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A Minimal Architecture for Human Journeys to Mars

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A Minimal Architecture for Human Journeys to Mars

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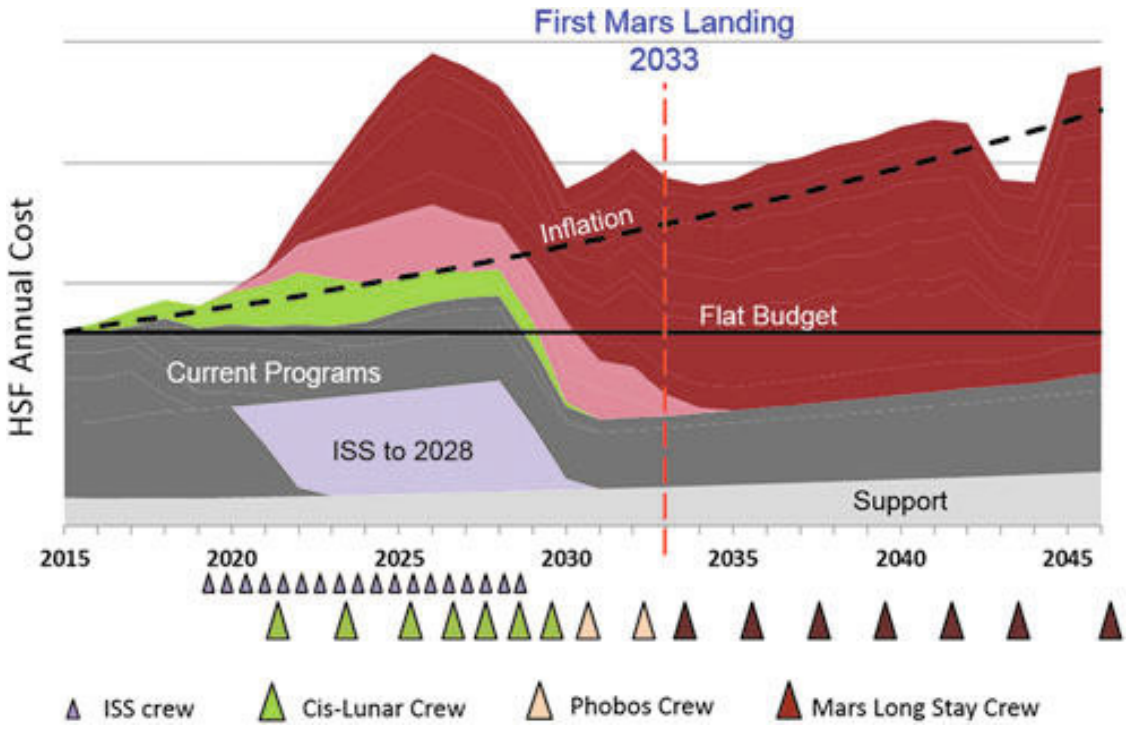
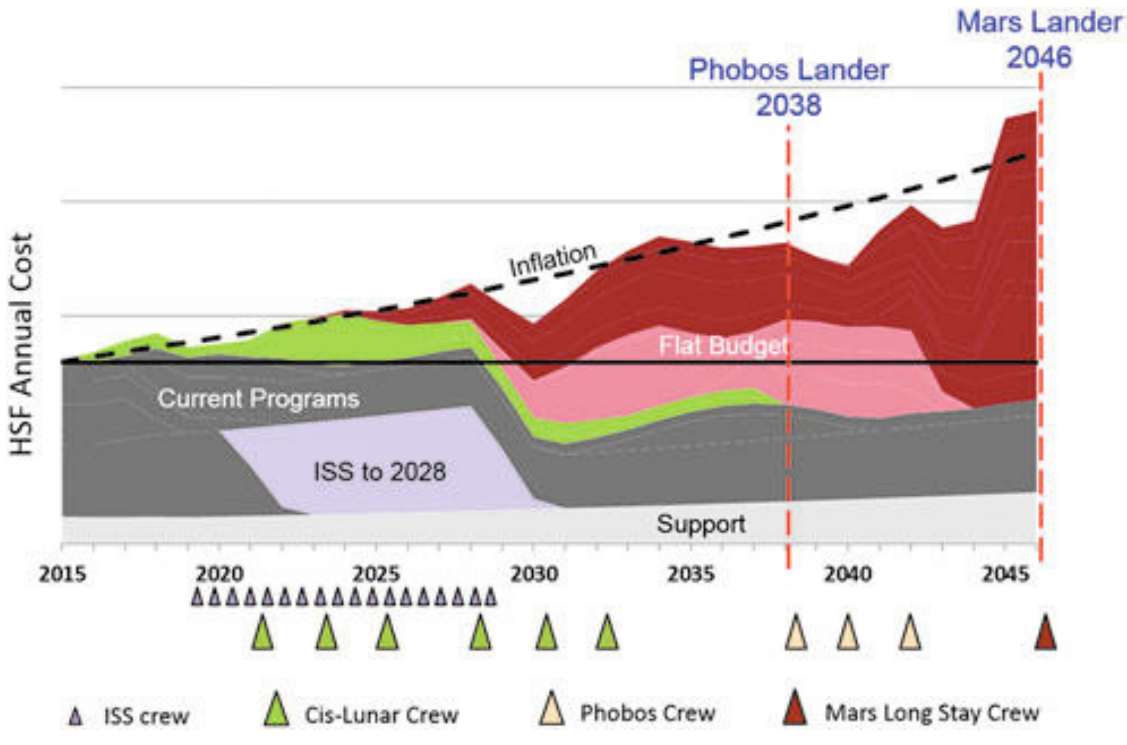
Background



In response to a Congressional charter to assess America's human spaceflight (HSF) program, the National Research Council (NRC) recently published its study findings in a report titled "Pathways to Exploration",1 in which multiple pathways were assessed to land humans on Mars. The results were sobering: Using Design Reference Architecture 5 (DRA-5) as the technical baseline,2 the cost for options that meet an early schedule (landing on Mars by 2033) peak well above the current annual HSF budget adjusted for inflation (Fig. 1). With the annual budget constrained, the schedule pushes out to near mid-century (Fig. 2).



Barring some compelling geopolitical phenomenon, there is not likely to be another "Kennedy moment", and the NASA budget is unlikely to see a dramatic increase. This was the motivation for this study of a "minimal architecture" based on a high technology readiness level and the concept of staggered mission campaigns, in order to stay close to the current HSF annual budget adjusted for inflation.

A Stepwise Approach

Getting a human crew to Mars orbit and then safely back to Earth poses significant technical challenges for the first mission. If one adds the challenges of landing a crew on the surface of Mars, conducting surface operations, and then lifting them off the surface all on that first mission, then it becomes an unaffordable first step to the red planet. To spread out the technical risk and also the annual cost, we have examined a stepwise approach as described below:

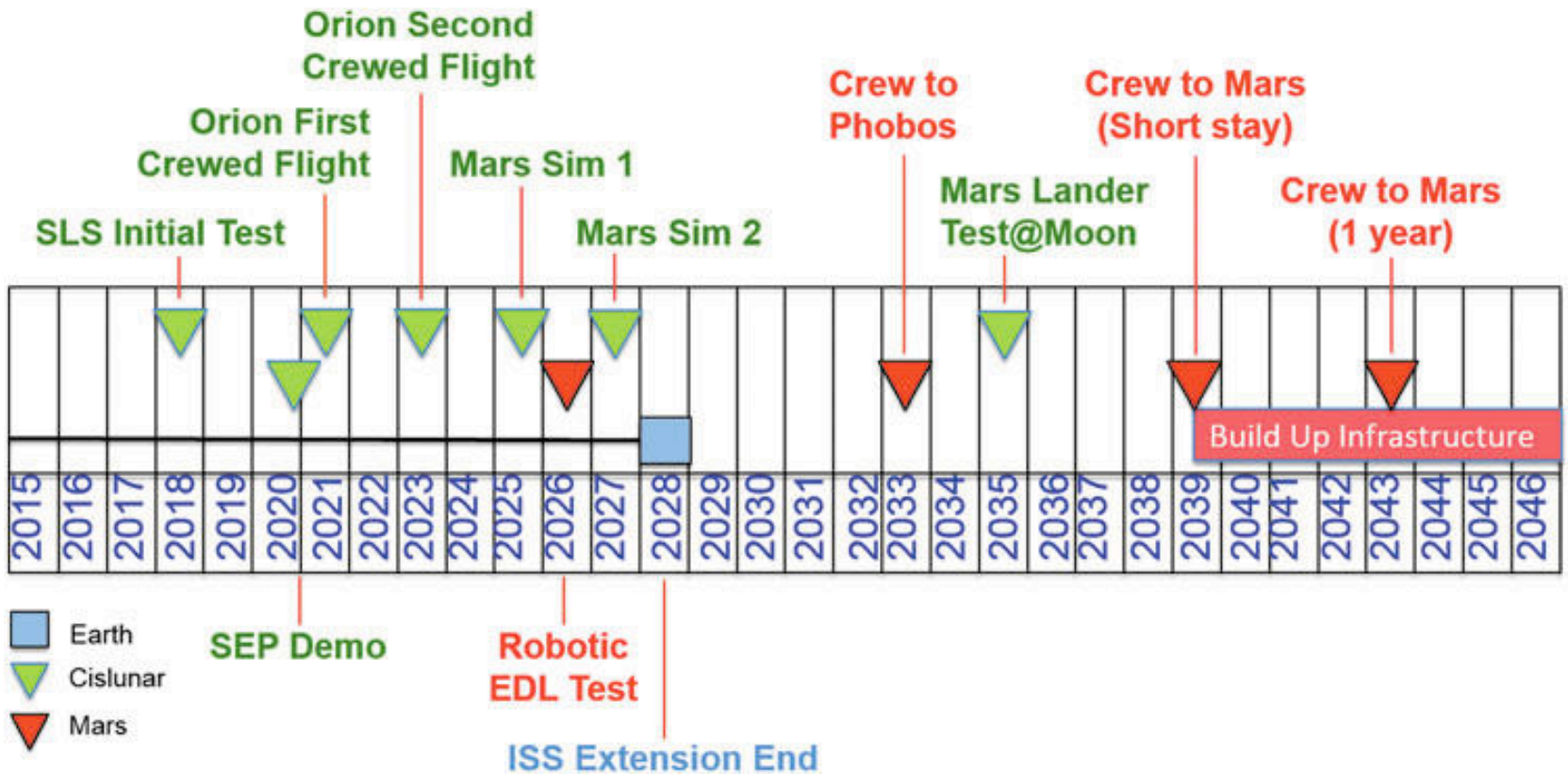
- a round trip to Mars orbit with a crew of four and a landing on Phobos;
- a one-month surface-stay mission with a crew of two on Mars; and
- a four-crew, one-year surface-stay mission.

These campaigns would be supported by the following earlier missions/activities:

- International Space Station research, technology development, and risk reduction;
- flight testing of a 50kWe version of the solar electric propulsion (SEP) vehicle in interplanetary space with crewed docking operations in cislunar space—this would be executed as part of the asteroid redirect mission (ARM) or, absent that, as a technology demonstration mission;
- a robotic test of the Mars lander entry and supersonic retro-propulsion (SRP) technology at Mars;
- a dress rehearsal and test flight of the first Mars landing system performed as a crewed landing on Earth's moon; and
- crewed testing of a deep space habitat (DSH) in cislunar space.

Figure 3 shows the proposed schedule for each of these steps starting with the International Space Station (ISS), which would continue to provide invaluable research and risk reduction for human missions to Mars through 2028. Initial test flights of the SLS and Orion systems would start in 2018 and continue through 2025, leading to the next phase, which would be the checkout of a deep space habitat prototype to test the system and validate the technologies (e.g., regenerative life support, radiation shielding) to support crewed missions to Mars. Two simulated Mars missions would be conducted in cislunar space, relatively close to Earth to provide abort op-

portunities, to validate the systems required for the 900-day missions. A robotic mission to Mars would be conducted to test the entry and SRP technology needed to reduce the risk for a human landing on Mars. Finally, a system test of the Mars lander would be performed at Earth's moon to validate the system design of the Mars lander. This approach provides a reasonable cadence of flight opportunities for astronauts on both the ISS and in cislunar space through 2029 prior to sending astronauts to Phobos in 2033.



Mission to Phobos

The Phobos mission concept is illustrated in Figure 4 and described in more detail in Price et al.3 Key attributes of the campaign would include:

- proving out the method for getting to Mars orbit and back;
- serving as a precursor to Mars landing campaigns;
- using four SLS launches;
- prepositioning assets in Mars system using SEP tugs prior to crew arrival; and
- round-trip mission length of about 2.5 years, including

about a 300-day stay at Phobos.

Each of the four SLS Block 2 launches and the mission phases are described in the following sections.

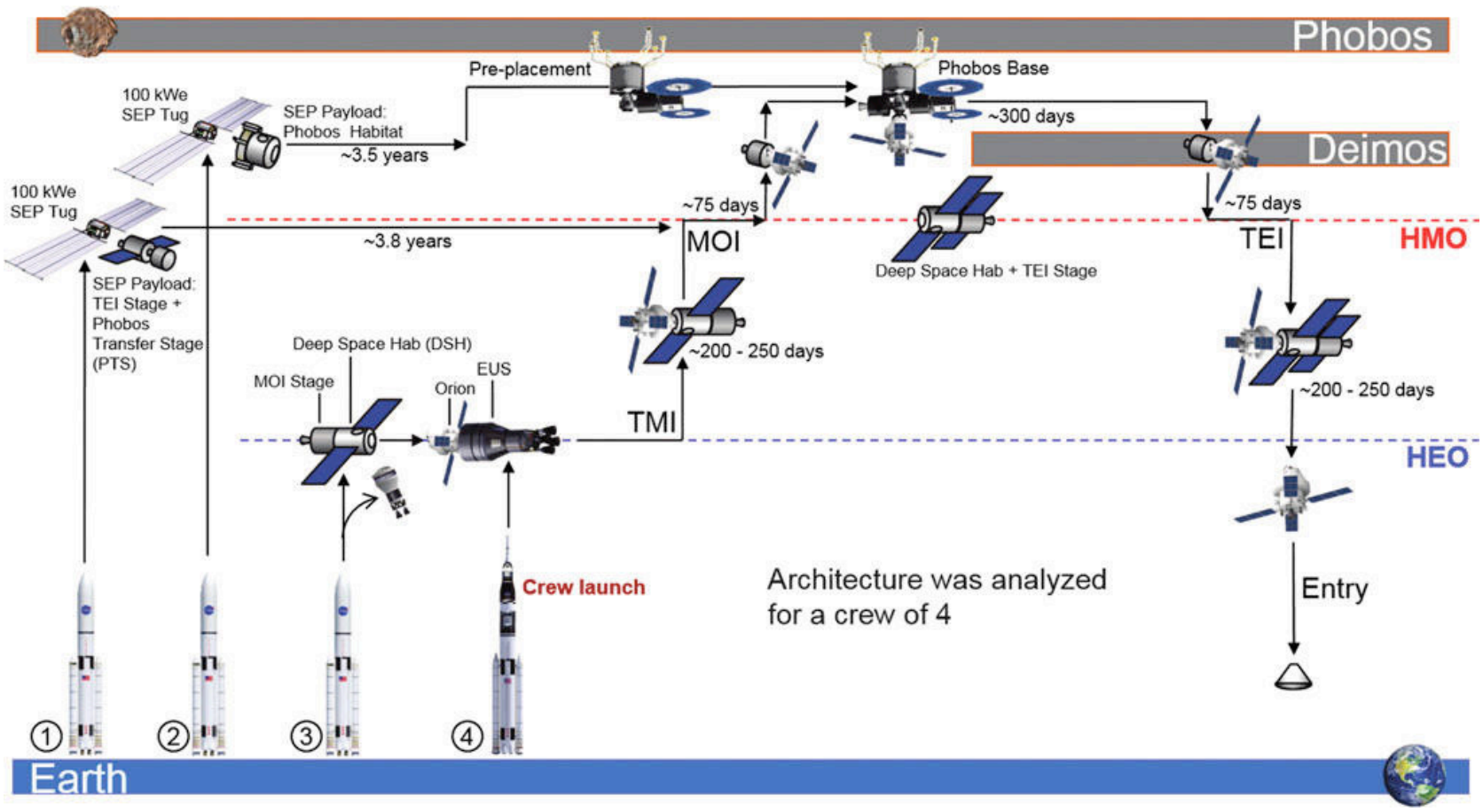
Launch #1: The SLS would inject a 100 kWe SEP Tug and its payload to Earth escape. The payload would be two in-space chemical stages to be prepositioned for use later in the campaign: (1) A Phobos transfer stage (PTS) to get a crewed Orion from high mars orbit (HMO) to Phobos and later back to HMO, and (2) A trans-

earth injection (TEI) stage for returning crew to Earth at the conclusion of Mars operations. The SEP tug would transfer its payload to HMO with a trip time of about 3.8 years.

Launch #2: This SLS launch would be similar to Launch #1 except that the SEP payload would be the Phobos Habitat. The SEP tug would preposition the habitat on Phobos and remain with the habitat to provide power and the capability for relocation. The habitat would be a common design with the deep space habitat (DSH) that transfers the crew to Mars and back.

Launch #3: The payload for this launch would be: (1) the DSH and (2) the Mars orbit insertion (MOI) stage. The SLS would launch this payload to High earth orbit (HEO) where it would loiter and wait for the crew arriving on the fourth launch.

Launch #4: An Orion with a crew of four would be launched to HEO to dock with the DSH and MOI stage. The exploration upper stage (EUS) would have sufficient propellant remaining to perform the trans-mars injection (TMI) burn to send the combined vehicle stack to Mars. The transit time would be about 200–250 days, and then the MOI stage would be used to inject the crewed assembly into HMO.

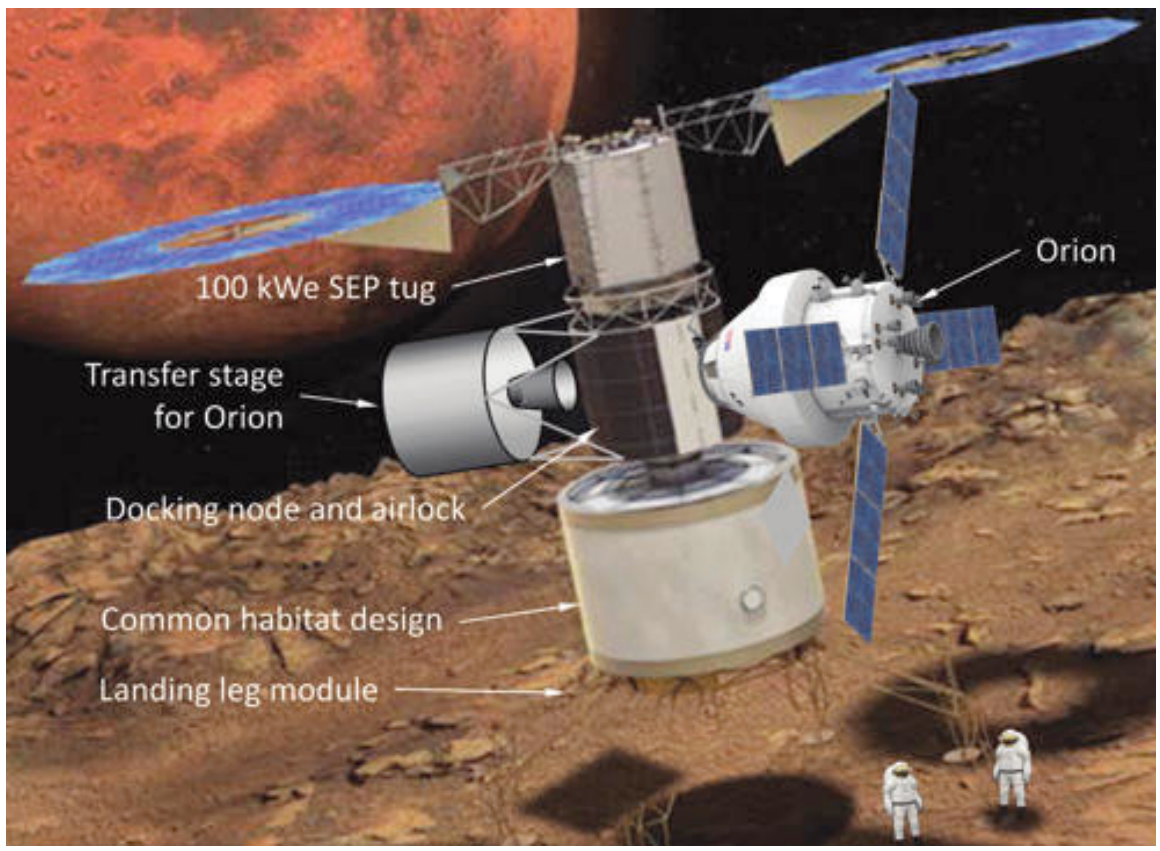


Mars orbit and Phobos mission phases: Meeting up with the chemical stages pre-positioned by Launch #1, the vehicles would be reconfigured in HMO so that the TMI stage is docked to the DSH, and Orion with crew is docked with the Phobos transfer stage. The Phobos transfer stage would take the Orion and crew to the Pho-

bos habitat, already put in place by Launch #2.

After arrival at the Phobos habitat, the transfer stage would be docked in a parking location on the habitat, and the Orion would dock to an entry hatch to the habitat (Fig. 5). The crew would live in the habitat for about 1 year and perform an extensive science mission there, including extra vehicular activities (EVAs) on the surface. Science observations and goals for crewed Phobos exploration have been described by Abercromby et al4. While at the Phobos base, the Martian moon would provide radiation shielding for at least half of their exposure field of view to the space environment.

At the conclusion of their Phobos stay, the crew would redock with the parked transfer stage and use the remaining propellant to return in the Orion to HMO to dock with the transit habitat and the TEI stage, potentially stopping at Deimos on the way back. The Phobos habitat would remain in place for potential reuse.



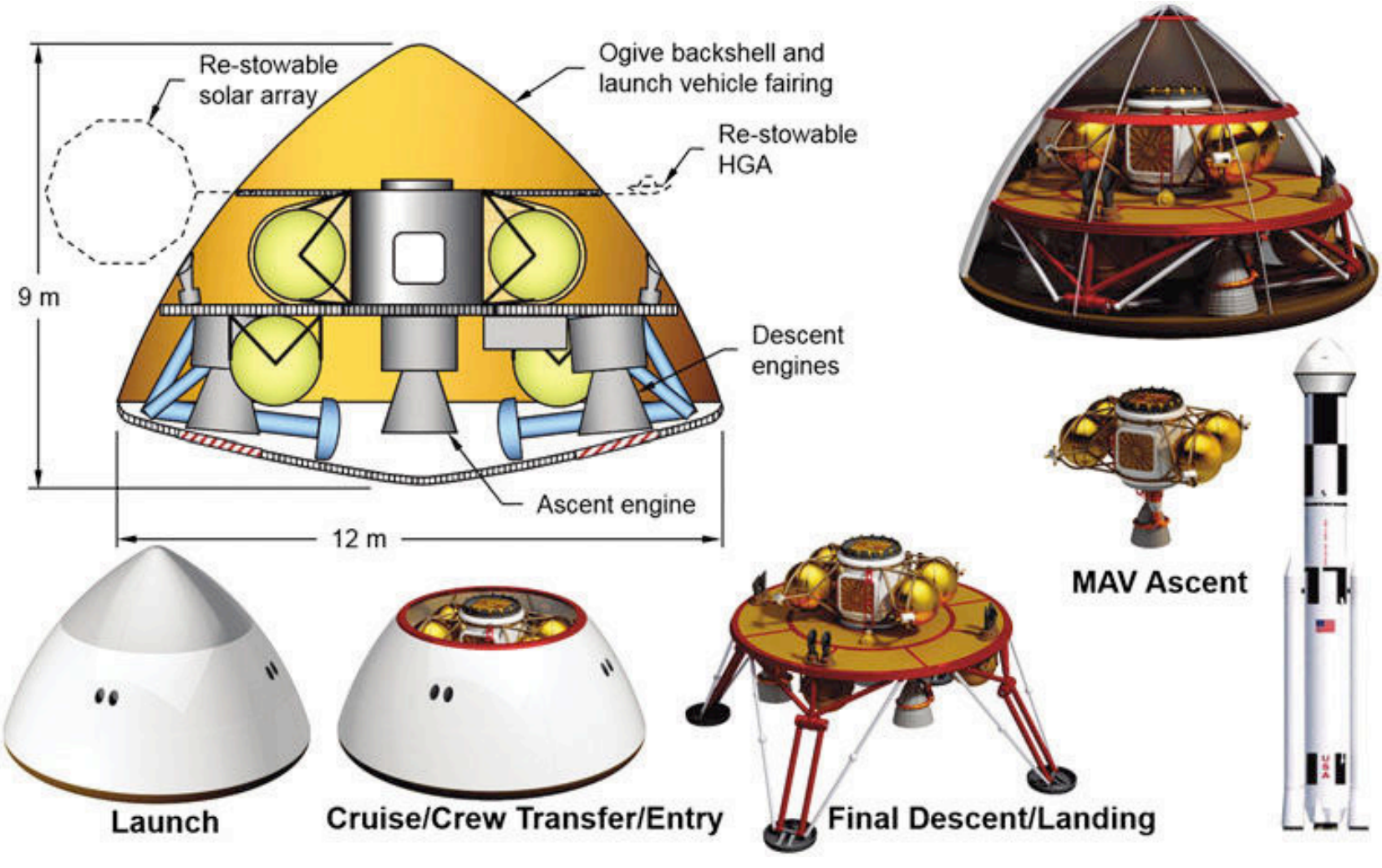
Return phase: At the conclusion of the 500-day stay in the Mars system, the TEI stage would be used to send the Orion and DSH on a return trajectory to Earth. After about a 250-day transit, the crew would perform a direct Earth entry and landing in the Orion crew module (CM).

Potential reuse: If there is adequate mass margin, a small amount of additional Xenon propellant in the SEP tugs would enable them to be returned to Earth orbit or lunar orbit for possible refurbishment, refueling, and reuse. Additionally, if a deflection maneuver is performed on the returning deep space habitat, it could potentially be recovered by one of the returning SEP tugs and also returned to Earth or lunar orbit for possible reuse.

Other options were considered for a Mars orbiting mission. One option focused on teleoperation of robotic assets without crewed Phobos exploration. This would likely result in a lower cost mission. A short-stay variant of this option was also assessed, spending only about 1 month in Mars orbit before heading back to Earth, but this requires an extra Earth return stage and a Venus gravity assist, which presents thermal control risks. Options for crewed retrieval of robotically orbited Mars samples have been studied, and that could be part of the mission if additional delta V can be allocated for the crewed Mars orbital operations.

Mars Lander Concept

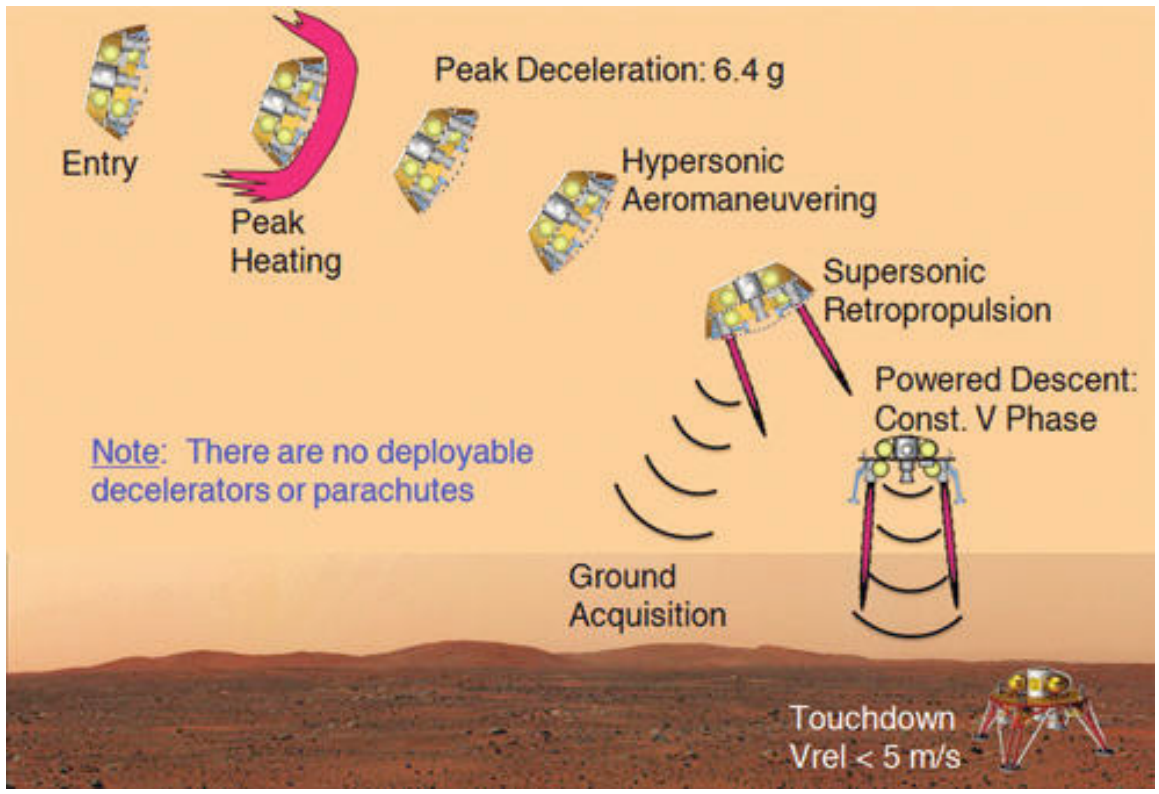
The lander concept (see Fig. 6) used in this example is a 12 m diameter traditional blunt-body entry vehicle with a heat shield that is scaled up from the Mars science laboratory (MSL) design. There would be no parachutes or deployable aerodynamic decelerators. The lander would perform a lifting descent and be steered to a precision landing. At about Mach 2, supersonic retro-propulsion (SRP) rockets would be ignited to perform the final descent and landing. Supersonic retropropulsion has been validated to some extent by Space X in their flight tests to return their first stage boosters for reuse. The upper atmosphere conditions for a portion of the Space X SRP profile are a good analog for the Mars atmosphere during SRP for a lander.



The propellants in this concept would be MMH and MON-25, using current technology pump-fed engines similar to the RS-725 or the Proton 3rd stage engine. It is assumed that some significant engine development work or modifications would

be required. The lander would have about a 75-ton entry mass and deliver a useful landed payload mass of about 23t. Because of its size, the lander would be launched in a "hammerhead" configuration on the SLS. Its ogive-shaped back shell would also serve as the launch fairing. This basic lander design would be used for both crew and cargo landers to the martian surface in the mission sets described here.

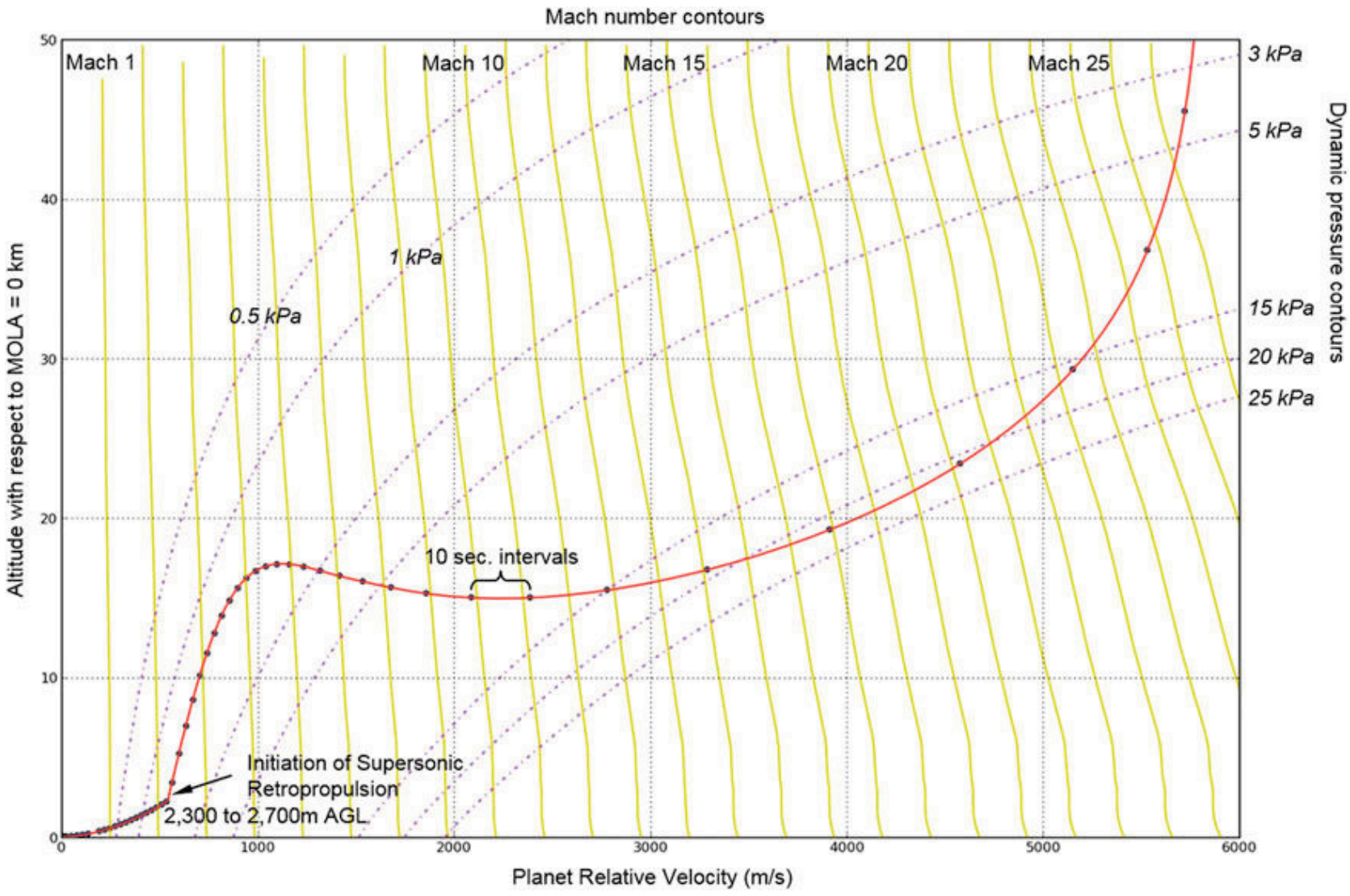
The lander design was assessed with a Monte Carlo simulation of the entry, descent, and landing (EDL) profile using the scenario depicted in Figure 7. The design was shown to close within the parameters of the simulation. A representative EDL profile is shown in Figure 8. In this chart, time moves from right to left. The vehicle enters the Mars atmosphere in the upper right, follows the curve, and then lands on the surface on the lower left corner of the plot. Contours of Mach numbers and dynamic pressure are indicated on the plot, along with tick marks for every 10 seconds of time.



The EDL case considered here did not include any deployable parachutes or decelerators. It is possible that the use of an inflatable aerodynamic decelerator, perhaps an advanced version of that being developed by the low density supersonic decelerator (LDSD) program, could improve the performance of a lander in this class.

The Mars ascent vehicle (MAV) would use the same propellant type and the same engine type as the descent stage. It would provide a single-stage ascent to a low mars orbit (LMO). There the MAV would dock with a prepositioned boost stage to perform a second set of burns to take the MAV to HMO and transfer the crew back to Orion and the DSH. Since this MAV concept carries a full propellant load, the lander could potentially perform abort-to-orbit at some points in the EDL profile and also after landing. Note that using a two-step ascent—first to LMO and then boosted to HMO—avoids taking extra propellant to the surface, enabling a more

mass-efficient and smaller lander and ascent vehicle.



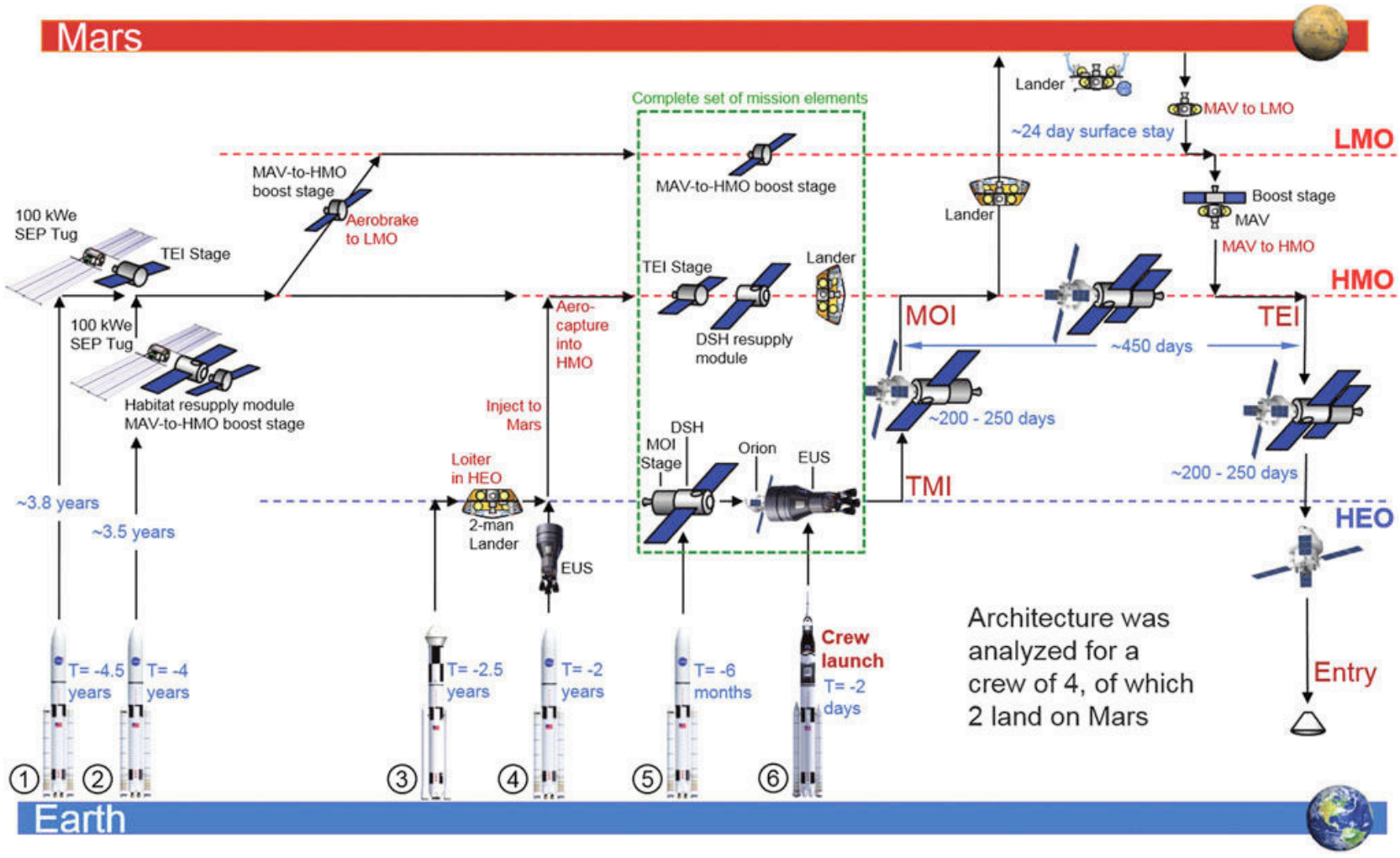
The MAV crew cabin in this example is mass limited, and there is a tradeoff between the number of crew members it can support versus the number of days of life support consumables it can carry. The 23 t MAV is estimated to be able to support a crew of two for about 28 days or a crew of four for about 6 days. The lander and MAV concept shown here requires further study and refinement to provide a higher fidelity validation of its mass and performance.

Short-Surface-Stay Mars Landing Campaign

The Mars landing campaign would use six SLS launches, four of which have high heritage to the Phobos campaign described earlier, using proven vehicles and mission profiles. As depicted in Figure 9, the SEP cargo missions would be very similar to those in the Phobos campaign (Fig. 4), except that on Launch #1 the Phobos transfer stage would be replaced with a similar MAV boost stage. On Launch #2, the Phobos habitat would be replaced by a cargo version of the DSH that would be used to resupply the crewed habitat in HMO. The crew delivery to HMO (Launches #5 and 6) would also be identical to the Phobos campaign (Launches #3 and 4).

The new feature for the landing campaign is the delivery of the Mars lander to HMO through two launches (Launches #3 and 4 in Fig. 9). A dual SLS launch scenario would be used to inject the 75 t lander on a trajectory to Mars. Upon arrival, aero-

capture would be used to place the lander in HMO. The lander would then wait in HMO for the arrival of the crew.



Once in HMO, the crewed vehicle integrated stack would dock with the habitat consumables resupply vehicle that had been previously placed in HMO and restock the DSH. The spent MOI stage would be replaced with the fresh TEI stage. The crewed vehicle stack would also rendezvous and dock with the lander.

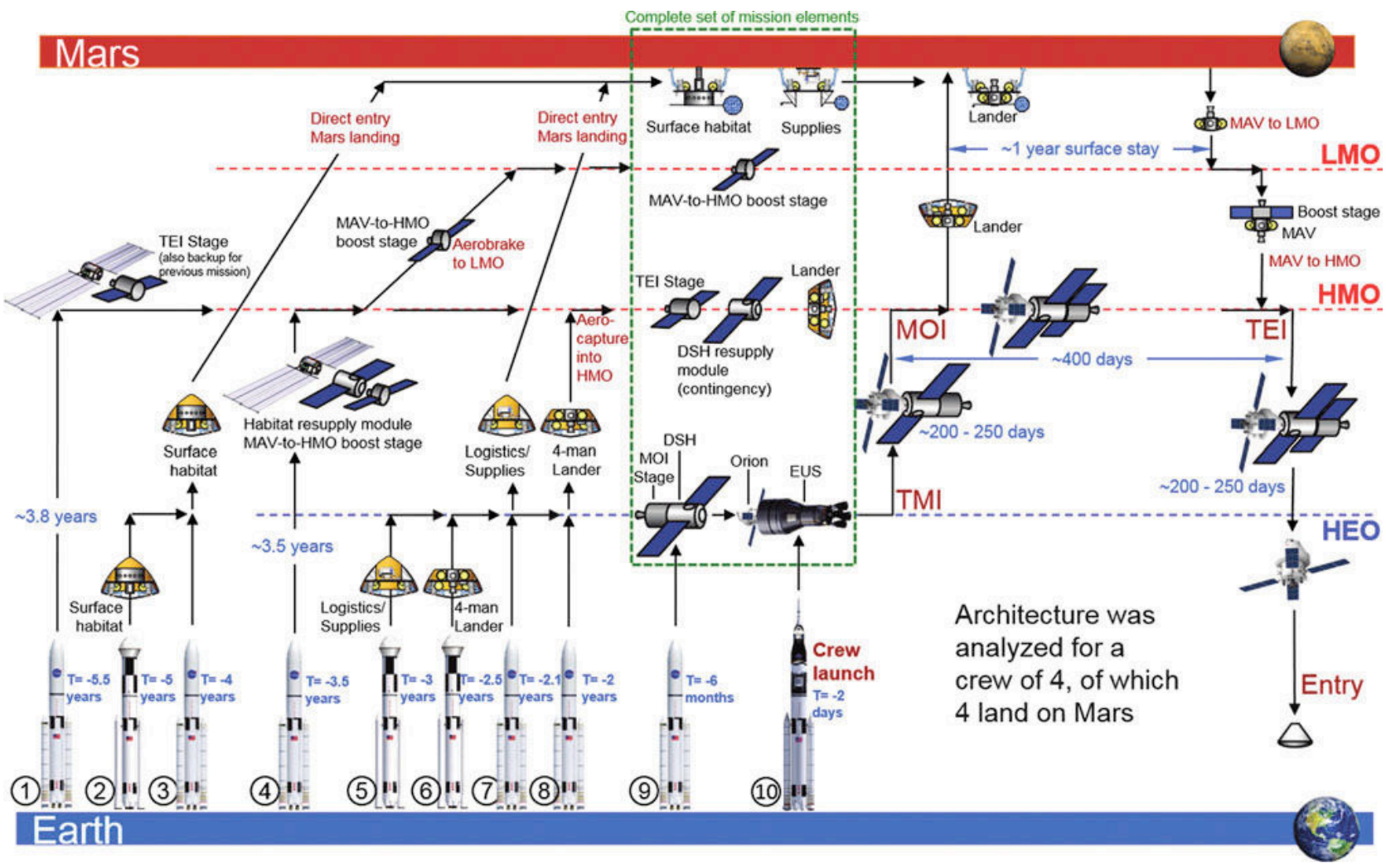
For this short-surface-stay mission, two of the crew would transfer to the lander, and the other two crew members would remain in the DSH in HMO. The lander would be deorbited and perform its EDL to the martian surface. The EDL phase of the mission is shown in Figure 6.

The first landing mission would be a short-stay visit, similar to Apollo 17 in scope. At the conclusion of the surface mission, the crew would use the MAV to launch to LMO. The MAV would dock with the prepositioned boost stage and use that to raise the orbit to HMO to rendezvous and dock with the DSH and Orion for crew transfer. From this point on, the mission profile would be identical to the earlier Phobos mission.

Long-Surface-Stay Mars Landing Mission Concepts

For the subsequent campaigns, a full crew of four would land on Mars and spend over 300 days on the surface. For these missions, a surface habitat and a cargo land-

er would be preplaced at the landing site (using similar 23 t landers) to support the crew. This campaign would require two additional landers (thus, four additional SLS launches relative to the short-stay campaign), bringing the total SLS launches for this campaign to 10. Each lander would be delivered in a manner almost identical to the crewed lander, with the exception that they could use direct entry and avoid aerocapture as an intermediate step. The crewed segments of the mission would be identical to the previous short-surface-stay mission, except that the full crew would go to the surface. This launch campaign would be implemented with a steady cadence of one SLS launch every 6 months. The exception is that once every 2 years, two SLS launches would need to occur within one month of each other. Additional ground infrastructure at the Kennedy Space Center would be required to support those biennial extra launches, and that capability would be needed by about 2040. The profile for this campaign is shown in Figure 10.



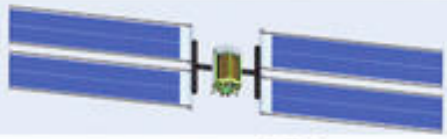
Toward a Permanent Outpost

In a continuing program of human Mars exploration using this example architecture, a new crew of four could be sent to Mars every 4 years along with two cargo landers. Over time, infrastructure could be built up for an expanding base on Mars. In addition to consumables, the cargo landers could bring exploration equipment such as pressurized rovers, advanced surface power systems, science equipment, drilling equipment, in situ resource utilization (ISRU) packages, and additional habitation volume. As the Mars base expands, some crew would stay for the minimum cycle time of about 350 days, but others could possibly stay for a much longer time and wait for the next Earth return opportunity. In this way, the base could eventual-

ly be permanently occupied and evolve toward increasing self-sufficiency.

The Vehicles

The vehicles and number of units that would be needed for the first Mars landing mission are shown in Figure 11. The SLS and Orion are under development, and the SEP tug development is planned for a technology demonstration mission. The DSH is under study, and NASA has plans for its development in the early 2020s. The lander was described earlier. The chemical-in-space propulsion stages would be a new development, but a low-risk, high-TRL approach could be used. In this architecture example, these units would be conventional bi-prop systems similar in size and performance to the Titan 2 second stage. We have assumed that they would use MMH/MON-25 propellants and the same type engines as the descent and ascent stages of the lander.

Vehicles	# Vehicles per Mission
Orion 	1
SLS 	6
SEP Tug 	2
Deep Space Habitat 	1
In-Space Chemical Propulsion Stages 	3
Mars Lander 	1

The vehicle masses used in the mission design analyses are listed in Table 1.

Affordability Sanity Check

Since affordability was established as a metric for this architecture, we sought a first look cost sanity check. We concluded that for a relative comparison on affordability with the recently completed NRC report, the approach we have outlined should be evaluated by the same organization, with the same individuals using the same process and the same cost databases that were previously used. For this reason, the Aerospace Corporation performed this part of the study. Their analysis took into account the technology readiness levels of the vehicles and components used

in the architecture. The results of their assessment, shown in Figure 12, suggest that the approach outlined here might be affordable within the current HSF annual budget adjusted for inflation with an ISS wedge opening in 2028. Additionally, because this approach uses elements with a higher technology readiness, it is reasonable that the cost risk will be lower and the schedule confidence higher. However, it should be noted that while this provides a good basis for a relative comparison with the NRC pathways, a much more detailed exercise is needed to establish a higher fidelity cost estimate for budget commitment.

Table 1. Vehicle Mass Table

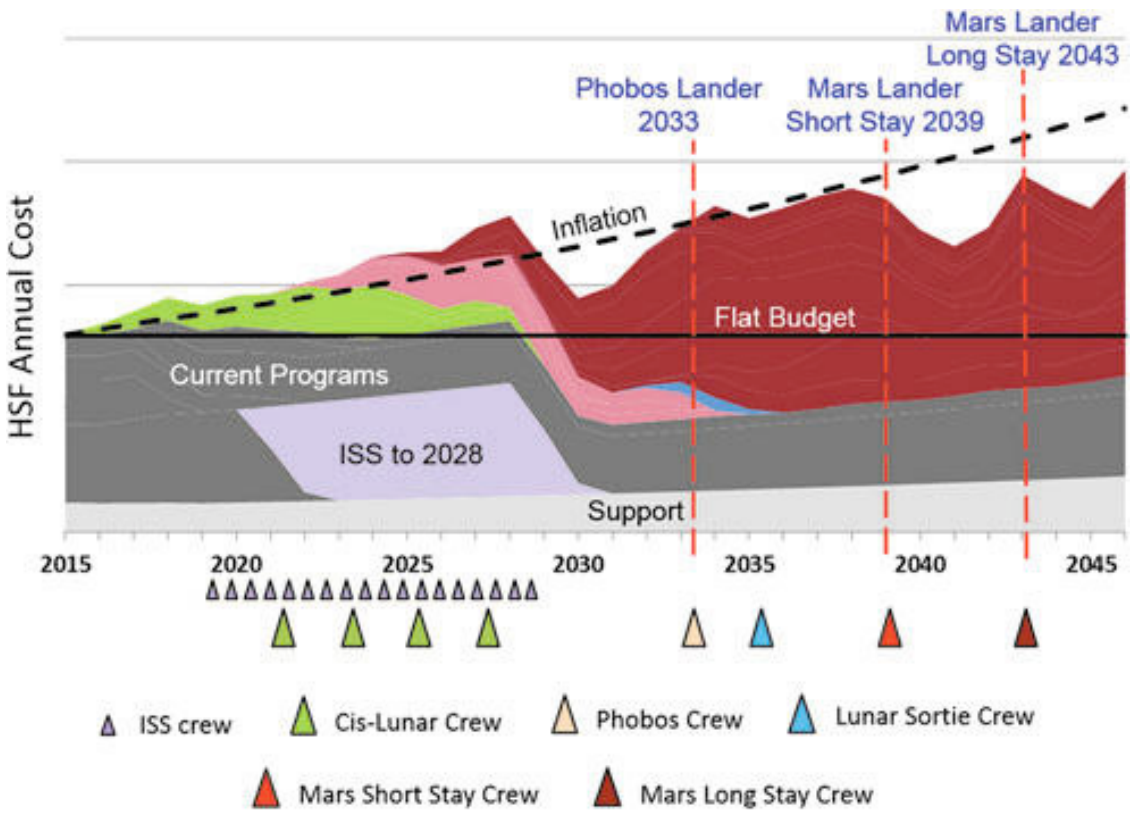
Mission Element	Mass Allocation, t
Orion command module	10
Orion service module	5
Orion service module propellant	4
Deep space habitat	30
Mars orbit insertion (MOI) stage	30
Trans-Earth injection (TEI) stage	26
Orion Phobos transfer stage	14
Phobos habitat	25
Phobos landing legs, docking node, exploration equip.	12
Mars lander descent stage	52
Mars ascent vehicle	23

Conclusions

Annual budget constraints need to be considered as a design requirement for human journey to Mars architectures since it is likely that the NASA budget will not see a dramatic increase beyond adjustments for inflation. This in turn requires a phased approach toward establishing a permanent outpost on Mars to allow the technical risk and the required funding to be spread out and still deliver significant and publicly engaging milestones along the way. One such approach is presented here as an example. It is a minimal architecture that relies on assets already under development or planned by NASA. A series of missions in cislunar space would lead to a Phobos lander in 2033 to be followed in short order by a dress rehearsal landing on the Moon, and then by a crew to the surface of the red planet by 2039.

We hope that the ideas and principles introduced here in whole or in part can be a useful input to the process of structuring an implementable human journey to

Mars in our lifetime.



Acknowledgements

The humans-to-Mars community is small, and ideas are readily shared and build on each other. This JPL internal study has evolved over the past 2 years and, along the way, has been shared with others both inside and outside of NASA whose comments and critiques have helped us improve on the concept. In turn, this study has spawned similar ideas within other teams who have adopted aspects of this architecture.

We would like to acknowledge contributions of colleagues Nathan Strange, Damon Landau, Ryan Wooley, Rob Manning, Mark Adler, Ian Clark, Bobby Braun, Rob Grover, Evgeniy Sklyanskiy, Steve Sell, Bob Shisko, and Raul Polit-Casillas. Finally, we acknowledge the Aerospace Corporation, specifically Torrey Radcliffe and Randy Persinger, who undertook the cost assessment of this architecture on the same basis as used for the NRC study.

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China: Market Means, Political Ends

Roubini Monitor, July 17, 2015

At the Third Plenum of the 18th Party Congress, the Chinese Communist Party (CCP) laid out plans to rely more heavily on markets to allocate resources, both real and financial:

The Third Plenum communique's focus on the market is not an end in itself, but a means to develop an economy that will further cement the legitimacy and control of the CCP. Chinese policy makers have traditionally been wary of jeopardizing that legitimacy, limiting their actions to gradual moves—pilot reform projects that are only scaled up once initial flaws have been overcome. But relying on open, competitive markets, while arguably more efficient, carries a higher risk of day-to-day volatility than is the case under a command-and-control system. This risk is heightened in situations where the market relies on skewed, incomplete information, regulatory frameworks are unpredictable and risks are divorced from returns—all of which applies to China today.

The Chinese government has been grappling with this efficiency/volatility tradeoff since it first moved to use markets in the late 1970s. The growth of China's financial markets, higher levels of leverage and persistent institutional shortcomings, though, have made this tradeoff more adverse today than at any time since market reforms began.

Treating Symptoms…

This challenge has been pushed to the fore by China's recent stock-market surge—a rally that was not justified by fundamentals. One clear measure of this dichotomy was the yawning gap that had developed between what Chinese asset prices implied about Chinese economic activity and direct measures of activity. The subsequent collapse of the implied activity series since mid-June, despite the rally on July 9 and 10, led to excess market volatility.

Faced with the collapse of the stock market bubble, officials have focused on finding ways to support share prices. These actions—providing state-owned entities with central bank funding to purchase shares, banning major shareholders from selling shares, prohibiting short futures positions, orchestrating "voluntary" IPO suspensions, allowing nearly half of Chinese listed firms to suspend their shares from trading—do not address any underlying issues that might drive market volatility. Rather, they assume that the chief problem in the market is excessive pessimism, which

can be dissipated by driving out sellers.

Chinese policy makers' actions have had a somewhat positive effect, with the Shanghai market up since July 8. The absence of inflation pressures limits the macro consequences of the expansion of base money engendered by the PBOC indirectly funding share buying through unlimited liquidity support to the China Securities Finance Corporation (CSF). Low inflation also adds to the credibility of the government's "buyer of last resort" commitment. Meanwhile, the state's large footprint in the market—SOEs represent more than 60% of the free float market cap of the A-share market and one-third of listed firms—makes coordinating actions a simpler process than it would be with purely private firms.

But applying a floor and a cap to the Shanghai Composite index (3,500 and 4,500, respectively) is not a viable long-run solution for achieving a sound stock market. Guaranteeing a range will divorce risk from return and exacerbate bouts of euphoria and pessimism. Near the bottom of the range, investors could look forward to a gain of 30% or so, while fearing a 20% loss near the top. An implicit guarantee on securities in non-bank financial institutions and implicit and explicit guarantees to bank depositors already skew risk and return in the banking sector. Worsening this by adding the stock market to the list of "guaranteed" investments is a recipe for further misallocation of capital down the line.

… Not Diseases

The efficiency of stock markets relies on the quality and availability of the information available to investors. Information, though, is far less relevant when potential losses appear to be capped. One need only look for the highest expected return; the downside is someone else's problem.

The other side of the coin, market stability, is a function of the regulatory framework: shareholders' rights, market-making conditions, access to margin finance, rules on shorting and the slew of other factors that characterize a market. Chinese policy makers are clearly aware of this, having moved at various times to alter the arrangements that affect market trading. In this surge, though, Chinese officials have seemed conflicted over their dual role as supervisors and promoters.

In mid-January, for example, following a late-2014 run-up in the market, the China Securities Regulatory Commission (CSRC) tightened the enforcement of margin-lending requirements and banned margin lending by China's three largest brokerage houses for three months. For the remainder of January and February, the market was flat but surged in the aftermath of the PBOC's late-February rate

cut. On April 17, the CSRC again sought to curb the market by easing the conditions for shorting stocks. That weekend, the PBOC cut its required reserve ratio. Shortly thereafter, the CSF stopped publishing data in English on margin trading, obscuring for the outside world information on leverage in the market (they continue to publish data in Chinese, though, as required by the company's statute).

One could argue that the RRR cut on Sunday, April 19 was in response to the weak March macro data, but clearly, its effect on stock prices ran counter to the CSRC's efforts toward disciplining the market. Some investors, though, took the view that Chinese officials wanted to promote higher share prices in an effort to boost consumption through a wealth effect. Interestingly, post 2008, the relationship between consumption and share prices in China is negative, perhaps because households curtail consumption to plough funds into stock rallies Ultimately, however, if equity prices rise, the additional wealth will be spent, if not by the original holder, then by his or her children or grandchildren. Along these lines, studies show that household consumption is influenced by a long-tailed moving average of stock gains, as those are more likely to be permanent rather than the sharp, short run-ups that often reverse, as seen in China of late.

Over the past seven months, the pattern of policy actions taken in response to stock-market developments mirrors the set of measures applied to the broader economy. There is a push for reforms, but an unwillingness to tolerate the volatility that those reforms entail, particularly when that volatility means lower economic activity and/or a loss of support for the government's policies. There is a fundamental incompatibility between pursuing greater reliance on the market and achieving the CCP's growth/stability goals—a conflict complicated by policy makers' fear of any change that may threaten their legitimacy. Creating greater stability/higher growth today is hardly a panacea; the government's tightened grip on markets today presages lower growth and greater instability tomorrow.

博弈大救市

王晓璐, 李勇, 曲艳丽, 财经, July 20, 2015

中国A股前所未有的恐慌，倒逼出力度空前的强力大救市。这是今年6月末7月初牵动全球的重要经济事件。

大救市源于大股灾。自去年7月开始的中国A股急速上涨，在一年后变脸。从6月15日开始，仅三周时间 A股市值大跌15万亿元，上证指数下跌30%，小盘股指数下跌更多，一场不折不扣的大股灾来临。

在这轮股市暴跌中，以金融监管部门为主，曾先后出台数个救市政策，但均以失败告终，股市加速下跌，股票连续跌停，持股者卖无可卖，股市出现流动性危机。一些杠杆资金，包括券商融资融券，纷纷临近触发强平线而无法卖出的风险，公募基金也面临无法赎回的可能。

空前的恐慌笼罩A股市场。监管部门和主流机构意识到，如果A股市场继续深度下跌，一些分级基金也将受损，股权质押将不得不补充抵押品，如果被强行卖出，上市公司控制权可能旁落。尤其令人担忧的是，随着更多资金沦陷，特别是已经入市的上万亿元银行系资金大面积受损，大股灾势必演变成全面金融危机，损失将难以估量。

《财经》记者随即获悉，正是基于对股灾有可能扩大化的判断，中央高层因此痛下决心，经过紧急磋商，开始调动一切资源救市，证券监管层自然充当急先锋，央行亦以空前特殊政策予以托底，其他金融、经济部门亦相继深度介入这场大救市。

市场虽然一度争论救市是否必要，但主张强力救市者很快占据绝对多数意见。直接在一线协调救市行动的中国证监会主席助理张育军称，“这是一场金融保卫战。”

7月7日，A股市场大跌效应传导至港股，恒生指数暴跌。随后，人民币汇率、大宗商品、中概股等几乎所有与中国相关的投资标的全面下跌，市场情绪几乎崩溃。

由此，在中央最高层拍板之后，强力救市成为多部委的迅速行动，大救市从金融监管部门局部强撑，演变为部委联合、央地统筹全面行动，公安部、网信办等强势部门亦参与其中，折射股灾之重和改革之难。

在多方合力大救市之下，A股市场下跌止住，主要指数开始反弹。但很快市场就发现，杠杆资金又有回流迹象，投资者情绪从悲观到亢奋仅仅用了两个交易

日，有机构人士调侃“韭菜的记忆只有七秒”。

止血的同时，监管层亦开始拆弹危险的杠杆，恒生电子宣布关闭HOMES系统开户功能，银监会也开始摸底银行资金入市规模。

目前来看，随着市场企稳，本轮股灾将逐渐平息，有望从危机模式向常态模式过渡。痛定思痛，巨额救市资金入市将如何平稳有序退出？如何让救市的临时性政策逐步回归常态？对救市及危机如何总结反思？都成为中国金融监管者重点思考且必须破解的难题。

救市升级

从央行双降，到证监会屡次释放利好信息都未能阻止市场下跌看，证监会已经调动一切能够调动的资源，仅靠证监会救市难以支撑

即便在诸多利好政策下，在有关方面组织资金明显托市的7月2日和3日，A股“救市”仍未奏效。上证综指一度击穿3700点，代表新兴产业的创业板指数从最高的4037点调整至2600点附近，市场人士感叹，行情可谓“惨烈至极”，投资者损失惨重。

统计表明，在那几周里，沪深两市跌掉的市值超过15万亿元人民币，相当于希腊2014年GDP总值的10倍多。

市场不断地失血，A股滑向流动性危机的边缘。7月3日A股以大跌结束一周交易，投资者一片悲观。全市场都在期待，政府还会有新的救市措施么？新的救市措施会是什么？

好在新的更大行动随即出现。7月3日傍晚，21家上市券商的董事长或总经理先后接到证券业协会和证监会的电话，通知7月4日到证券业协会开会。被通知的证券高管们都知道，市况危急，监管层通知周六开会，肯定有要事商议。

第二天上午9点，21家券商负责人如约来到北京金融街富凯大厦B座2层的中国证券业协会大会议室。会议由证监会主席肖钢主持，就A股面临的难题及如何应对展开讨论。

《财经》记者获悉，由于情况紧急，当天的讨论也较为无序，救市与不救市、如何救，各种意见交织，肖钢数次打断发言者讲话，希望大家统一认识。最后，中信证券董事长王东明提议：“肖主席，你说怎么办，我们就怎么做。”随后达成的一致意见是，21家证券公司以6月底净资产的15%出资，合计不低于1200亿元，用于投资蓝筹股ETF。

为了尽快筹措救市资金，监管层希望周一开盘前资金即能够到位，但由于周末筹措资金有困难，最后确定周一上午11时资金到位。

一位参会者告诉《财经》记者，由于事先难以有针对性地做准备，各证券公司的董事长们取得共识后，先在一张空白的《联合声明》上分别签字，然后补上声明内容，各家公司负责人签完字，会议宣布结束。

据悉，当天的出资协议签署后，通过什么方式将资金合法合规地转给中国证券金融股份有限公司（下称证金公司）成为一大难题。证金公司成立初衷是为了融资融券提供转融通业务，并未有过直接从券商接收资金的先例。如果各家券商出资按对外投资算，每家公司都需要走董事会、股东大会等程序，如果这些资金按基金份额算，证金公司又没有基金管理人资格。

为了解决接纳资金问题，7月5日，证金公司邀请一家大型券商从法律、IT、清算、交易等方面人员到金融街办公室，帮助证金公司理清相关法律关系，设计好相关交易通道。

证金公司还在中信证券新开四个账户，分别设在中信证券总部营业部、望京营业部、呼家楼营业部和金融街营业部。随后数个交易日，这四个营业部每天的动向成为市场的风向标。

7月4日下午，基金业协会也召集25家公募基金开会，并达成一致，积极引导申购，新增基金积极建仓。

从之前央行的双降（降息、降准），到证监会屡次释放利好信息都未能阻止市场下跌看，证监会已经调动一切能够调动的资源，仅靠证监会一己之力救市则难以支撑。而市场暴跌已经引起高层重视。就在7月4日，国务院召集一行三会、财政部及部分央企负责人开会，商讨救市对策，高层领导倾向强力救市。

7月5日下午，中国证监会公告，中国人民银行将协助通过多种形式给予证金公司流动性支持。这标志着，以国务院协调的多部委联动救市开始实施，证金公司作为救市平台。央行提供流动性，则是最大限度的支持。

黑色半周

A股大跌效应传导至海外市场，人民币汇率、大宗商品、中概股等所有与中国相关的标的全面下跌，投资者情绪到达了崩溃的边缘。

7月6日星期一上午，证券公司的资金陆续转进证金公司账户，中信证券、海通证券、银河证券、中信建投分别选派交易员和投资经理入驻证金公司。当天，中国证监会副主席刘新华亦赶赴证金公司督战。

受到周末诸多利好消息提振，当天上证综指以高开8%开盘，多方意图通过拉抬银行股和两桶油保卫指数，但空方在中小创现货及股指期货市场继续肆掠，盘中一度高开近8%的中证500期指最后砸至跌9%。上证综指当日收涨2.4%，投资者对于救市结果深感失望，恐慌情绪弥漫市场。

7月7日周二，市场继续下跌，国家队救市资金仍然只拉蓝筹股，创业板几乎全面跌停，陷入全面的流动性危机。为了自保，两市超过二分之一的上市公司停牌。

当晚，A股大跌效应传导至海外市场，人民币汇率、大宗商品、中概股等所有与中国相关的标的全面下跌，投资者情绪到达崩溃边缘。

“心脏骤停的感觉。”上海某私募基金经理对《财经》记者描述道，那两天感觉时间过得特别慢，充满无力感。

市场急跌后杠杆资金蜂拥而出，流动性危机骤至。7月7日当天，一段时间期指做空也受到限制，尤其是套保账户亦限制做空，大量对冲基金、公募基金和保险机构无法做空期指对冲风险，在中小创股票大量停牌的情况下，被迫减持一些并不想卖的股票。

值得注意的是，7月7日下午开盘后，创业板龙头股在跌停板上每分钟出现了固定的买单，例如乐视网每次固定1592手，东方财富每次固定1462手。市场机构推测，这是国家队在测试中小创股票跌停板上的抛压。

前几周市场急跌后，配资公司或者券商两融业务部门还可以同客户商量是否强平，出现了“下午2点或者2点半集中强平”的说法，到7月6日这周，股票被死死按在跌停板上无法卖出，便无所谓几点钟集中强平了，所有的交易时间都开始平仓。

一个相对平静的夜晚过后，市场在恐慌中无奈地等待。7日8日甫一开盘，金融股等蓝筹溃败，股指期货全线暴跌，除停牌股票外，仅有几只股票勉强翻红。创业板指数成分股一共100只，停牌77个，跌停23只，指数开盘即跌停于-2.01%。

显然，救市资金只购买蓝筹维护指数的策略出现问题，一方面护盘大盘股需要巨量资金，另一方面，小盘股股票又全面陷入流动性问题。7月8日上午10点，证监会公告称，将加大对中小市值股票的购买力度，缓解市场流动性紧张状况，国家队开始向小票注入流动性。接近午后时，民间游资跟随国家队涌入小盘股，拉起跌停板，创业板从此刻开始有了希望。

7月8日，证金公司藏身的中信证券望京营业部、中信证券金融大街营业部、中信证券总部和中信证券呼家楼营业部分别净买入254.71亿元、181.02亿元、152.91亿元和34.62亿元，合计净买入623.26亿元。这4家营业部近3个交易日净买入高达825.58亿元。

除了证券现货市场，证金公司还在这一天，通过中信期货买入3万多手沪深300期指多单，锁定了市场三分之二的空单。深圳一家大型私募合伙人认为，中信期货多单的目的不是为了赚钱，是为了平衡市场，也是为了在关键位置给出明确的信号。

国家队期现联动的操作打破了多空力量的平衡，暴跌多日的A股市场转折点也随之来临，救市开始起到作用。

迎来逆转

期现市场配合救市的举措止住了市场持续下跌，投资者的预期开始转变

国家队只拉蓝筹股，并不能解决中小创股票的流动性问题，市场形势不见好转，证监会与券业交流频次逐渐增多。

7月8日早晨，中国证监会主席助理张育军召集多家券商负责人开会，对维护市场稳定提出五点意见，其中最重要的是监管机构将给予证券公司流动性支持，证券公司要扩大自营规模，加大对中小盘股票的购买力度，同时，在海外上市的证券公司发布H股公告，提振海外投资者信心。

据参会人士回忆，上午的会很简短，三四位券商负责人一批，交代任务后大家分头回公司安排工作。然而，随后的事态发展还是超出了部分券商人士的预期。当天，海通证券宣布因股东和高管回购股票计划停牌，价格较市场价有较大折让，此举引发香港市场的内地券商股遭遇资金大举做空。因无法卖空海通，很多投资机构选择中信证券、银河证券、广发证券等券商的H股进行卖空，对冲风险。据一位接近港交所的人士介绍，中信证券H股当天40%的卖盘来自借券卖空。

两地市场的联动，导致A股市场券商股跌停，部分券商H股跌幅一度超过20%。

当天收盘后，证监会再次召集证券公司负责人开会，要求各家证券公司带着当天的交易数据来。原本以为上午会议后，证券公司会大举买入股票，但看到20多家券商全天买入只有150亿元至160亿元规模时，这样的迟缓行动让证监会领导非常不满。

当晚，中国证券业协会成立应急小组，加强与证券公司沟通；证监会要求上市A股或H股证券公司报送工作日报；做好资本市场正面宣传；证券公司内部制度和风险指标可以适当突破。证监会机构部副主任梁永生还特别提到，在这次救市中表现好的证券公司，监管部门会在分类评审中对其加分。

其实，在当晚的会议之前，证金公司下发通知向华夏基金、嘉实基金等五家公司共申购2000亿元主动性基金份额，每家各获得400亿元，部分资金在7月10日完成申购。

除了金融部委协调救市，7月9日，公安部副部长孟庆丰带队，开始打击证券期货市场的违法犯罪活动。对涉嫌内幕交易、泄露内幕信息、编造并传播证券期货交易虚假信息、操纵证券期货市场等犯罪案件要坚决依法查处，对恶意卖空股票与股指涉嫌犯罪的线索，将要依法调查处理。这一威慑作用明显。

综合多方信息，市场看到了救市的强大力量。7月9日，部分中小盘股票在开盘后5分钟内的成交量已经逼近前几日的日均成交量。投资者预期逆转，个股全面反弹，两市出现涨停潮，沪指涨幅5.76%。

至此，A股市场的流动性危机暂时得以解除。

配资回流

一位资深券商人士预计，只要股市继续回暖，即便监管部门展开严厉的打击，银行资金仍会通过其他渠道进入股市

当A股市场面临反转突破时，最敏感的资金开始蠢蠢欲动。

《财经》记者了解到，7月8日当晚，一家股份制银行下发通知，对股市进行较为全面的分析，同时鼓励该公司金融市场部可以继续开展配资业务，抢占市场份额。随后，多家银行重新开始操作配资业务。

场外配资野蛮生长，被认为是此次市场大跌的元凶。在经过激烈的调整之后，一些高杠杆入市的资金多已被强平，甚至连1：1杠杆率的券商两融资金也纷纷减仓，以免损失更大。

相关统计表明，7月6日至16日，券商融资余额从1.9万亿元迅速下降到1.4万元亿，而与2.3万亿元的融资余额历史高点相比，两融规模下降了9000亿元，去杠杆行动开始见效。

此前，申万宏源策略报告估算，场外配资规模存量约为1.7万亿－2万亿元左右，其中银行理财资金存量约为7000亿元－8000亿元。如果比照券商两融下

降幅度，场外配资下降规模将超过1万亿元。在市场转暖之后，“两融”规模稳定在1.4万亿元的规模，而商业银行亦在市场回暖中寻觅机会，也因此暴露出新的风险。

《财经》记者获悉，证金公司获商业银行授信规模约2万亿元。

银行对证金公司相关业务趋之若鹜，也与监管的升级相关。在股灾之后，证监会和银监会都严厉整肃场外配资，可以预计的是，银行资金通过配资进入股市的渠道在一段时间内会受到限制。

国家互联网信息办公室也向各地网信办和网站下发通知，要求全面清理“配资炒股”等违法网络宣传广告信息，然而，不管是股灾前还是股灾后，银行资金通过各种渠道入市的冲动依旧强烈。

在经济结构调整期，银行资金“避实就虚”的逻辑可以理解，与其开展大量占用资本金的贷款业务，不如通过购买金融产品的方式将资金引入股市，获取高额利差，承担有限的风险，还能减少资本占用。

一位资深券商人士预计，只要股市继续回暖，即便监管部门展开严厉的打击，银行资金仍会通过其他渠道进入股市。将场外资金纳入监管才是当下最合适的应对之计。

救市争议

救与不救，在同一时间永远无法同时验证两种结果，谁也无法看到现实选择外的一种结果

救与不救，在同一时间永远无法同时验证两种结果，谁也无法看到现实选择外的一种结果。只是作为决策方，是否愿意冒另外一种选择的风险。

在A股暴跌之际，对于决策层出台一系列措施救市，曾有部分声音认为应当让市场去决定，政府不应该干预。比如7月3日，中欧陆家嘴国际金融研究院执行副院长刘胜军表示，政府不应该托市，也托不起市。他认为，股市的调整是对前期暴涨的风险释放，并未对金融体系稳定性带来冲击。“两融”业务有明确的杠杆要求和平仓机制，股价下跌不会转化成券商倒闭，对银行体系的影响更是不必忧虑。

事实证明，这些不救市的观点未影响监管层的救市行动。一位资深金融衍生品研究教授告诉《财经》记者，如果放任市场继续下跌，市场流动性极为匮乏，基金的赎回必然面临违约，进而影响投资者心理预期，进一步引发银行挤兑也是有可能的。

一家券商的融资融券负责人告诉《财经》记者，在A股每天千股跌停的时间里，大家争相平仓，引发踩踏，最终导致谁也平不出去，肯定会影响券商的资产安全。

当时的情况是，个股的下跌完全丧失了理性，如果说一些个股因为估值泡沫出现暴跌还可以接受，但在流动性缺失下，一些优质个股被抛售来获得流动性，则彻底让市场失去意义。此时，市场本身已经不能进行自我调节了，必须要政府出手干预。

在这轮牛市兴起之初，主流的声音认为，中国经济的改革，资本市场必须要发挥更大的作用，只靠商业银行的间接融资并不能满足企业融资需求，必须要发挥资本市场的资源优化配置功能。所以央行方面实行宽松的货币政策，资本市场则保持较快的融资节奏。

从市场结构看，这轮牛市散户参与广泛，一大型券商上半年增加开户数70余万。有统计显示，目前，市场散户已经超过9000万。在市场急剧下跌之下，散户的风险承受能力有限，维护市场稳定是必要的，防止因股市风险引发社会稳定问题。据《财经》记者了解，在7月7日A股市场大跌的下午，有上市银行加强了安保，防止基民因基金赎回不了而迁怒作为销售渠道的银行。

国泰君安首席经济学家林采宜认为，政府救市的原因在于二级市场的估值决定了同类企业在一级市场融资的难度以及融资的成本；规范杠杆投资形成的多米诺骨牌效应可能造成金融市场的系统风险；新一轮国企改革和政府的积极财政政策需要二级市场的牛市配合；资本市场的财富效应既是防通胀的药方，也是缓解资本外流、人民币汇率贬值压力的缓冲器。

前述券商高管说，讨论救市与不救市没有意义，市场肯定需要救，如果不救，市场没了，一切依赖于资本市场的改革都无法进行。

他认为，政府的救市目标在于解决市场的流动性，给予市场稳定的预期，而不在于拉抬指数，一旦市场回稳，流动性恢复，政府应当最大限度减少干预。

如何退出

救市资金的重头在证金公司从银行体系获得的资金，这部分资金入市规模巨大，一旦处理不好，容易使此前救市的努力付之东流

此次救市，监管层随机应变，打破了很多规则限制；同时，证金公司运用大批资金入市维稳，规则的回归和入场资金的退出，成为市场恢复常态模式的关键。

此前，为鼓励上市公司股东和高管人员增持股份，证监会修改了一系列短线交易的相关规定；证监会还修改了证券公司两融业务、股票质押业务的管理办法，为了让券商自营持股，还放松了券商相关经营指标的限制。

这些规则的修改是应对市场出现危机时的权宜之计，危机一旦解除，政策回归常态是监管工作的应有之义。

维稳资金的平稳退出更加牵动市场的神经。上万亿的资金持有的股票该如何处置？如何平稳有序地退出？据《财经》记者了解，监管机构已经开始考虑救市资金的退出方案问题。

目前证金公司的资金分为两部分，一部分是21家券商以2015年6月底净资产15%出资，合计1280亿元，另一部分是证金公司从银行体系获得的资金，知情人士向《财经》记者透露，截至7月17日，这部分资金的买入规模超过万亿元。

券商的出资退出有三种可选方案，各有利弊。第一种方案是将券商出资买入的股票按出资比例分给各家券商，主要考虑是救市期间，包括大股东、证券、保险、公募等机构的股票都被锁定，市场可供交易筹码不足，一旦资金回流市场，容易再次出现暴涨行情。

第二种方案是将券商出资买入的股票留在证金公司，留作以后融券业务的券池，证金公司返还各家券商的出资，这个方案的好处是锁定了这部分股票，不会引起市场对卖盘的担心，而且证券公司不用承担救市的损益。

第三种方案更折中一些，将券商出资买入的股票换成ETF基金，按比例分配给券商，这样便于切割，不会引起不同股票后市走势分化带来的权益分配不均。这部分出资属于证券行业自救，资金规模不大，决策流程短，预计很快会有结果。

救市资金的重头，在证金公司从银行体系获得的资金，这部分资金入市规模巨大，一旦处理不好，容易使此前救市的努力付之东流。

证券业界的建议是，参照全国社保基金委托专业机构管理资金的办法，将买入的股票按照招标方式委托给专业机构，允许他们在未来很长一段时间内慢慢卖出，甚至可以没有盈利的要求，只需要把资金回收就可以。

有关这部分资金的退出仍需多方协商，目前证监会正在研究可供选择的方案。讨论期间，是否设立平准基金再次被提及。

据《财经》记者了解，无论是证监会还是证券公司代表都不赞同成立。海外市场并没有成功的案例可以借鉴，平准基金一旦设立会带来很多公平性和道德风险的压力。平准基金的设立是一种应急机制，目前A股市场还看不到设立这一机构的必要性。

更多投资者开始关心，A股从危机模式向常态模式的过渡是否需要更长时间，接下来监管部门能否与市场进行良性互动，切实管理好资本市场预期，避免重蹈此次股灾的覆辙。