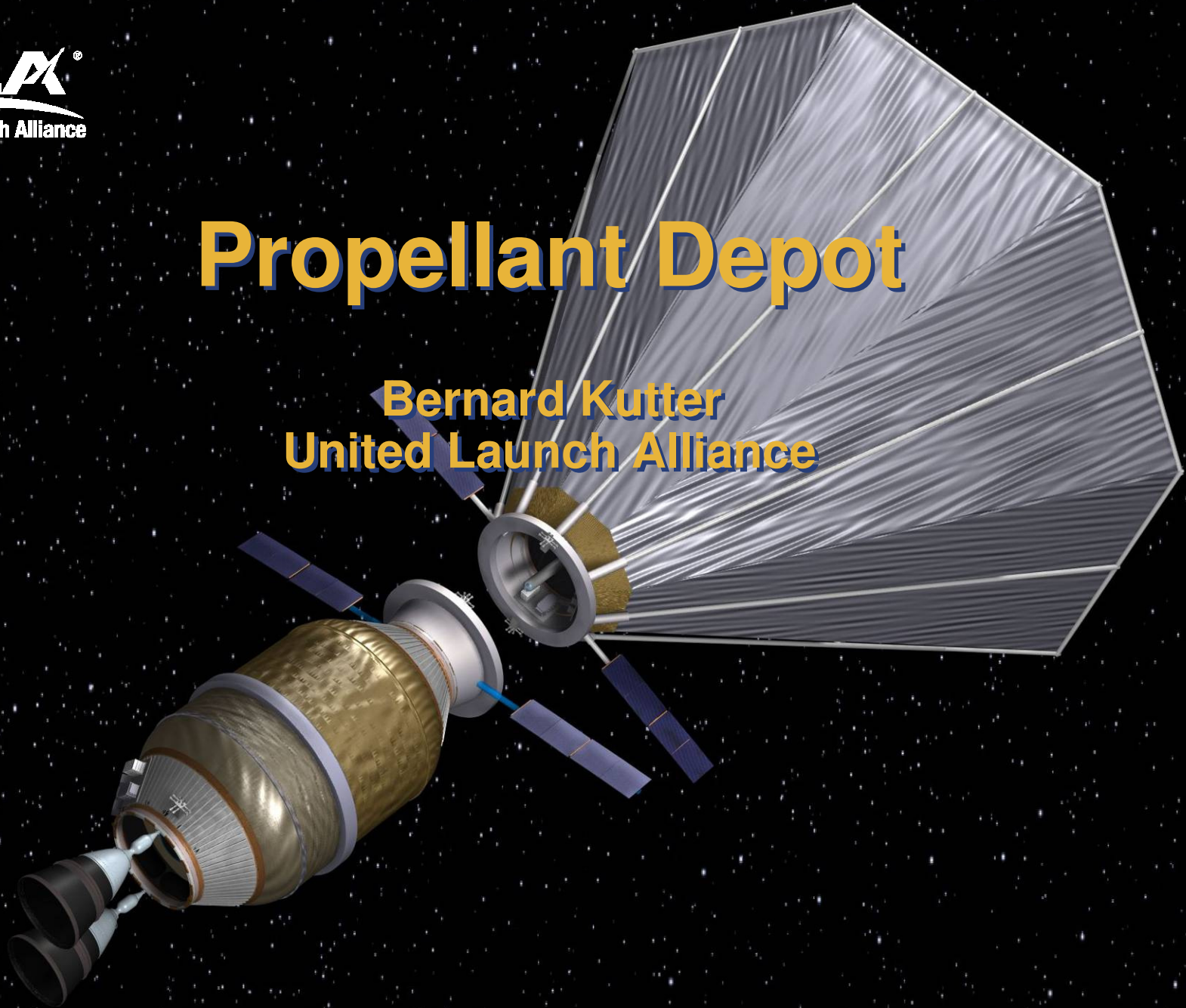


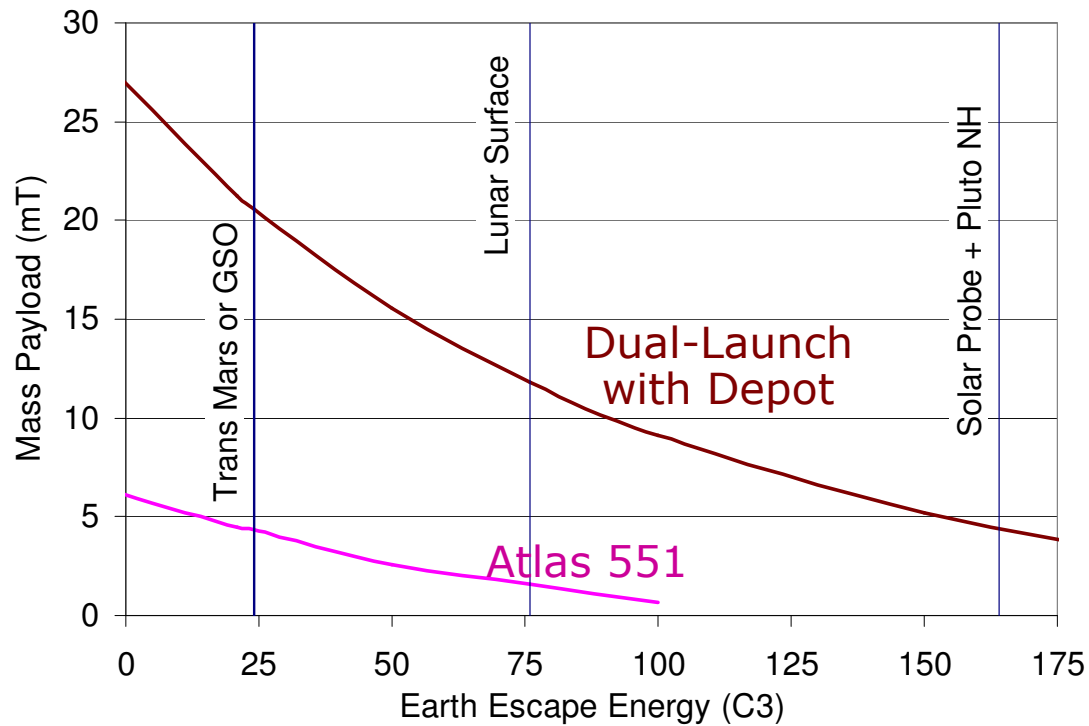


# Propellant Depot

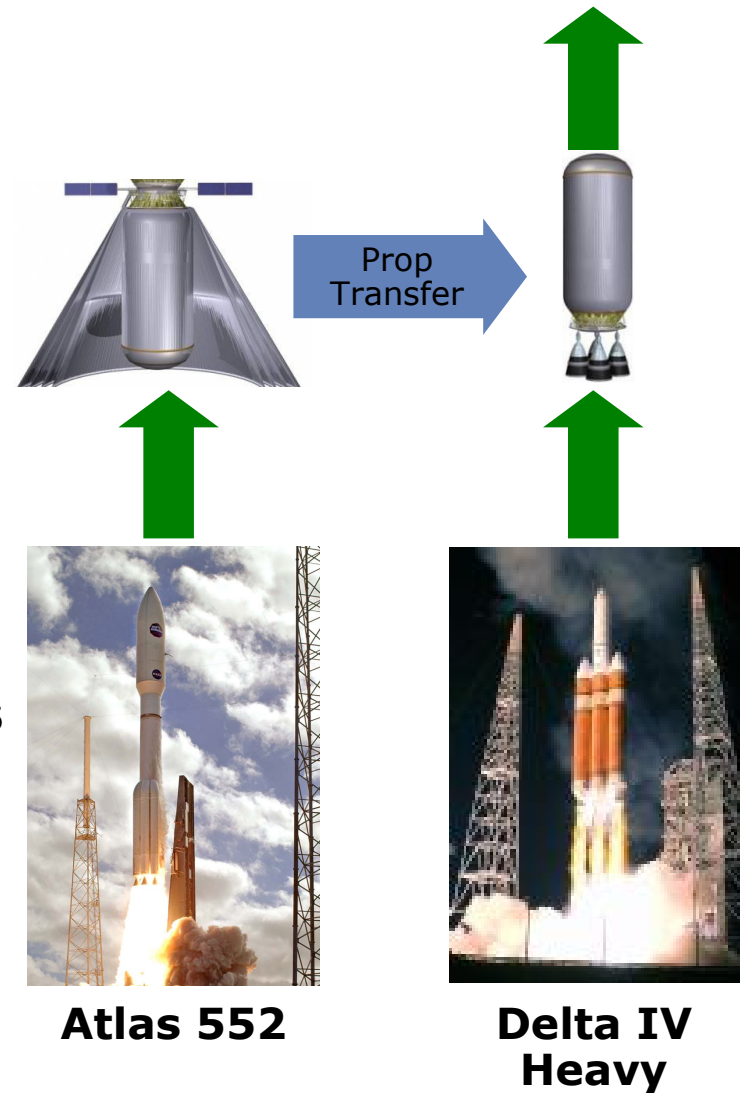
Bernard Kutter  
United Launch Alliance



# Propellant Depots Enable New Missions



Large Missions Enabled without Developing Brand New Rocket

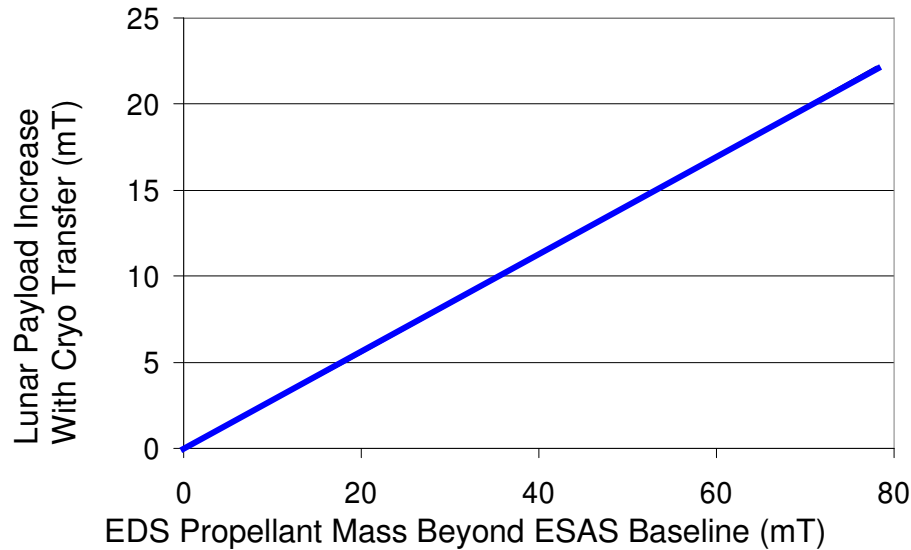


**Atlas 552**

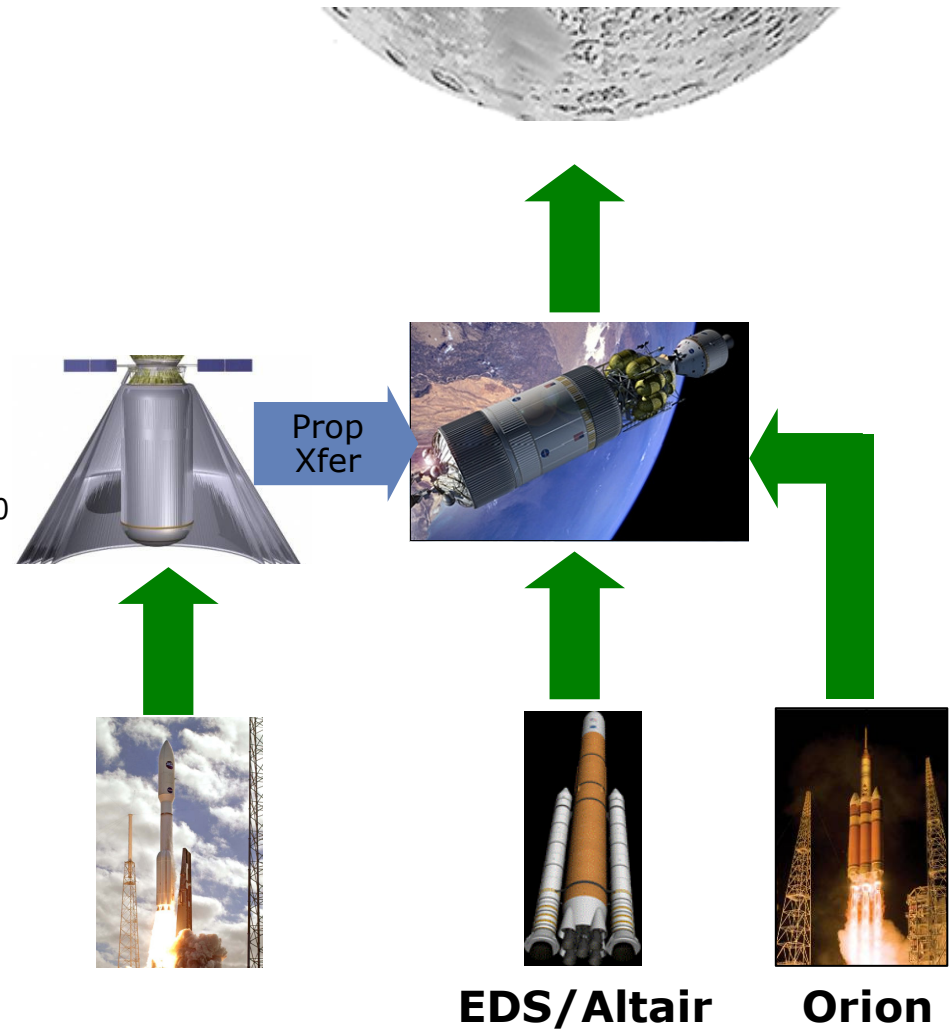
**Delta IV Heavy**



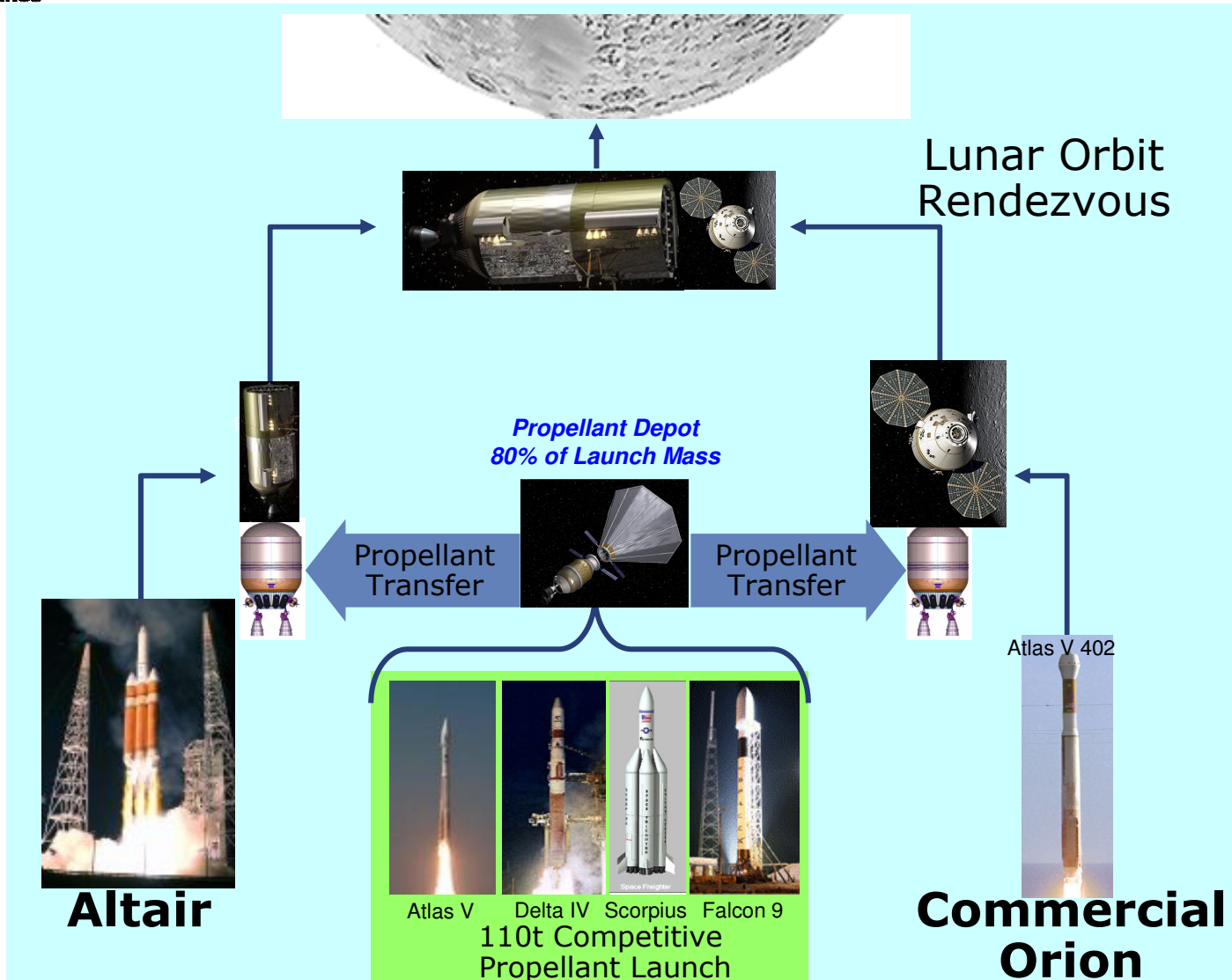
# Depots Can Enhance CxP Ares V Architecture



Propellant Depots Provide Exploration Flexibility to Accommodate Performance Needs



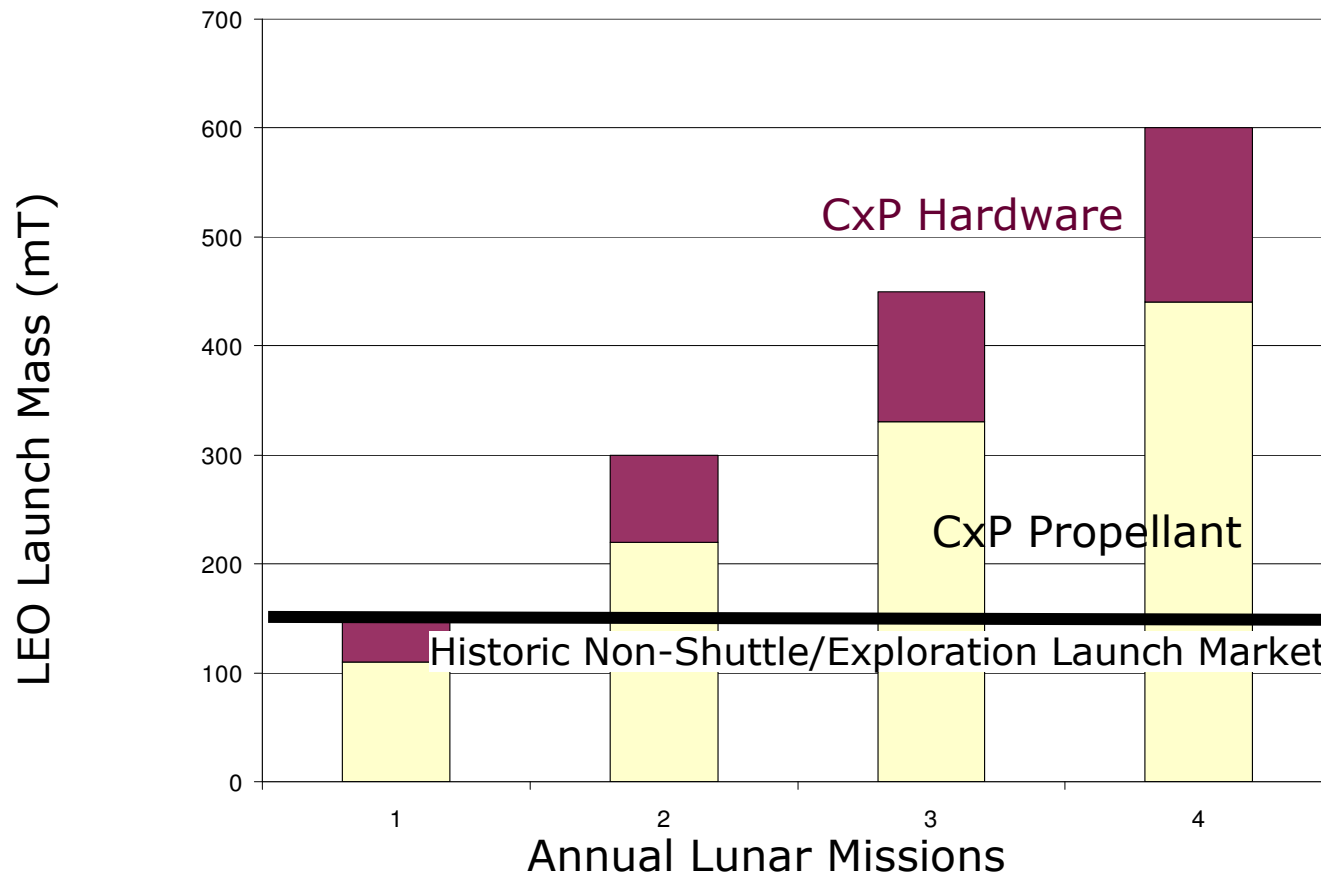
# Depots Enable Alternate Architectures





# Propellant Depots Can Revolutionize Launch Market

- ❑ Exploration Represents Vast New Launch Market
- ❑ Depots Stimulate Competitive Launch Market
- ❑ Supports Robust Healthy US Launch Industry

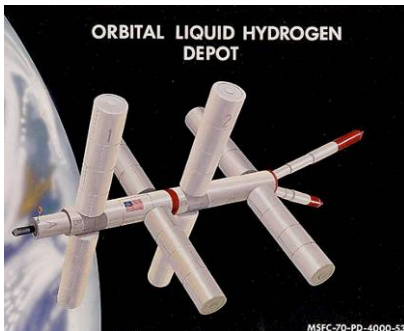


# Upper Stage Experience Enables Depots

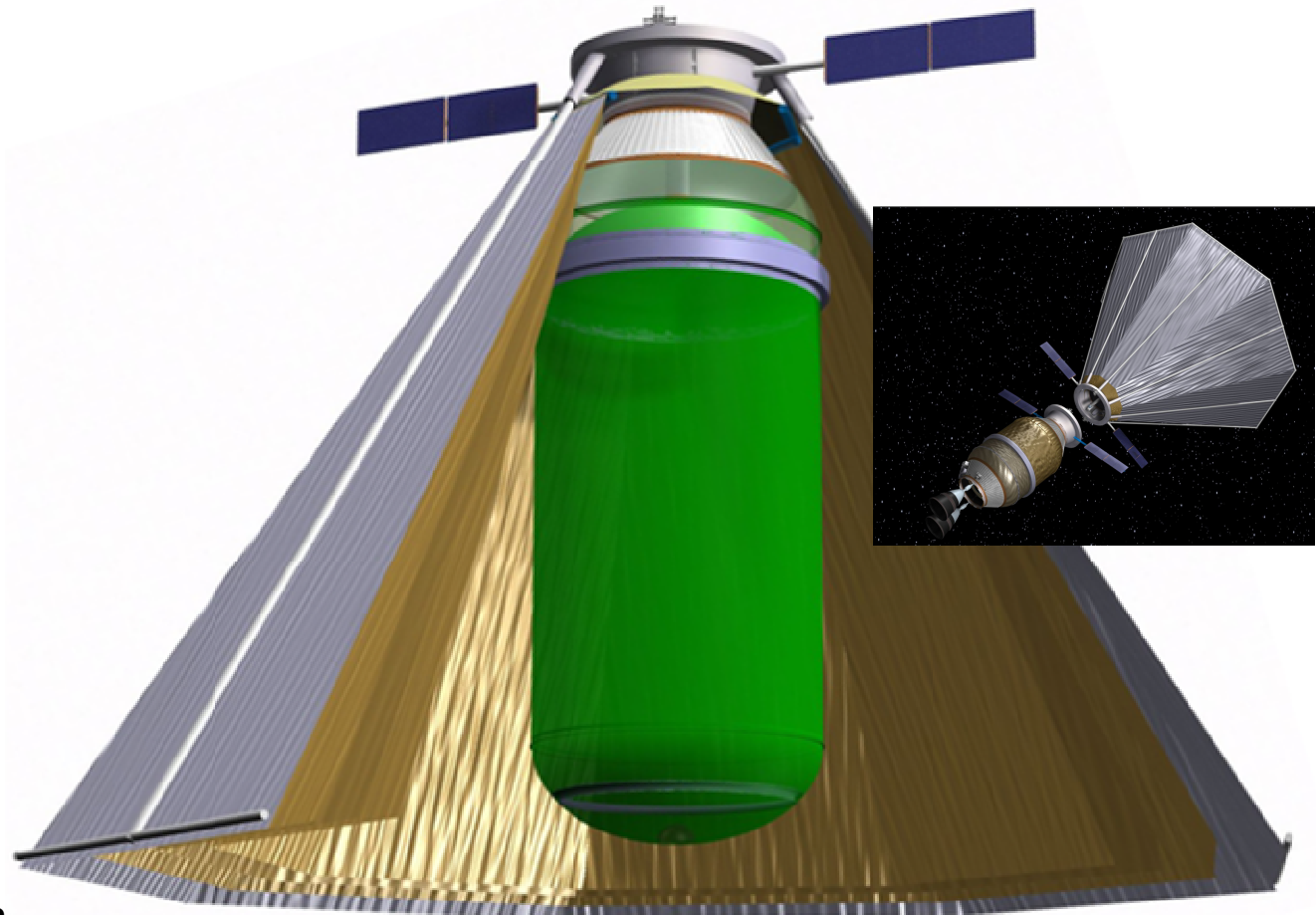
- Depots Derived from Existing Upper Stages Support Near-Term Application



**Centaur-Derived  
"Disposable" Depot**



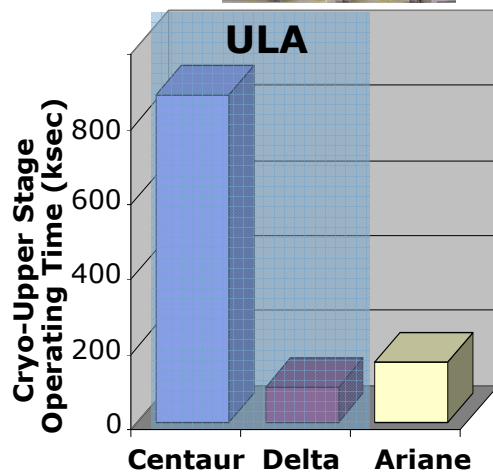
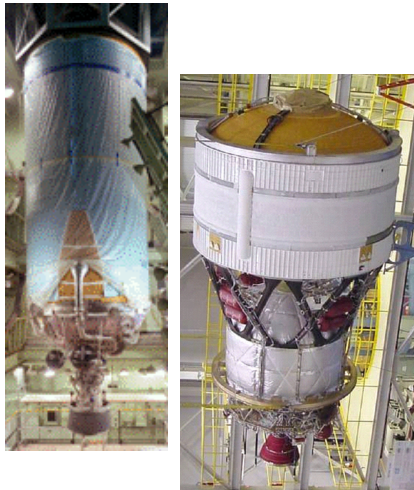
**Historic Space Station  
Depot Paradigm**



**Single Fluid Depot**

# Depot Technologies are Mature

- Upper Stage Cryo-Fluid Management Directly Applicable to Propellant Depots



Cryo Transfer Technology	TRL	
	0-G	Settled
Pressure Control	4	9
Ullage & Liquid Stratification	3	9
Propellant Acquisition	3	9
Mass Gauging	3	9
Propellant Expulsion Efficiency	3	8
System Chardown	8	8
AR&D	7	7
Transfer System Operation	3	6
Fluid Coupling	6	6
Passive Long Duration Storage	5	5

# Summary

- ❑ Propellant Depots Create Vast New Launch Market
  - Stimulate Commercial Space Flight Capability
  - Increased Launch Demand Supports Healthy Robust Launch Industry
- ❑ Joint Utilization of Flight-Proven Systems by NASA, DoD & Commercial Provides a Safe, Affordable & Sustainable Approach to Exploration
  - Leverages Existing Investments & Reduces Annual Standalone Lien
- ❑ Atlas V & Delta IV Provide Proven Foundation for Reliable, Affordable & Sustainable Launch
  - Reduced Launch Vehicle Investment Allows Enhanced Investment in Innovation
- ❑ ULA is Prepared to Support the NASA & the Nation

