Propellant Depots for In-orbit Lunar infrastructures

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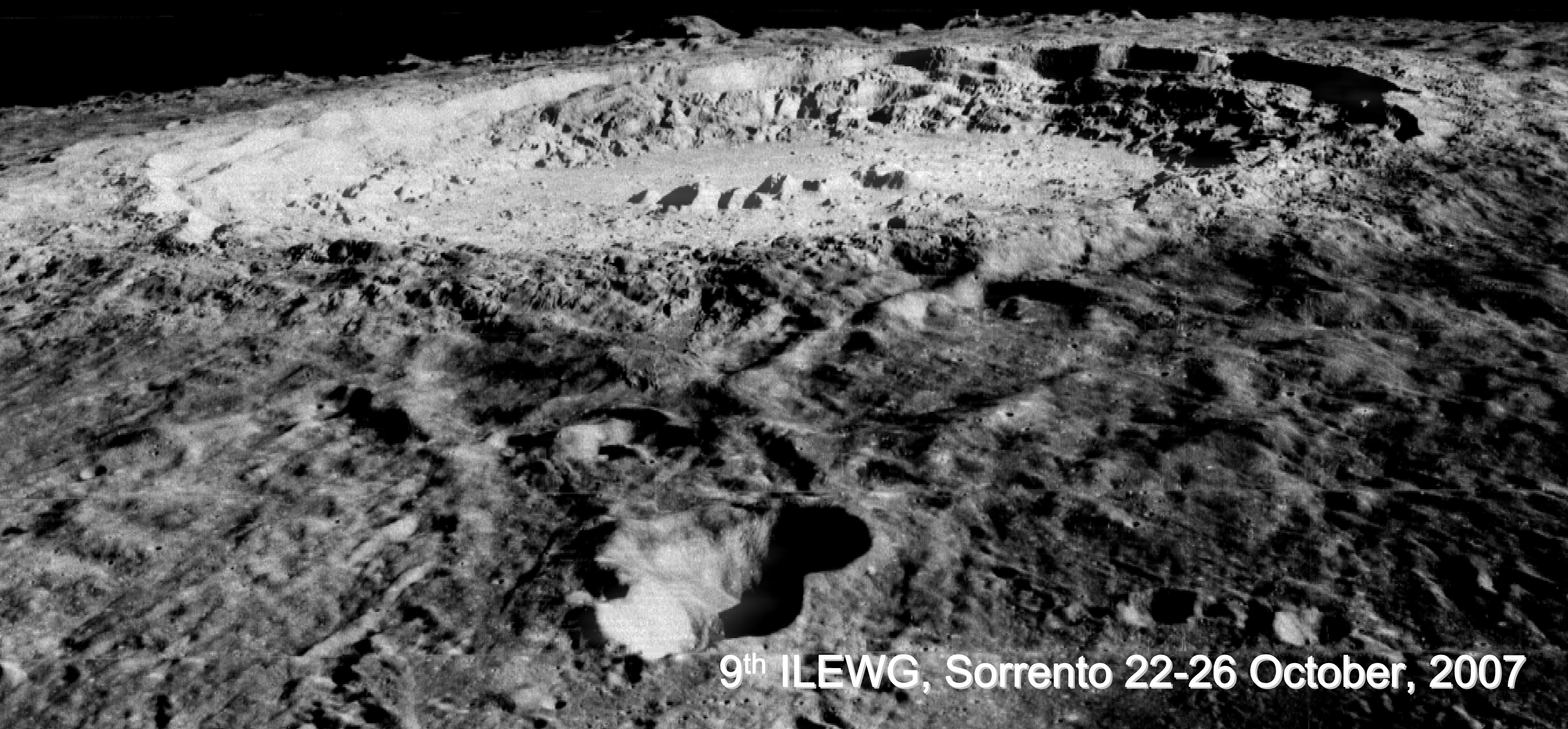

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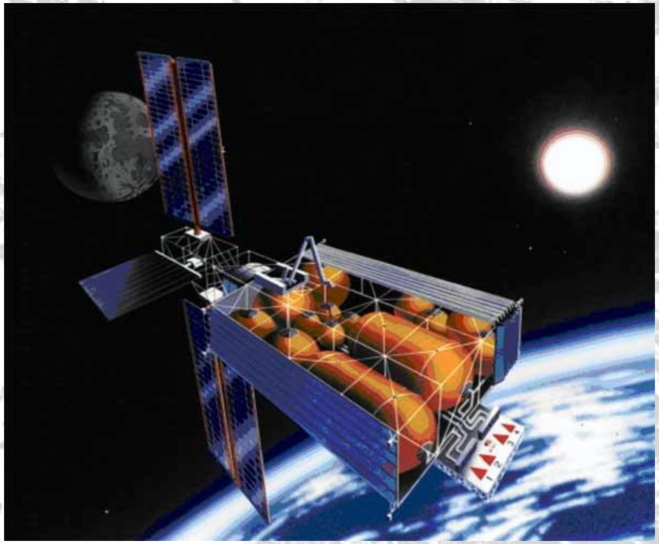
Scenario

Even if planned to be one of the component of the Lunar mission support infrastructure, NASA cut back Orbital Depot in 2005 when the agency decided it was not required to fulfill the short-term goal of returning humans to the Moon.

“even if such a station would be a highly valuable enhancement", it isn’t affordable under current budget constraints and "the mission [to the Moon] was not hostage to its availability".

Mike Griffin’s speech to the American Astronautical Society, November 2005



Why a Depot?

An In-Space Cryogenic Propellant Depot (ISCPD) is an important stepping stone to provide the capability to:

- ✓ Preposition
- ✓ Store
- ✓ Manufacture
- ✓ Use

propellants for Earth–neighborhood campaigns and beyond.

Main reason to have a depot in orbit is the selection of a modular/incremental design approach:

- *Affordability*
- *Adaptability*
- *Reusability*
- *Capability*
- *Dependability*
- *Incremental developability*
- *Feasibilty*

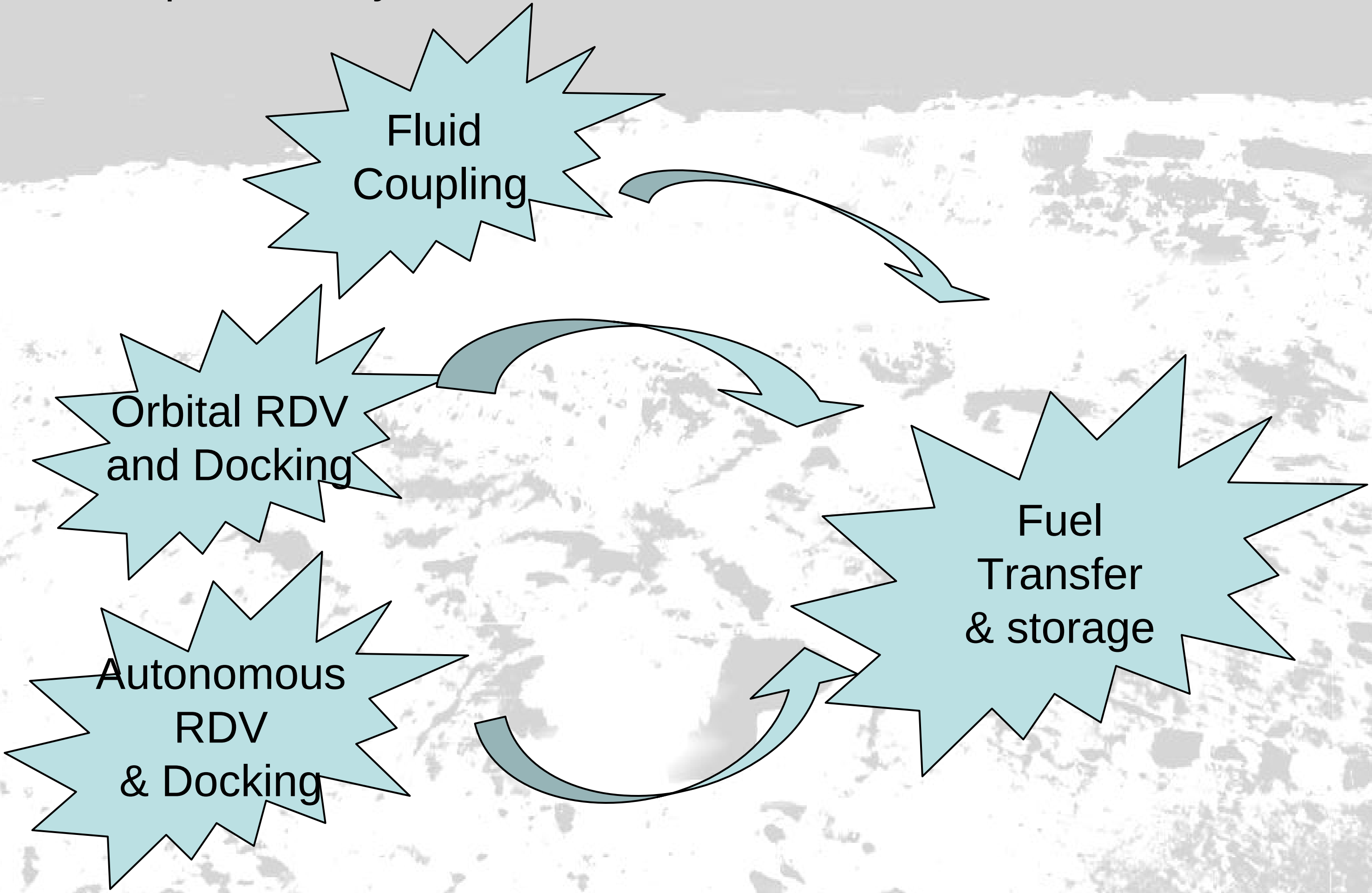
Key Technology: Propellant storage and transfer

MSFC/Boeing concept

Why a Depot…

Feasibility

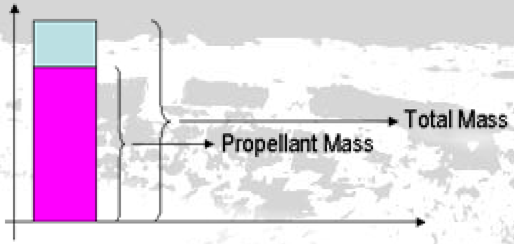
There really is a lot of prior art and experience that demonstrates that it is possible to make a depot a reality.



Transportation policy

Propellant depots allow you to develop reusable in-space transportation vehicles. While you could possibly refuel and reuse a reusable space tug without the benefit of a fuel depot, a depot would be a lot nicer.

Depots allow you to decrease the size of your launch vehicles (propellant is often 75-90% of the mass of transfer vehicle in LEO)
The ability to launch dry and fuel-up in orbit means:
much smaller vehicles flying at a higher flight rate, .



Smaller Vehicles

Higher Flight Rate

and in turn:

Better Price

Higher Reliability

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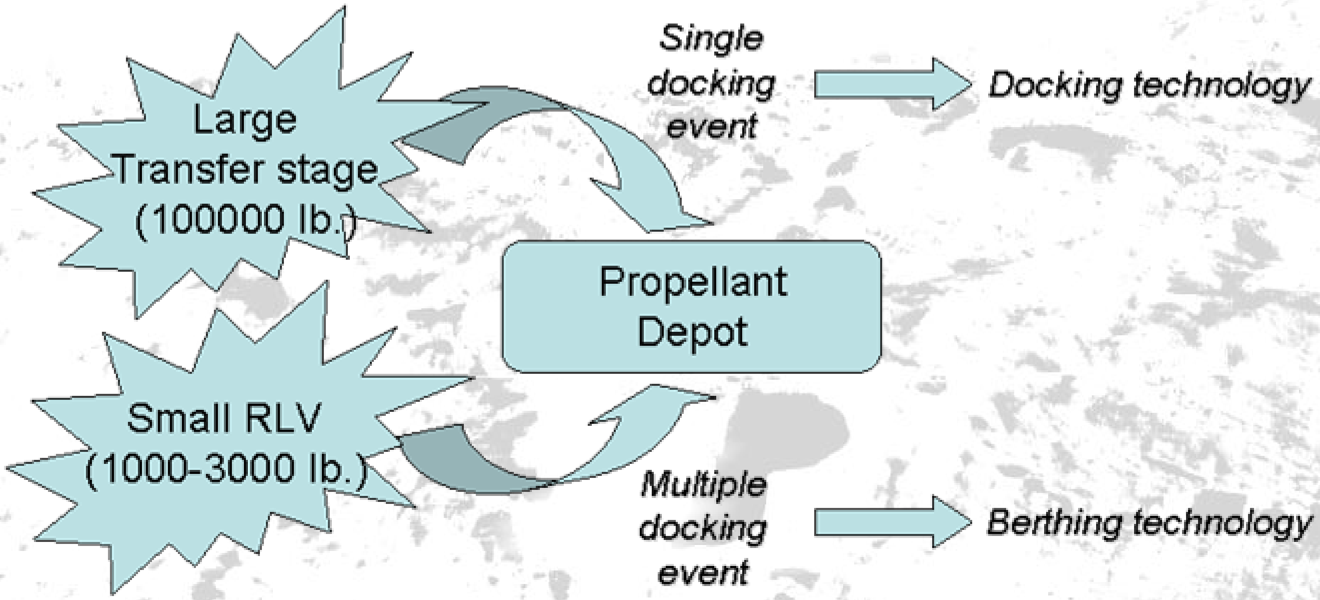
Value added: Decoupling

One of the biggest benefits of a propellant depot, particularly one with fairly decent sized tanks is the *complete decoupling between end-user's vehicle and suppliers' vehicles*.

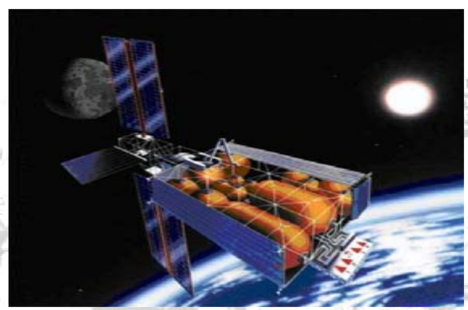
For instance, with a buffer tank like that, you could reasonably use high flight-rate, small RLVs (in the 1000-3000lb payload class) to refuel the depot, while the depot refuels a large transfer stage (e.g. 100,000lb propellant class).

The large transfer stage only has to deal with a single docking event, so the odds of damage to it are much smaller than if it had to handle 30-100 docking events.




N/A

In-space Specifications: Architecture Capability

Requirements	Architecture Capabilities	Trade-offs
GR11 The architecture shall reduce dependency on supplies from Earth by utilization of in-situ resources. [E6] GR12 The architecture shall facilitate the emergence and sustainability of commercial services. [E7]	Propellant Depot 	In-Space Depot of Moon produced propellants with refueling capability to the element of the Transportation Architecture. Options: • Location • Type and mass of propellants

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In-space Specifications: Architecture Capability

Element: Propellant Depot		
Parameter	**Value**	**Note**
Location	L1/LLO, LEO	Options: Depot mated with the orbital infrastructure or stand alone
Typology	Cryogenic, Storable	Tanks + refuelling station. Different propellant to be assessed.
Storage capacity	20 tons in LLO	Of storable propellants. The storage capacity can be increased in time: at beginning, only the landers may be refuelled.
Additional functions	Power Heat rejection Health Management AOCS (*)	(*) if the Depot is free flying for safety reasons

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What next? Key technology development priorities

An in-space propellant depot not only requires technology development in some key areas:

- Zero boil-off storage
- Fluid transfer
- Lightweight structures
- Highly reliable connectors
- Autonomous operations.

These technologies can be applicable to a broad range of propellant depot concepts or specific to a certain design.

In addition, these technologies are required for spacecraft and orbit transfer vehicle propulsion and power systems, and space life support. Generally, applications of this technology require long-term storage, on-orbit fluid transfer and supply, cryogenic propellant production from water, unique instrumentation and autonomous operations.

Cross-disciplinary interest

Vehicle propulsion

Power systems

Life support