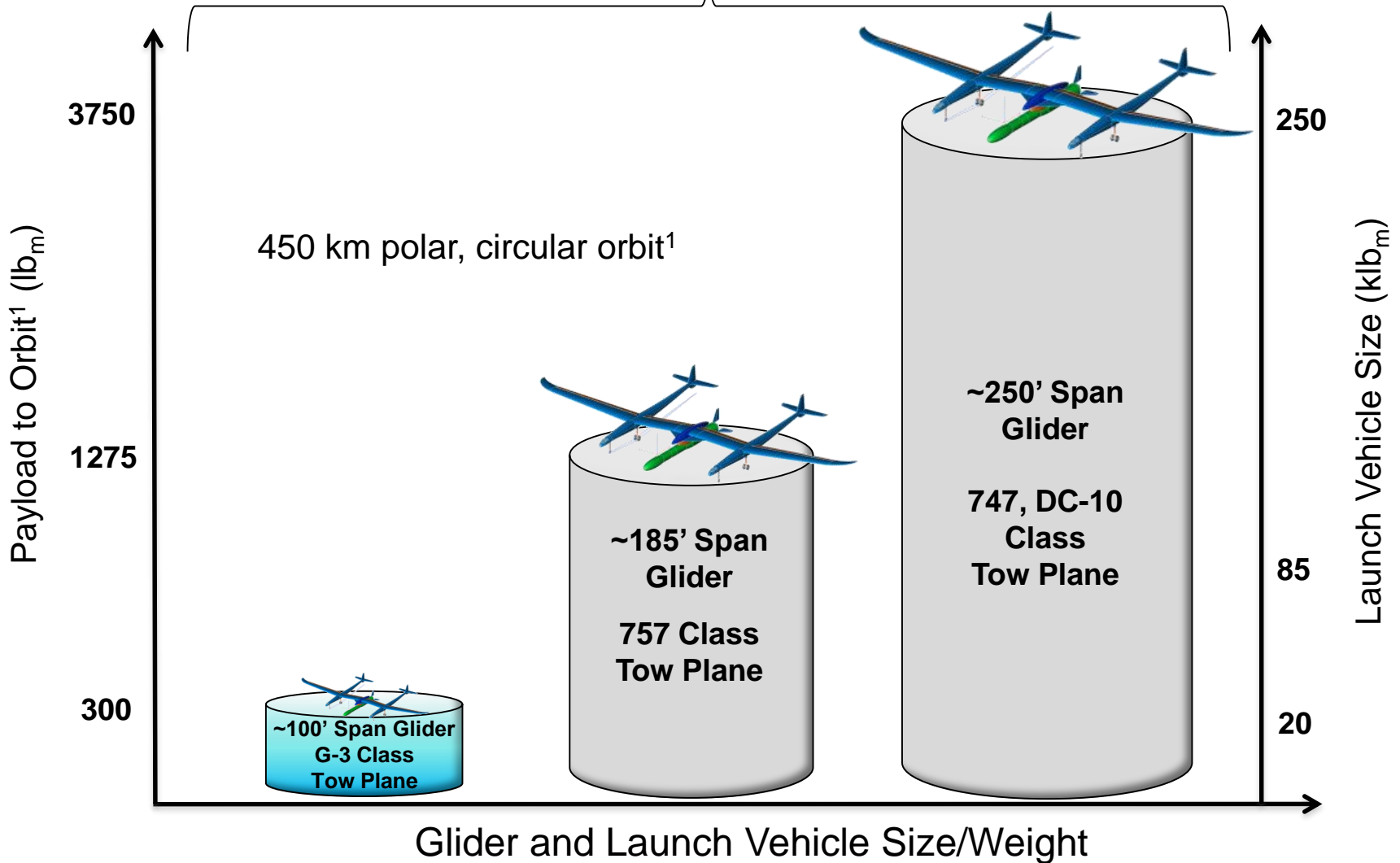
- All three studies concluded that:
 - The concept is viable;
 - It offers significant improvements in efficiency, performance, and cost, over current state of the art launch methods.

The studies showed the concept is do-able...next step is the Proof of Concept

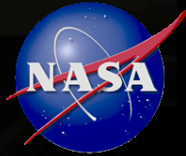
Towed Glider Technology is Scalable



Achievable with conventional aircraft for Tow Plane

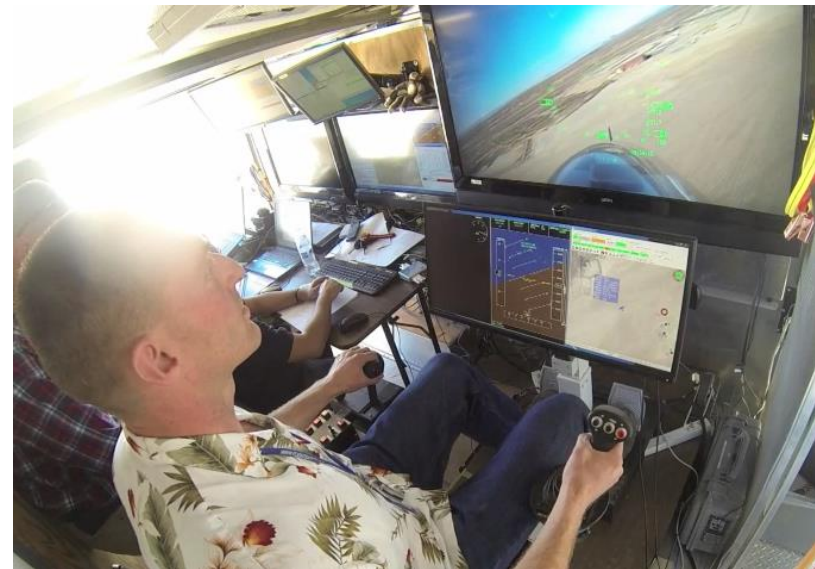


Current Risk Reduction Testing - 1/4 Scale Model Glider



NASA funds used to develop a 27' span twin fuselage glider for testing under tow behind a NASA small, unmanned model aircraft

- Glider remotely piloted using a stick and rudder based Ground Control Station with down-linked video and a Heads Up Display
- 1st Flight on October 21st, 2014; subsequent flights focused on general handling qualities evaluations (including stall)
- Future flights planned for
 - Glider rocket motor risk reduction testing
 - Glider aerodynamic characterization
 - Surrogate payload carry and release demonstration



Business Case Differentiators



Rapid Deployment with Cost Savings

Mobile Range Approach allows for flexibility in launch operations from airfields around the world

Strategically Located Launch Vehicle on an unmanned glider protects human crew from potential LV safety concerns

Parallel Processing of Payloads is accomplished through multiple, modular center wing/ fuselages

Custom-Sized Low-Cost Scalable Gliders optimize service for an array of payload sizes

- 🕒 Reduces launch delays
- 💰 Reduces range safety/launch approval & licensing costs
- 💰 Avoids costs associated with human rating of launch vehicle
- 💰 Reduces overhead costs for smaller payloads

Savings in Time and/or Money versus Traditional Launch

The Towed Glider concept architecture saves time and money

Summary



Goal: **Enable** Affordable, Resilient, Responsive, Space Access

Approach: Remotely piloted GLIDER carrying a small LV, TOWED by a minimally modified business jet, releasing the LV at the optimal trajectory for launch

Program: NASA provides FTEs, infrastructure, and \$\$; DoD provides procurement \$\$; Industry partners provide towed glider system and small LV's

Key: GLIDER enables small, affordable launch vehicles to reach orbit, reduces launch cost and overhead, yielding highly resilient, agile launch operations



Backup Material

Glider Design Creates Trade Space



Next Generation Air-Launch Design

Remote piloting eliminates need for human rating for the LV and the glider

Glider can be sized to allow growth for future desired payloads

Payload max size virtually unconstrained due to glider geometry and ability to build to suit

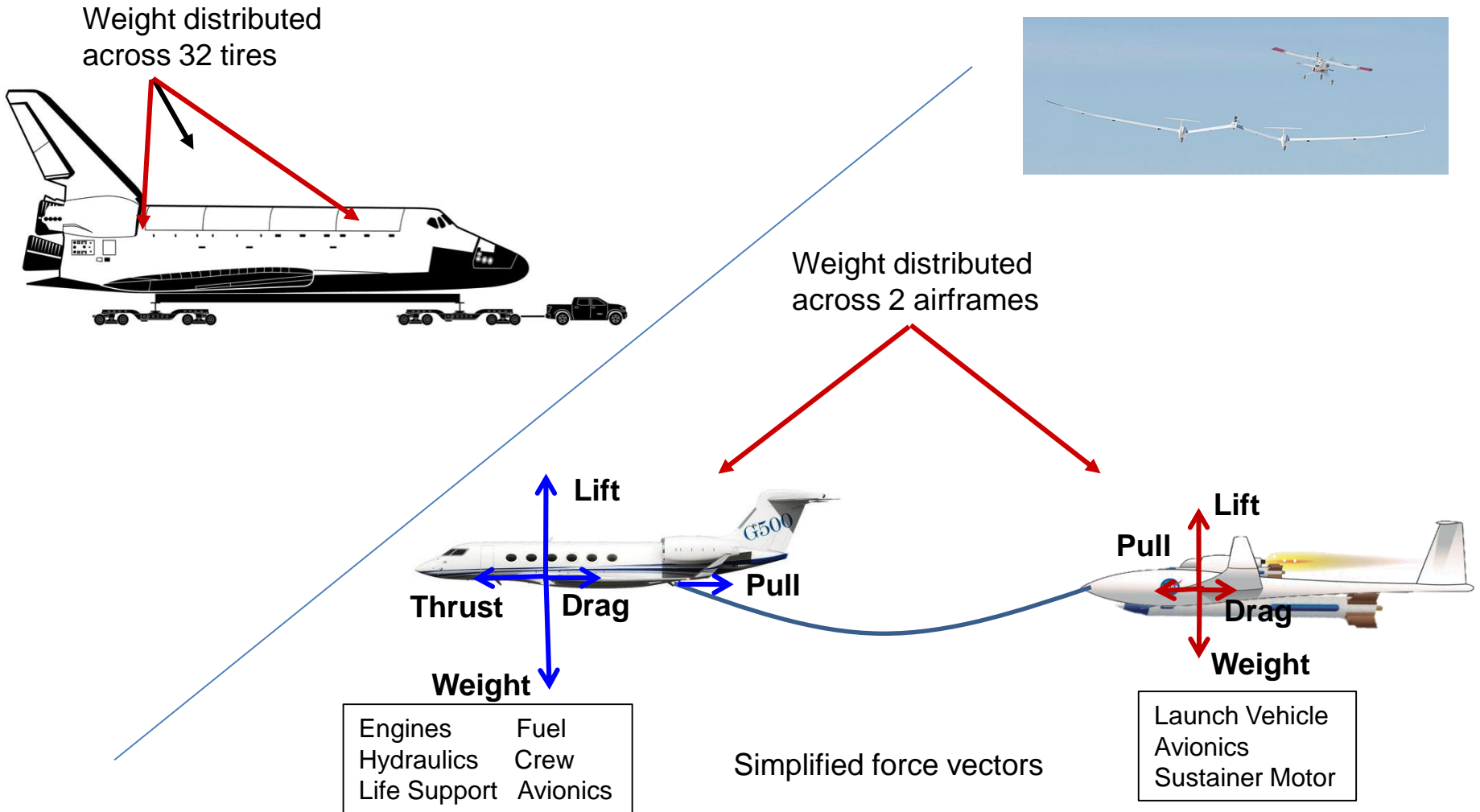
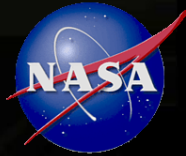
Minimal separation analysis required for un-crewed aircraft

Open center wing design minimizes LV clearance issue

Glider simple design is low maintenance

Towed Glider flexibility ensures design success

Its all about Weight Distribution...



Towing, on the ground, or in the air, is more efficient for moving large, heavy objects