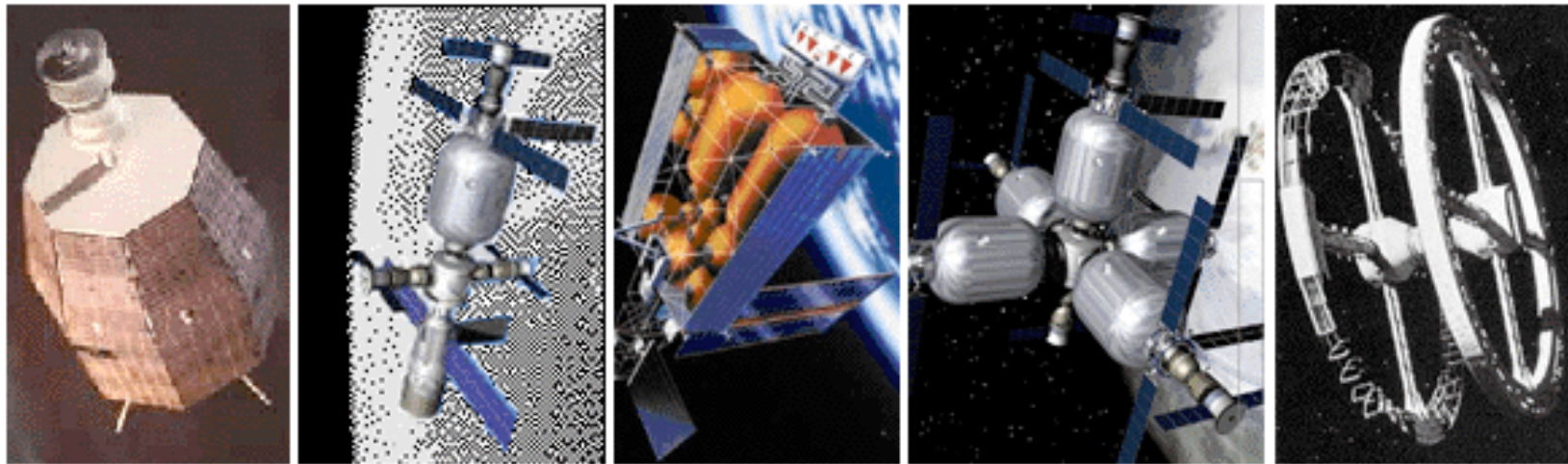


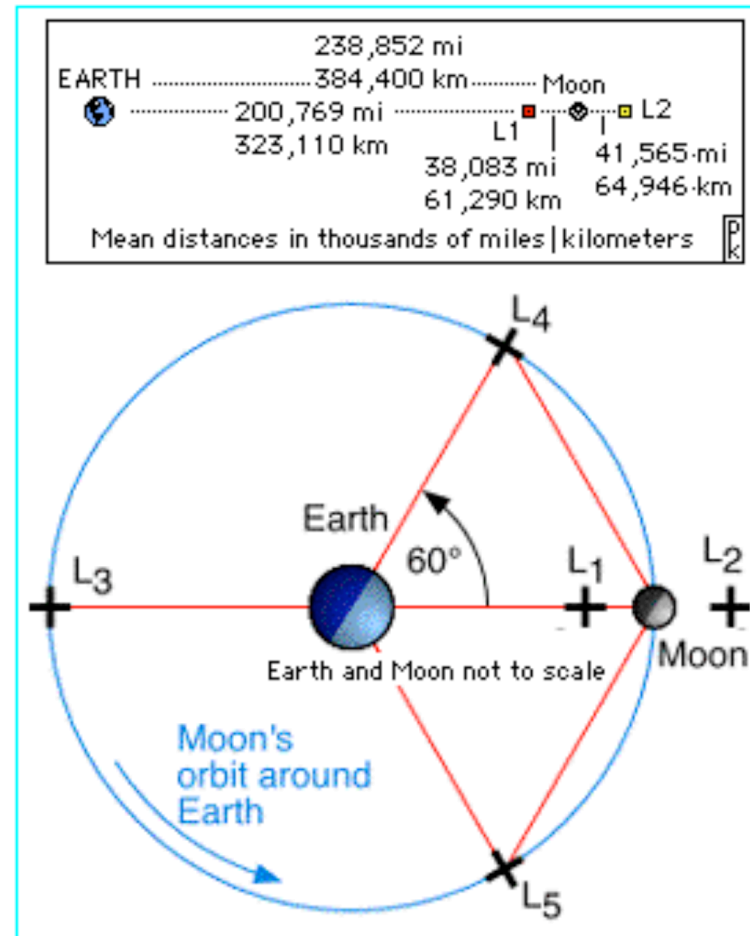
Building an L1 Depot in Phases: growing in step with operations on the Moon's surface

by Peter Kokh

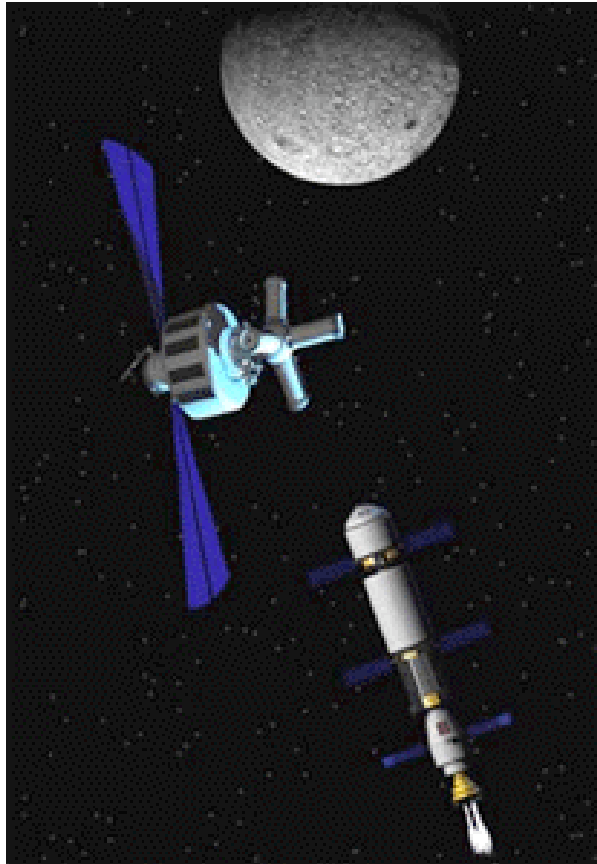


Building an L1 Depot in Phases: Strategic Location of the L1 Lagrange Area

- *“The Earth-Moon L1 point is the physical entry point into the lunar environment.”*
- Badri A. Younes/GSFC
- Here, the gravitational attraction of Earth and that of the Moon balance. Because the Moon’s orbit is not perfectly circular, an object at L1 will tend to “slip off the crest” meaning that some amount of “station-keeping” will be necessary. Nonetheless, L1 offers many strategic advantages, many of them, however, dependent on high traffic.

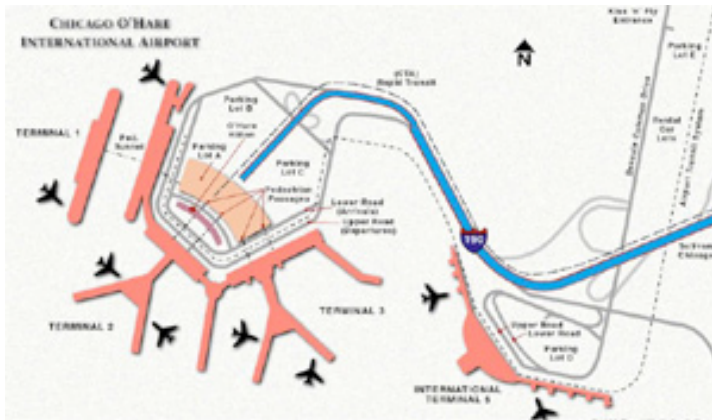


Background: NASA NExT Proposal, October 2002 - a Space Station at L1



- NASA, in an effort to keep busy *doing something*, while waiting for the country to decide between Moon and Mars, came up with a proposal to build a second space station, this one at the L1 Lagrange point.
- The thinking was that such a station would be able to launch missions to either destination.
- But meanwhile, it would have been even more expensive to maintain, while having nowhere to go and nothing useful to do.
- Initial traffic to either world would in no way justify the money and time spent to develop LI, another budget “black hole”

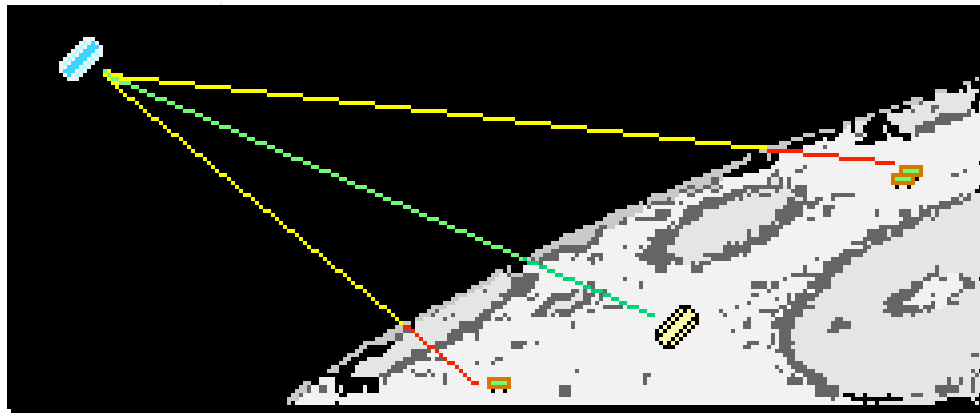
Building an L1 Depot in Phases: Starting with a full buildout makes no sense



- It would have been stupid to build O'Hare airport as we have it today, before the first shovel was turned to build Fort Dearborn at the mouth of the Chicago River in the early 1800s.
- Building another space station (when we didn't bother to complete the first one) before we return to the Moon and deploy our first Lunar Surface Station, and before there is any traffic, would make as little sense,

Building L1 Station in Phases

Upper & Lower Moonbases

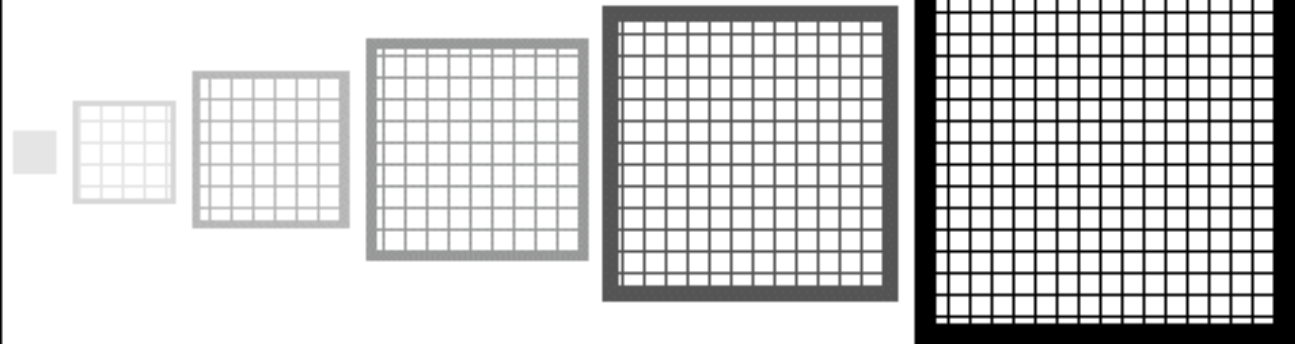


- We should be thinking in terms of a **pair of moon bases**, one on the surface, one parked above the surface in space
- We should **develop both symbiotically** in co-dependence
- Such “**just-in-time**” **side-by-side development** will advance rather than retard the pace at which surface operations expand at and beyond the original settlement site

Building an L1 Depot in Phases: The Sense of the “Just-in-Time” Approach



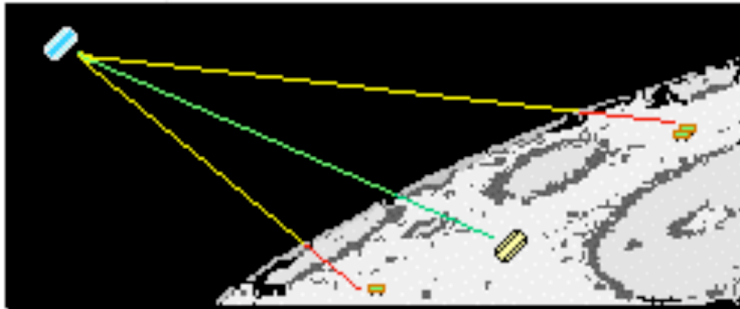
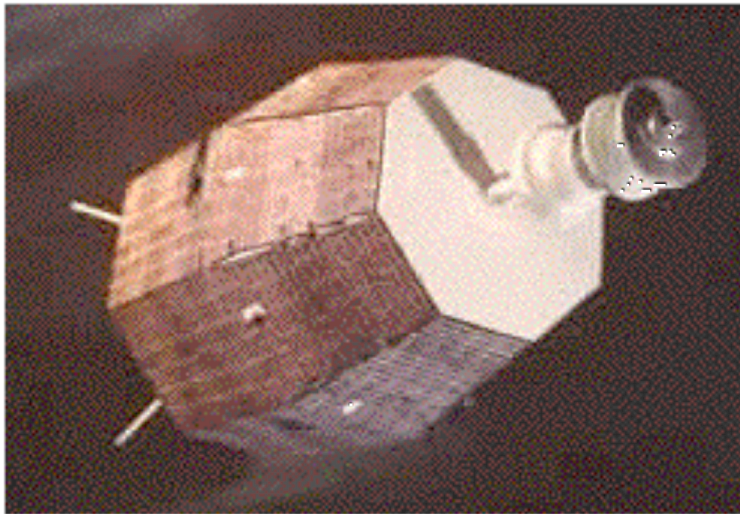
Matching the SERVICES PROVIDED



To those SERVICES NEEDED

Building an L1 Depot in Phases:

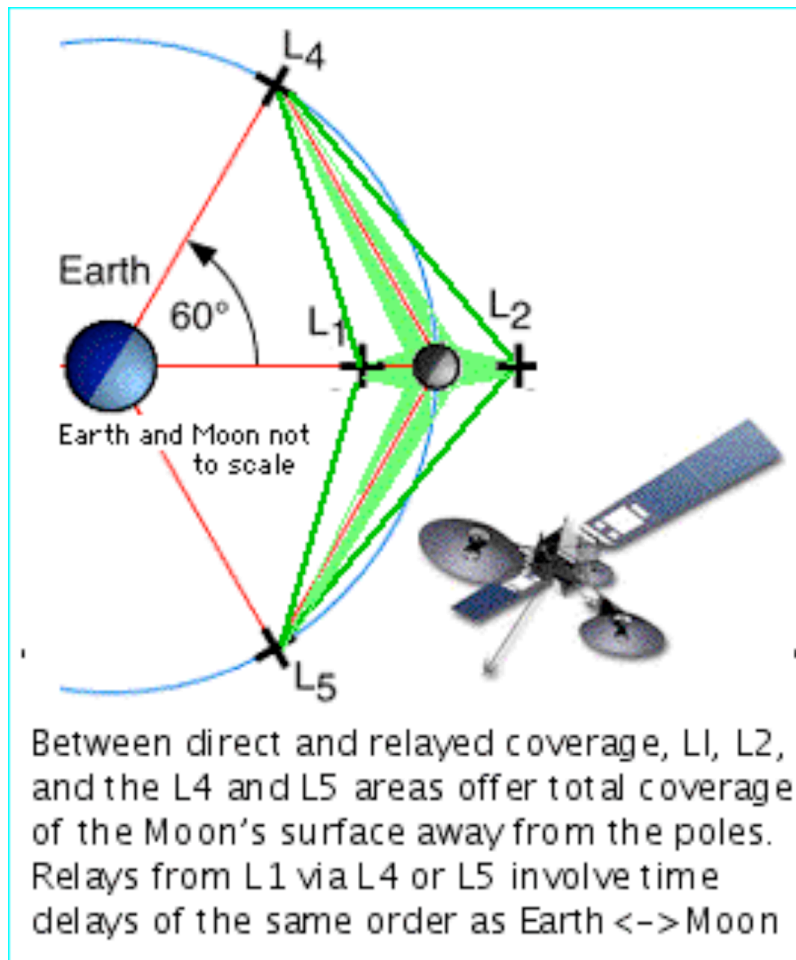
Phase I: a Simple Relay Satellite



- A relay satellite in L1 would need solar panels for power, and possibly an efficient ion drive to be activated as needed for station keeping purposes
- With such a station, **a surface outpost could teleoperate robotic rovers elsewhere on nearside,** whether they were searching for resources, building roads, or preparing a secondary site for use and occupation.
- Thus **a relay sat could extend the operational reach of an outpost**

L1 Gateway: Phase 1:

L1, along with sister relaysats can provide global coverage



- L1 can cover most of nearside
- Similar relays at L4 and L5 would overlap that coverage and reach much of the Moon's Farside
- A relay sat at L2 would close the Farside gap
- Communications between Nearside and Farside would be relayed from L1 and L2 via L4 and/or L5 with time delays on the same order as Earth-Moon communications
- Near polar areas would be poorly served by this system
- These relays could carry visual information as well as data.

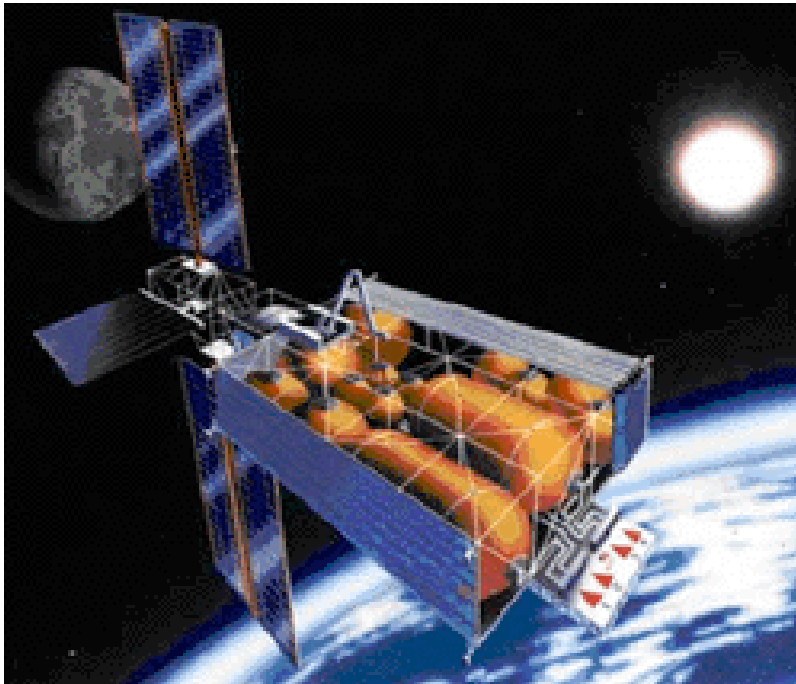
L1 Gateway: Phase 2

a Cache for Supplies

- Once L1 comes to be used as a staging or transfer point between Earth-Moon Ferries and Lunar Landers, it makes sense to begin **storing useful supplies** there:
- **Tools & Equipment** for needed maintenance & repairs
- **Power storage** for recharging batteries and fuel cells
- **Cargo** in either direction waiting to be loaded on another later vehicle
- **Food rations, water**



L1 Gateway: Phase 3 Fuel Depot

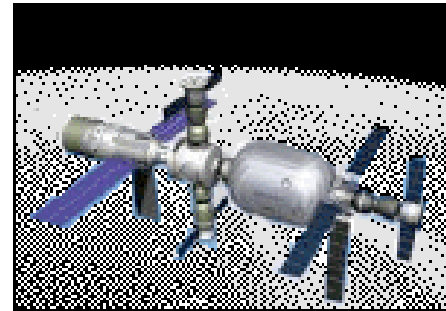


- **Fuel Storage** at L1 could come sooner -- as soon as fuels are produced on the Moon for
- Refueling **lunar landing craft** with retro rocket fuel
- Refueling **Earth-Moon Ferries**
- Refueling **craft bound for Mars**
- For **transshipment to a depot in Low Earth Orbit** for refueling Moon-bound Ferries
- Liquid Oxygen, and Liquid Hydrogen would be priorities
- **Liquid Oxygen** would provide the greatest benefits early on

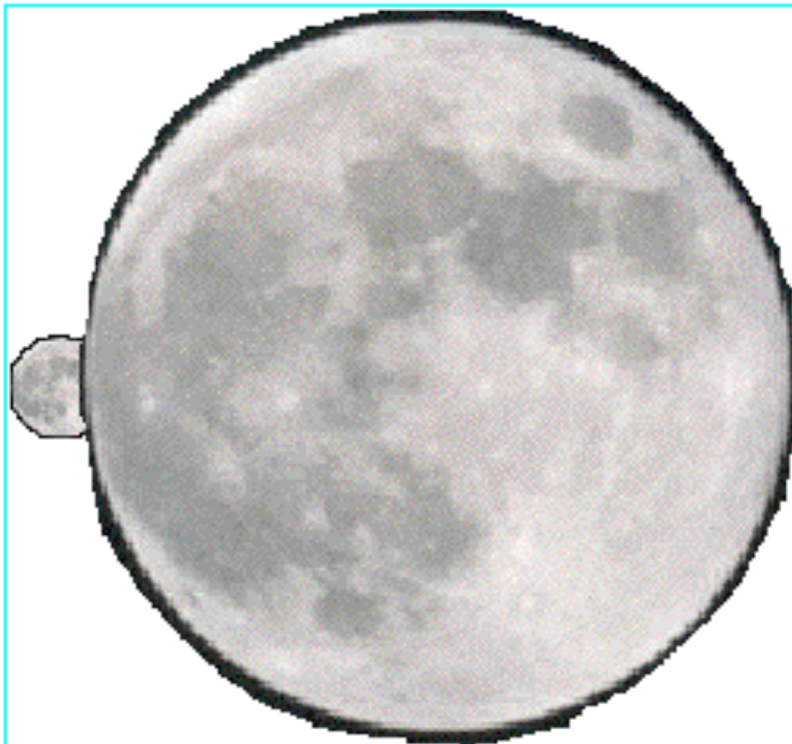
Expanding the L1 Facility:

Phase 4: Intermittent Manning

- As the frequency of traffic warrants, we can provide shelter for crews in transit
- Now we transition from virtual (teleoperated) staffing, to manning when ferries and/or moon landers are cocked
- As all necessary facilities are on board the ferries and landers, shelter might consist of big dumb volume lounge and recreation space
- A “garage” bay could be provided for any needed maintenance

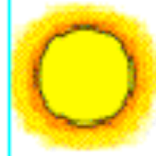


An the L1 Gateway: The Views of Earth and the Moon



The Moon, above, as seen
[left] from Earth and from L1 [right]

PK



[left] The Sun, as seen from all 3 locations

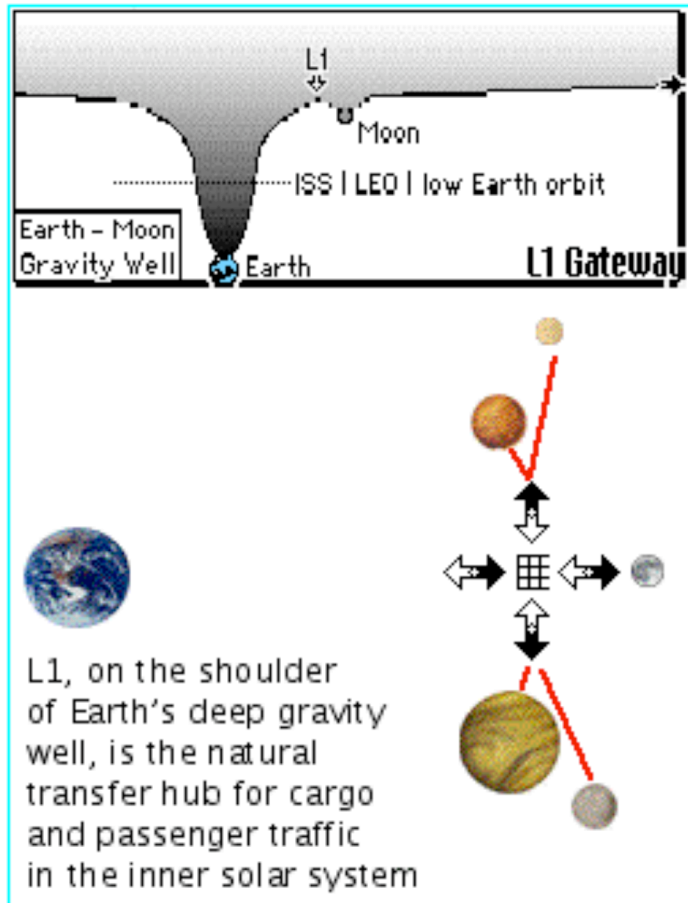
PK

Earth, below, as seen
[left] from the Moon and from L1 [right]



PK

Phase 5: L1 as an Inter-Planet Hub for both Cargo & Passenger Traffic



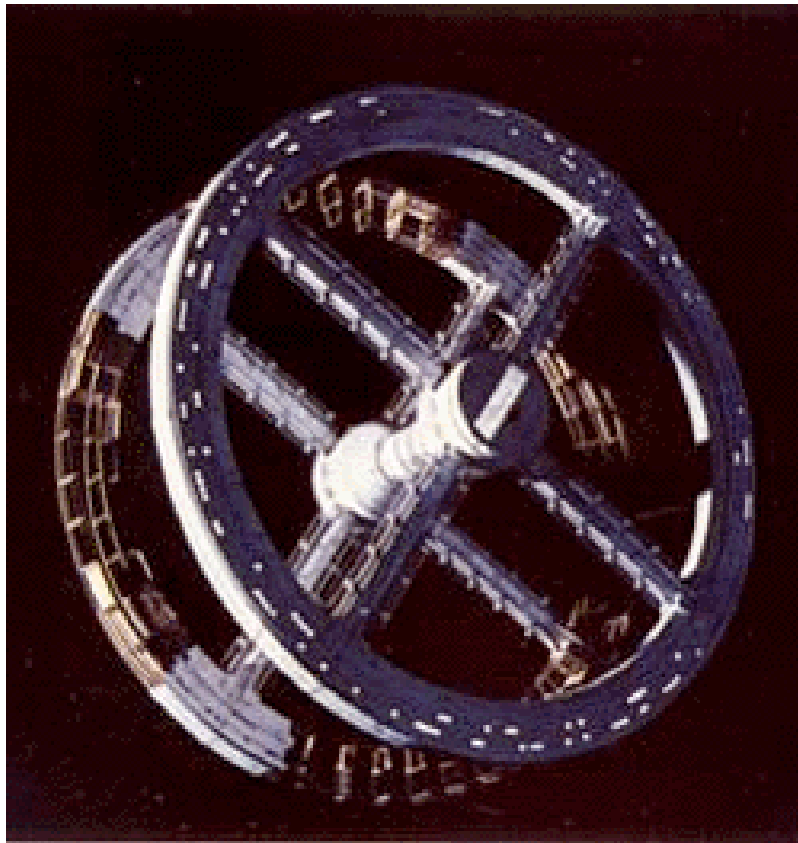
- **Robert A. Heinlein** remarked “once you are in low Earth orbit, you’re half way to anywhere.”

He might have gone on to point out that once you are at L1 you are 90% of the way to anywhere.

In our illustration, L1 perches on a “gravity divide” hill crest, equally handy to the Moon and Mars, and someday to other planets, major moons, and the asteroids

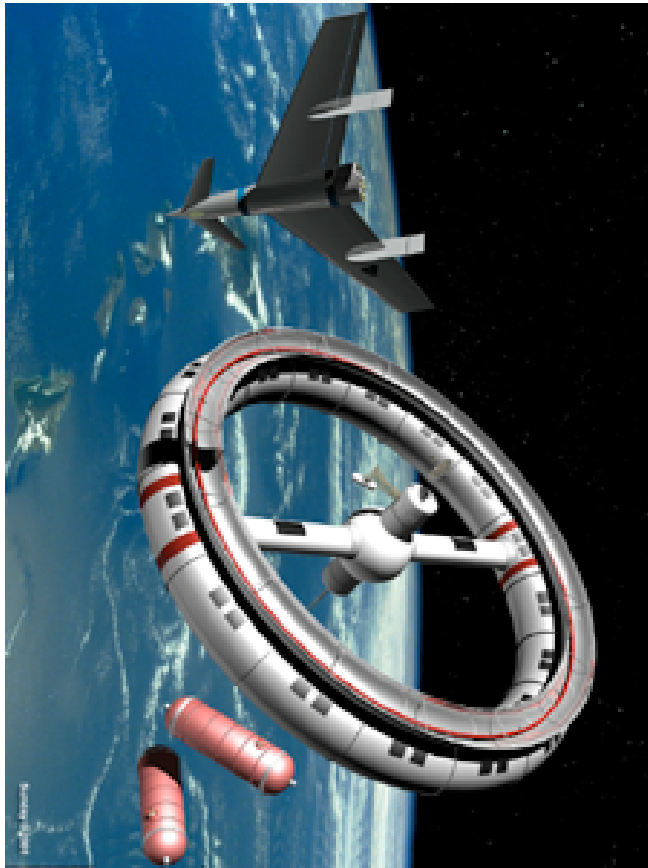
L1 Gateway: Phase 5

Emergence as an Interplanetary Hub



- **Once human exploration of Mars begins to lead to settlement** of a new frontier, the growing traffic will warrant the expense of creating a true interplanetary Hub at L1.
- Here, Mars bound craft can top off their fuel tanks. **This will make sense *if*** it means that they can thereby deliver more people and cargo to destinations in the Mars-Phobos-Deimos system
- Once craft regularly go to and from other solar system destinations, the Hub will have come of age.

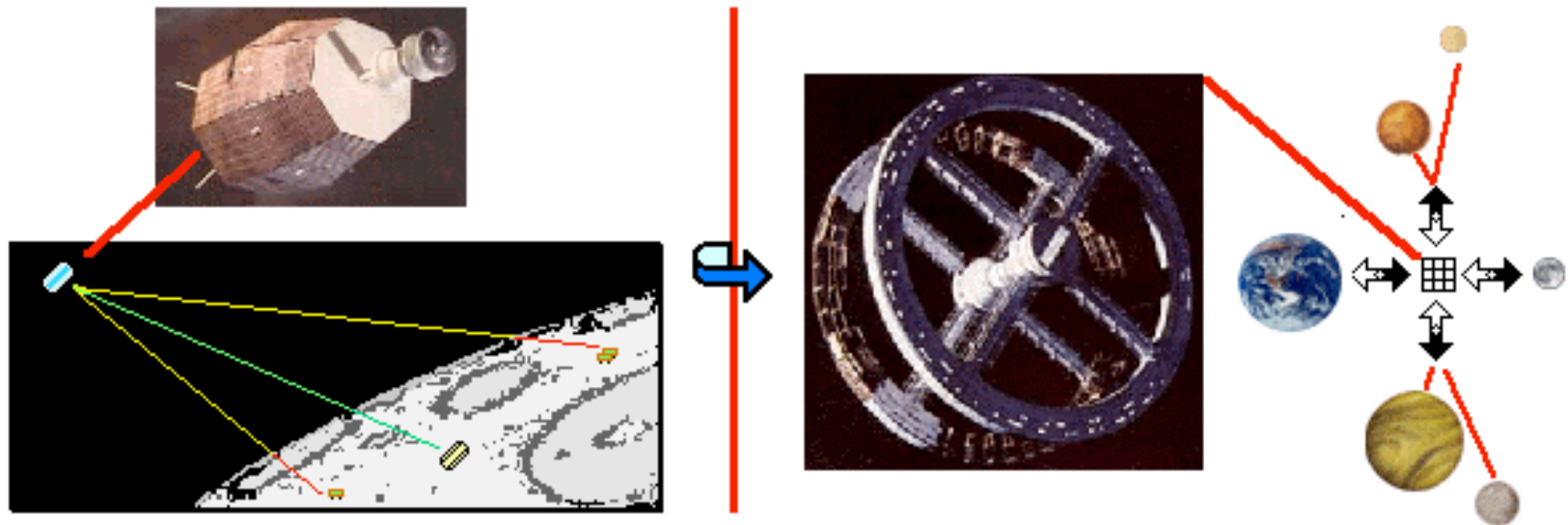
L1 as a developing Interplanetary Hub



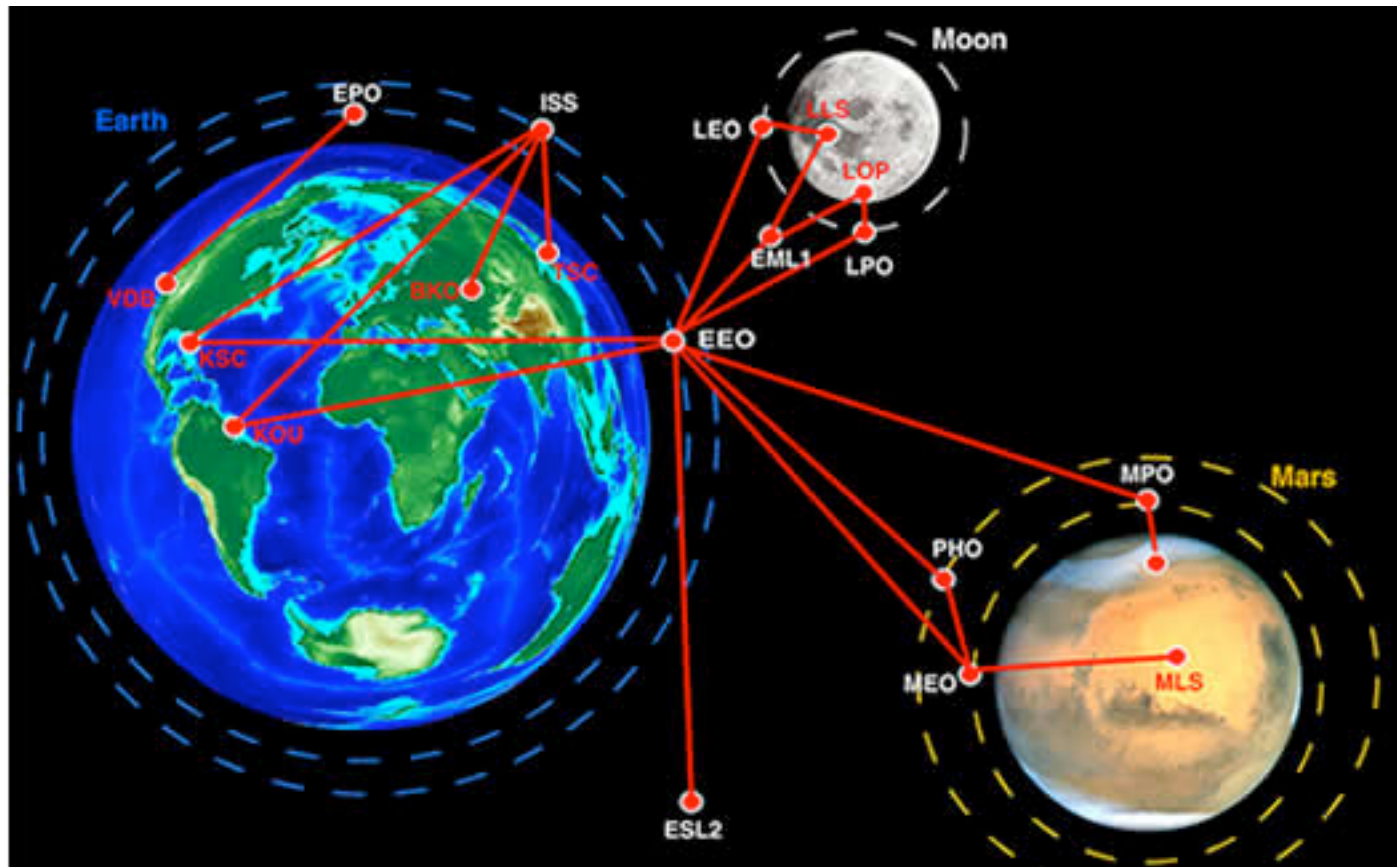
- A Hub is a place where people make connections, but not always timely ones
- As traffic and “the market” demand, the L1 Hub will add all these services:
 - √ hotel
 - √ recreation options
 - √ duty free shops
 - √ chapel
 - √ frequent flyers clubs
 - √ legal services, banks, insurers
 - √ tour agencies
 - √ private lander taxi service

L1 Gateway, *from humble beginnings ...*

- from *far less* than NASA envisioned
- to *far more* than NASA envisioned
- all “*just-in time*” *step by step* as traffic and need requires
- **It’s all about the market**



The Space Hub could be located elsewhere, however
See: <http://spacelogistics.mit.edu/>



Contact Info

- Peter Kokh
KokhMMM@aol.com
(414) 342-0705
1630 N. 32nd St, Milwaukee, WI 53208
- Editor, Moon Miners' Manifesto
www.MoonMinersManifesto.com
- President, The Moon Society
www.MoonSociety.org
- Member, NSS Board of Advisors
www.NSS.org