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Manned mission to Mars in 2019

A Proposal
for the Augustine Commission
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Abstract: This document proposes a world-wide joint and manned mission (including manned landing) to Mars no later than 2019. Instead of a chemical propulsion or a Nuclear Thermal Rocket this proposal suggests a Nuclear Electric Propulsion. The most feasible propulsion system seems to be a nuclear fission powered VASIMR with 200 megawatts of electrical power. By boosting NASA's projected annual budget of $19.1 billion to $23.8 a year from 2010 to 2025, the agency could return to the moon by 2017 and put Man on Mars by 2019. Some of the funding should come from other space agencies.
Keywords: Mars, 2019, VASIMR, NEP

Glossary

A short list of acronyms and their definitions..

CaLV Cargo Launch Vehicle

CLV Crew Launch Vehicle

ESA European Space Agency

ISS International Space Station

JAXA Japan Aerospace Exploration Agency

LEO Low-Earth Orbit

NASA National Aeronautics and Space Agency

NEP Nuclear Electric Propulsion

NTR Nuclear Thermal Rocket

RSA Russian Federal Space Agency

SSC Superconducting Super Collider

VASIMR Variable Specific Impulse Magnetoplasma Rocket

VSE The Vision for Space Exploration

Contents

1 Introduction

1.1 2030s is too far away

On 24th of September 2007 the (then) NASA administrator, Michael Griffin, hinted that NASA could send a crew to Mars in 2037. The purpose of this proposal is to shave almost two decades from that NASA estimate.

Our present generation must be the one to put Man on Mars. We must return to an Apollo-like program with hard goals of manned landing within as short timeframe as possible. As was with the Apollo program, a timeframe of one decade (10 years) is suitable. If it was any longer (for example, more than 15 years), it would be so underfunded it could not resist diversion of money to other places as political winds change. Very long timeframes will cause costly and frequent redesign and bureaucratic process paralyses. These avoidable situations delayed the construction of the International Space Station (ISS), and doomed the Space Station Freedom and Superconducting Super Collider programs (SSC).

1.2 Long duration mission vs. short duration mission

There is no reason for chemical propulsion missions which typically lasts from 500 days to 1000 days. If we want to open the Solar System, we have to develop (sooner rather than later) new propulsion systems so that fast transits to Mars (and beyond) are possible.

Pros and cons of long duration (500–1000-day) missions:

+ propulsion systems already exist?
- long transit is a waste of time for the crew and Mission Control team
- it is not possible to send many crews during a couple of years or so
- problems with the possible zero-g environment (if no artificial gravity)
- problems with cosmic radiation (if no appropriate shielding)
- greater possibility of health problems

- greater possibility of equipment failure
- worse abort scenarios
- large amounts of consumables (water, food, oxygen, etc.) needed

Pros and cons of short duration (less than half a year) missions:

- developing new propulsion systems is expensive and time-consuming
+ it is possible to concentrate more on science (instead of just observing the crew)
+ it is possible to send many crews during a couple of years or so
+ not so much problems with zero-g environment (even if no artificial gravity)
+ not so much problems with cosmic radiation (even if no appropriate shielding)
+ lower possibility of health problems
+ lower possibility of equipment failure
+ better abort scenarios
+ feasible amounts of consumables (water, food, oxygen, etc.) needed

It is a fact that short duration missions are cheaper, safer and more realistic than long duration missions usually proposed.

2 Proposal

2.1 DIRECT launch system

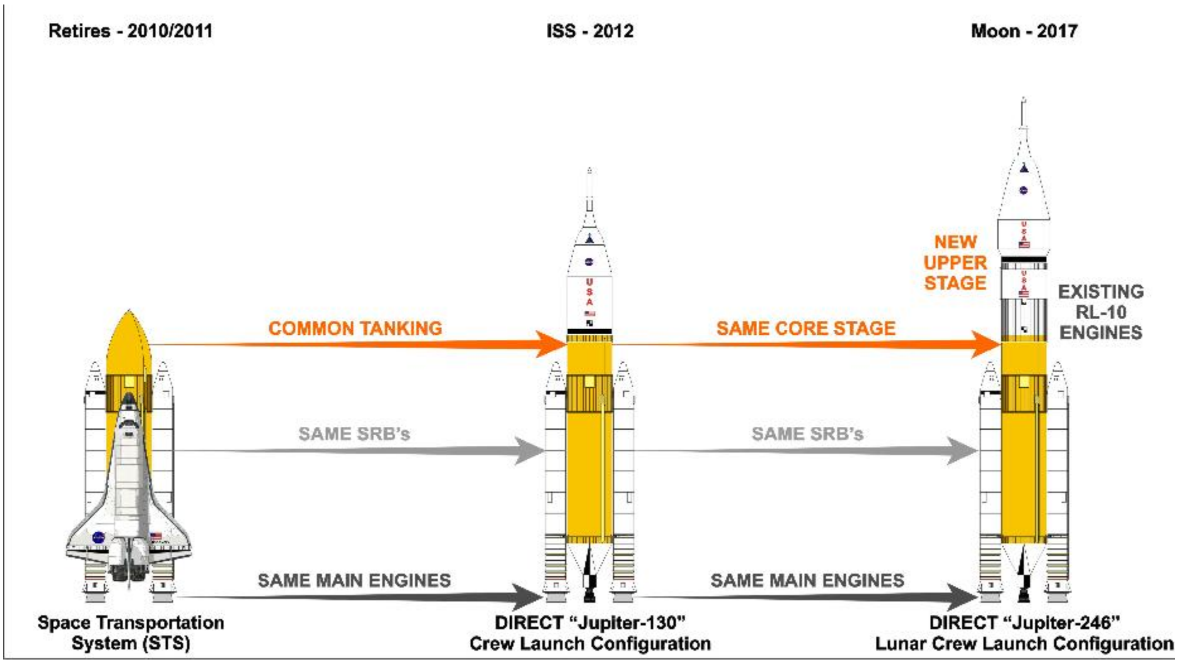

Figure 2.1: The Jupiter common core stage is based heavily on Space Shuttle components.

At the moment (as of 2009) there are no heavy-launch vehicles to put the hundreds of metric tons of payload (needed for the Mars trip) to LEO. The cheapest, the safest, and the simplest way to launch missions planned under NASA's new mandate (VSE) is probably the DIRECT approach. It would replace both Ares I (CLV) and Ares V (CaLV) with one single launcher called Jupiter. The Jupiter launcher would be capable of performing both roles.

2.2 VASIMR thruster

Variable Specific Impulse Magnetoplasma Rocket (VASIMR) is an electro-magnetic thruster, which should bridge the gap between high-thrust, low-specific impulse, and low-thrust, high-specific impulse propulsion systems. It is capable of functioning in either mode. VASIMR is being developed by the Ad Astra Rocket Company, which was founded by the former space shuttle astronaut Franklin Chang-Díaz.

A ship with VASIMR and 12 megawatts of electrical power could reach Mars in about four months. With 200 megawatts of electrical power, the outbound trip could be only 39 days.

Potential applications include

- Drag compensation for space stations.
- Lunar cargo transport.
- In-space refueling.
- In-space resource recover.
- Ultra high speed transportation for deep space missions.

2.3 Nuclear fission power

200 megawatts of electrical power is needed to power a VASIMR thruster for a fast transit to Mars. The best way to produce this much of power is to use nuclear fission reactor(s).

Currently (as of 2009), SNAP-10A is the only nuclear reactor launched and flight tested by the United States. It was launched on 3rd of April 1965 and it provided about 500 watts of electrical power. The failure of an onboard voltage regulator (within the spacecraft) had nothing to do with the SNAP fission reactor itself. The reactor core has been shut down since and it is expected to remain in the orbit for about 4000 years.

Nuclear fission reactors are not very radioactive, before they are activated, which will happen after they are safely in LEO, so they do not pose environmental risks. Radioisotope thermoelectric generators (RTGs) are much more dangerous, because they are already radioactive during the lift-off from Earth to LEO. RTGs are used in many spacecrafts.

Of course, one alternative is to use solar arrays, but a solar array grid to power the 200 MWe VASIMR is too massive.

3 Discussion

3.1 Some open questions

- Is co-operation really better than no co-operation?
- How massive is a 200 MWe VASIMR thruster?
- How many years does it take to build and test a 200 MWe VASIMR thruster?
- How massive is the radiator to dissipate the waste heat of this VASIMR system?
- Are there any other (fast transit) thrusters that are feasible to build in the early 2010s?

3.2 Big questions

There are some big questions left.

- How to get funding?
- How to land safely on Mars?
- How to ascent safely from Mars?

To the first question: Give NASA a $75 billion boost: By boosting NASA's projected annual budget of $19.1 billion to $23.8 a year from 2010 to 2025, the agency could return to the moon by 2017 and put Man on Mars by 2019. Of course, this is not enough for a manned mission to Mars, but if the rest of the funding comes from other space agencies (ESA, RSA, JAXA, etc.), the mission may be feasible.

Scenario	Average Annual Funding, 2010 to 2025 (Billions of 2009 dollars)	Ares 1's and Orion's IOC	Humans' Return to the Moon	No. of Science Missions Through 2025	Space Shuttle's Retirement	End of Support for ISS
NASA's Plans	19.1	March 2015	2020	79	September 2010	December 2015
Scenario 1: Keep Funding Fixed and Allow Schedules to Slip	19.1	Late 2016	2023	64	September 2010	December 2015
Scenario 2: Execute NASA's Current Plans and Extend Operation of the Shuttle and Space Station	23.8	March 2015	2020	79	March 2015	December 2020
Scenario 3: Achieve the Constellaion Program's Schedule and Allow the Science Schedule to Slip	21.1	March 2015	2020	64	September 2010	December 2015
Scenario 4: Absorb Cost Growth to Achieve Constellation's Schedule by Reducing Funding for Science and Aeronautics	19.1	March 2015	2020	44	September 2010	December 2015
Scenario 5: Execute NASA's Current Plans as a DIRECT approach, and do not Extend Operation of the Shuttle and Space Station, instead use the extra funds for a manned Mars mission	23.8	N/A	2017	79?	September 2010	December 2015

NASA needs \$3.3 billion annually from 2011 to 2015 to fly the shuttle to the International Space Station three times each year. This makes 16.5 billion dollars. Some industry experts have also recommended that NASA continue to support the International Space Station until December 2020 instead of ending that support after December 2015. NASA would require additional funding averaging about \$1.4 billion annually from 2016 to 2020. This makes 7 billion dollars. The total costs are \$16.5 billion + \$7.0 billion = \$23.5 billion. This money should be put to the manned Mars mission.

It is difficult to answer to the other questions (how to descent/ascent safely?).

4 Conclusions

4.1 A short summary

The new decade (the 2010s) has not started yet, so we still may be able to put humans on Mars, before the end of the new decade. This is not going to be easy nor cheap, but we have to do it. This document proposes a fast transit to Mars by using a propulsion technology that starts to be mature in the beginning of the 2010s. Nuclear fission reactors as a power source could easily be done today. The three biggest problems are a) how to get funding?, b) how to land on Mars safely?, and c) how to ascent from Mars safely?. It is not easy to find a solution to these problems.

4.2 Things to do in 2009 and the early 2010s

- Solve the funding problems and choose between international co-operation or no co-operation (no later than 2009).
- Choose a target year for the manned Mars mission (2019) and stick to it.
- Choose the DIRECT approach for heavy-launch vehicles (no later than 2009).
- Start to develop (no later than 2009) a safe way to land a crew on Mars.
- Start to develop (no later than 2010) a multi-mega watt fission reactor for space.
- Test the VF-200 VASIMR thruster on ISS as soon as possible (no later than 2011).
- Start to develop (no later than 2011) a multi-mega watt capable VASIMR thruster after testing VF-200 on ISS.