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NewSpace—delivering on the dream

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ABSTRACT

After more than half a century of spaceflight, our activities in space are still limited to a relatively small set of markets whose growth is driven mainly by government funding. Worse still, human access to space is restricted to a few people flying very infrequently to a single destination in low Earth orbit (LEO). Contrasting today's reality with the high expectations of the 1960s – as epitomised in Stanley Kubrick's film "2001: A Space Odyssey" – begs two questions: what went wrong and can we fix it? The objective of this paper is to address these questions and, in doing so, indicate how the nascent NewSpace industry may help us realise past dreams by enabling a paradigm shift in our space-based activities.

1. Half a century of spaceflight—how did we get here?

We begin by identifying the key factors and trends that have driven our progress in space over the past half century. Though complex and varied, these factors can be summarised in a relatively simple manner and, in doing so, can help us identify likely future trends.

1.1. Dawn of the golden age (1957–1969)

The space-age began in 1957 with the launch of Sputnik, followed relatively quickly by the launch of the first human in 1961 and the first steps on another world in 1969. Such rapid progress during this first decade was essentially driven by a single dominant factor; national security—the Apollo programme was, in effect, a national security programme aimed at demonstrating to the world the superiority of capitalism over communism! Moreover, many of the world's launch vehicles were based upon military missiles that were "converted" for civil launch applications (e.g. the Soviet R7 and the US Juno, Thor, Atlas and Titan).

Unfortunately, the success of Apollo served only to ensure its demise because, once it had served its political purpose, its expendable architecture made it far too expensive to maintain through discretionary funding and non-government funding was essentially impossible.[1] Moreover, the political and economic environment had also changed significantly, resulting in pressures to curb spending down to more sustainable levels and activities that focused more on applications that exploration.

1.2. Consolidation and commercialisation (1970–1989)

The 1970s was effectively the second decade of the space-age, which saw government economic constraints force both a slow-down and a consolidation of the major space programmes. The Shuttle programme aimed to make space launch more affordable but also helped conserve the US industrial base that had been established by Apollo. Meanwhile, the commercial potential of space was beginning to emerge: in the near-term via communications, earth observation and navigation satellites; and

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[1] A commercial venture, Project Harvest Moon, was mooted to pay for an Apollo mission via sales of lunar materials, TV and story rights (www.nss.org/settlement/L5news/1985-beginnings.htm).

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in the long-term via visions of solar power satellites and even space colonies and starships! Some government programme employees recognised this potential for launch services and formed "proto-NewSpace" ventures like AMROC that, although unsuccessful, showed how entrepreneurs could play a significant role in the provision of mature launch service.

However, financial constraints began to lift in the 1980s as programmes like "Starwars", the National Space Plane (NASP) and Space Station Freedom (SSF) gained a real political justification, while improvements in both market and legal environments for ventures like PanAmSat enabled commercial programmes to grow, along with the emergence of quasi government/commercial entities like Arianespace and Spot Image.

1.3. Rationalisation and the entrepreneurs (1990–2010)

The fall of communism meant the 1990's was a time of military "rationalization" and political change, with major curbs in government programmes, as "Starwars" became a more modest ballistic missile defence system and the SSF became the more modest International Space Station (ISS) with help from Russia. Similarly, as NASP faded away, expendable launcher programmes became the preferred option, though experimental programmes like DC-X and then X-33 did maintain the hope of an alternate path into space. Meanwhile, as commercial activities grew with more advanced projects like VSATs and ventures such as SkyTV, Iridium and Teledesic, the first wave of NewSpace ventures emerged in the form of Kistler Aerospace, Kelly Aerospace, Pioneer Spaceplanes and the Rotary Rocket Corporation, whose goal was to service these new commercial markets and, in so doing, reduce specific launch costs, increase flight rates and deliver substantial improvements in flight safety, reliability and availability (see Section 3.2).

Unfortunately, the commercial "rationalization" of the early 2000s (i.e. the dot-com bubble burst and the commercial failure of Iridium) led to the demise of most NewSpace ventures, while government programmes also underwent a kind of re-invention with the advent of the Vision for Space Exploration (VSE) and programmes like Galileo. However, development of these programmes was extremely slow due to their Byzantine organisational structures and wavering political support, which meant that both eventually underwent a process of severe scrutiny and fiscal "rationalization" that resulted in either major programme changes or, in the case of the VSE's Constellation programme, outright cancellation.

1.4. Summary to date

The past five decades of space activity have, to a large degree, been driven by a few specific issues such as *national security and conservation of the industrial base*. In contrast, the slow growth of commercial ventures has been due mainly to *market and financial constraints*, rather than any basic limitation of the available technology. As a consequence, the diversity and intensity of spaceflight operations have also been paced by these trends, though the manner in which they are performed on both the ground and in space has been radically improved by the phenomenal advances in computing and software over this same period.

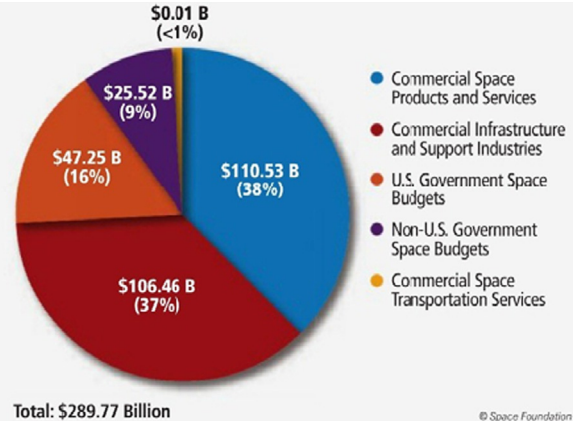

Fig. 1. Global space activities, 2011 [1].

2. Future possibilities—what are we waiting for?

Having gained an understanding of the factors governing past space activities, we now consider future possibilities and try to identify the key factors that may either prevent or severely restrain their realisation.

2.1. Current activities and constraints

Current space activities range from pure science missions through to civil and military applications like communication, navigation and observation systems. Nevertheless, growth and evolution in all these areas is limited by a few key factors:

- government priorities and constraints;
- competition from terrestrial alternatives;
- low market elasticity (i.e. lower prices stimulate little market growth);
- launcher cost/availability/reliability.

The first factor is important because the growth of space activities is still dominated by government programmes, both civil and military. Communication satellites represent the nearest thing to a truly commercial market sector, but government funding still underpins much of their basic R&D while the second and third factors have placed significant restraints on their growth and evolution, as witnessed by the problems of commercial ventures like Iridium, Globalstar, ICO, SkyBridge and Teledesic.

To put the situation into perspective, Fig. 1 shows a breakdown of the *global* space industry's annual revenue, which was $290 billion in 2011. However, this was still less than the annual turn-over of a *single* successful commercial company like Wal-Mart [2], which was founded in 1962 but has managed to outgrow the entire world space industry by