



Falcon 9 first stage landing on Drone Ship. Photo SpaceX

What's up with NewSpace?

NewSpace means a great many things to a great many people; the colonisation of Mars, space tourism, easier and more affordable access to space. The list is as seemingly unending as space itself. But what exactly is NewSpace, and who is involved?

Like many comparatively new terms, **NewSpace** is an umbrella phrase that describes the move towards today's emerging private spaceflight industry. Gone are the days when the satellite and space sectors were dominated by government entities – today, it's all about the commercial aspects. These commercial entities are looking to harness space in an entirely new way, developing faster, better, and improved access to space and spaceflight technologies.

So, what are we leaving behind? Old Space is everything today's space entrepreneurs are trying to overcome, namely the massive barriers to space; cost, time, regulation, all of these and more have prevented easy access to spaceflight. Old Space is space programmes being restricted to government entities, with new satellites taking years to go from the design to launch phase, and costing tens of millions of dollars. The slow clunking of the Old Space regime is coming to an

end as NewSpace entrepreneurs push the boundaries of what is possible, reducing the prohibitive costs and other barriers to entry of space, creating new markets and profit incentives, and opening our eyes to the overwhelming possibilities of space.

NewSpace activities

So, what are these NewSpace companies actually doing? Let's take a brief look at who's active in the massive array of NewSpace fields.

Space tourism

Space tourism is, without a doubt, the most widely publicised NewSpace area. It's hardly surprising – it's only become common to travel abroad on holiday in the last few decades, so hopping on a flight to space for your holidays is a huge deal. SpaceX, the NewSpace golden child, is making waves, but so are Blue Origin and Virgin Galactic. Less well-publicised are the commercial spaceflight plans from Boeing and Space Adventures Ltd. There's a lot of scope in the space tourism arena – companies are making plans for anything from suborbital spaceflights, lunar orbits, and missions to land on the moon and Mars, with the first test flights for some of these projects expected later this year.

Space colonisation

Another topic straight out of science fiction, space colonisation is something several entities are actively working towards. SpaceX's Elon Musk has stated that one of his longer-term goals is the colonisation of Mars, while the Mars One project, headed by Bas Lansdorp, is aiming for a permanent manned Mars landing in 2032. The primary argument for colonisation is the long-term survival of human civilisation, although there are many challenges to overcome before it becomes a reality; transportation, sustainable habitats, settler health and well-being, energy, resources, terraforming, communications with Earth, etc., the list goes on and on.

Launch services

Commercial spacecraft launch entities working on next-generation technologies are in good company. SpaceX, of course, is spearheading the reusable rocket launch campaign with the Falcon 9, alongside Blue Origin with the New Shepard. Both are also developing additional reusable launch vehicles. The huge number of small satellites expected for launch in the coming years has created a massive market opportunity for dedicated small satellite launch vehicles; NanoRacks is launching CubeSat missions from onboard the ISS, Rocket Lab has completed the world's first private orbital launch complex, and is nearing launch-readiness for small satellites, Virgin Galactic is exploring in-air launches of small satellites with its LauncherOne and SpaceShipTwo vehicles from airplanes, and new start-up Orbex is developing a dedicated small satellite launch vehicle in the UK.



Mars One aims to establish a permanent human settlement on Mars. Photo courtesy Mars One

Earth observation

Next-generation, commercial Earth observation is coming on in leaps and bounds right now. Utilised for anything from weather forecasting, biodiversity and wildlife trends, atmospheric chemistry, disaster recovery operations, ocean management, and protecting the environment from poaching and illegal fishing, you can see why Earth observation is such a major field. DigitalGlobe, 'the first and only company to deliver true 30cm resolution imagery,' collects more than one billion square kilometres of imagery annually, while Spire Global, which monitors the Earth via a network of small satellites, recently won the world's first Commercial Weather Data Pilot contract with the National Oceanic and Atmospheric Administration (NOAA). ImageSat International (ISI), Planet Labs (which now includes Terra Bella, formerly Skybox Imaging), Earth-1, Hera Systems, Satellogic, and BlackSky are all transforming the Earth observation sector with exciting new steps forward in capabilities.

Satellite constellations

Small satellite constellations have been heavily discussed in recent years as O3b Networks (now part of SES) and Globalstar have demonstrated the possibilities. Medium Earth orbit (MEO) and low Earth orbit (LEO) have been arguably underused in the commercial satellite sector until now; the majority of satellites using those orbits have to date been used for scientific research applications and government programmes. All that is about to change. Iridium NEXT, OneWeb, LeoSat, Telesat, Boeing, Fleet, Samsung, Kepler Communications and SpaceX all have constellations somewhere between the planning and operational stages, and it's broadly expected that around 2,000 new commercial small satellites will be launched by 2026, including almost 1,000 for OneWeb. Most of the planned constellations will target the global connectivity market, delivering low-cost high-speed Internet services, and are expected to help bridge the digital divide.

Satellite manufacturing

Of course, someone must manufacture all these ground-breaking next generation satellites, and given the boom in small satellite demand, manufacturers with the appropriate specialisations are expected to thrive. Clyde Space, Boeing, Surrey Satellite Technology Ltd (SSTL), Lockheed Martin, Mitsubishi Electric Corporation, Orbital ATK, SSL and Thales Alenia Space are all heavily invested in small satellite manufacturing, while Airbus Defence and Space has made spectacular progress, having inaugurated several serial production lines in France and the USA for the assembly, integration and testing of OneWeb's small satellites.

Satellite servicing

We all know that the biggest lifespan limitation for satellites is fuel



Mars rover space travel robot



The same New Shepard booster that flew to space and then landed vertically in November 2015 has now flown and landed again. Photo courtesy Blue Origin

capacity. A typical geostationary telecommunications satellite is retired after 15-20 years, not because any of the components cease to operate, but because they no longer have enough fuel to maintain station-keeping duties and attitude control. The space sector has been debating satellite servicing for decades, but it's only now that pioneers Orbital ATK and Effective Space Solutions Ltd have taken the first steps towards on-orbit satellite servicing. Both are working with the 'space tug' model, wherein a spacecraft docks to the satellite in question and utilises its own fuel to maintain the satellite and its own station and attitude. In an example of the type of public-private partnership that is expected to become increasingly ubiquitous in the NewSpace era, the US Government's Defense Advanced Research Projects Agency (DARPA) has selected SSL as its commercial partner for its own Robotic Servicing of Geosynchronous Satellites (RSGS) programme, which will develop technologies for cooperative inspection and servicing in GEO.

Asteroid Mining

Mining space-based resources, whether from moons, planets or asteroids, is yet another opportunity that has made its way from science fiction to an actual possibility. The attractions of asteroid mining are clear; precious metal resources like platinum, palladium and gold are



Working in Space



NewSpace era has highlighted a change in priority

becoming depleted on Earth, yet are plentiful in some near-Earth asteroids. Deep Space Industries plans to send small 'Fireflies' satellites into space to prospect for minerals and ice ahead of a larger spacecraft for extraction, while Planetary Resources plans to prospect asteroids using telescopes, again prior to sending a larger spacecraft for extraction. The challenges to mining asteroids include technology, economics and regulatory.

Manufacturing in space

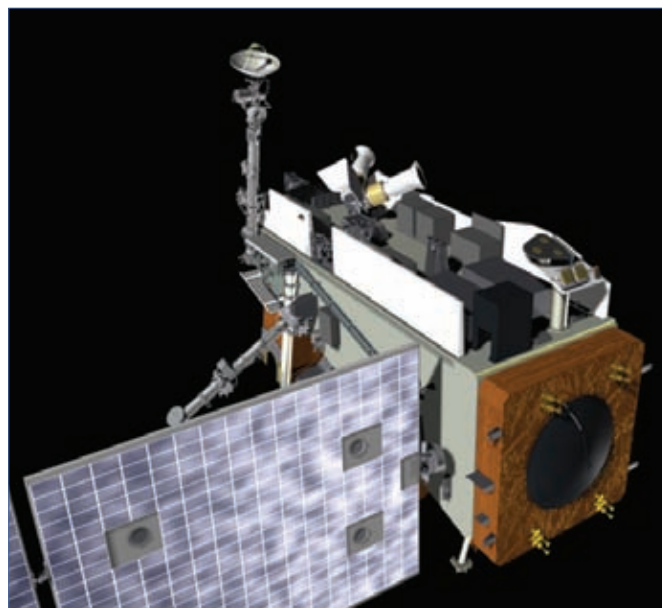
Space-based manufacturing might sound a little odd at first glance – why would anyone bother? It turns out, there are several advantages to manufacturing items outside a planetary atmosphere; The unique environment of space can enable industrial processes that cannot be readily reproduced on Earth; Potentially hazardous processes can be performed in space with minimal risk to Earth's environment; Raw materials, mined off-Earth, can be used in space instead of being transported back to Earth at great expense; Items too large to be launched into space economically can be assembled there instead. Made In Space has been instrumental in demonstrating manufacturing in space. It's 3D printers, designed specifically for a zero-gravity or micro-gravity environment, were launched to the ISS in 2014, and are

currently demonstrating closed-cycle in-space manufacturing, and exploring the possibilities of 3D printed food, among other tasks.

What's next?

As with any movement, change won't happen all at once. Old Space is here to stay for the foreseeable future, however, we're already beginning to see the first steps beyond it; billionaires are, for the first time, investing heavily from their private funds into fantastical futuristic NewSpace projects, while venture capital investors and venture funds are also getting in on the action.

For the first time in a long time, the NewSpace era has highlighted a change in priority as far as education goes; the movement owes as much to science and engineering advancements as it does to the arts. No longer is the space community solely about STEM; it's now all about STEAM (Science, Technology, Engineering, Arts and Maths). For NewSpace endeavours to be successful, it's as vital to imagine and create as it is to have a well-constructed business model and the engineering capabilities to back it up. Just as Arthur C. Clarke imagined the world's first satellite communications system in 1945, so do today's entrepreneurs have to dream and imagine of what might be possible decades down the line.



Next-generation, commercial Earth observation is coming in leaps and bounds



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You will be able to find NewSpace international at www.satellite-evolution.com and from April, its own dedicated site at www.newspaceinternational.com.

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