CHALLENGES BRIEF

New Frontiers

Innovation in spacecraft design

The space race helped develop many technologies we use today, such as digital imaging chips. But satellite technology is now lagging behind consumer electronics, making access to space is costlier than it needs to be. It's time to bring innovation back into space.

Our vision

We want to bring the radical innovations seen in consumer electronics into the commercial space sector. Today's smartphone processors are more capable than a top-of-the-range PC of a decade ago, but a fraction of the size. Space hardware has not seen the same progress. And yet innovations in miniaturisation have great potential to cut costs, improve satellite design and support commercial space applications. The UK's thriving space sector stands to benefit from these innovations, and society will benefit from cheaper and more ubiquitous use of satellite services. But for that to happen, there need to be new incentives that embolden satellite designers to take risks and make changes.

The challenges and their context

Commercial spaceflight is big business. Though it has a low public profile compared to government-funded missions like the International Space Station or Rosetta probe, private money makes up the lion's share of the global annual space budget. Commercial spaceflight (using a broad definition that includes things like satellite TV, weather forecasting and global positioning) is worth more than double all the spending by national space agencies and military space programmes in the world combined ($181bn to $75bn annually).[1] While the details of this accounting can be quibbled with, the importance of spaceflight cannot: vital services from crop monitoring to storm forecasting rely on it. Expanding the sector and making it more efficient would bring worldwide economic and social dividends.

Britain plays a significant role in commercial spaceflight. Although we don't build our own rockets (in Europe, France is the dominant player), British firms are both huge providers of the hardware that gets launched on them, and of the services that are provided by them. This includes UK domiciled multinational corporations like Sky or Inmarsat, large British branches of foreign firms like Airbus Defence & Space in Stevenage, and a plethora of small and medium enterprises, like pioneering small satellite manufacturer SSTL and innovative

[1] OECD (2014). "The Space Economy at a Glance". Available from: http://www.oecd.org/sti/the-space-economy-at-a-glance-2014-9789264217294-en.htm

space hardware designer Oxford Space Systems. Britain also plays an outsize role in space science and engineering research through labs like UCL MSSL and RAL Space.

Yet spacecraft design remains fairly conservative. Satellites are largely bespoke; launching them costs tens of thousands of dollars per kilo. Once in space, hardware faults can't be repaired. Being risk-averse, sticking to tried and tested technology is completely rational.

That means that spacecraft are often built using relatively old technology. There has been little experimentation with standardised and miniaturised electronics like those used in smartphones. Satellites still run mainly on bulky hardware similar to the desktop computers of a decade ago, because while they may be large, they are reliable and well understood.

The result of this entirely rational behaviour is spacecraft that are less technologically able, heavier and bulkier than they could be.

Challenge prizes could be one solution to give satellite designers incentives and the confidence to make the radical improvements that modern technology could allow.

Current innovation

- SSTL's STRaND-1 satellite (2013) incorporated a Nexus One smartphone as part of its payload. The mission was only partly successful.
- NASA's PhoneSat programme has launched a handful of Android smartphone-based nanosatellites.
- Oxford Space Systems specialises in lightweight foldable, deployable structures - going so far as employing an engineer with expertise in origami as part of their team.
- CubeSats are a standard for small satellites with a volume of just 1-3 litres, requiring extensive miniaturisation of components. Several dozen have been launched since 1999, for commercial, research and amateur applications.
- TechDemoSat-1 an Innovate UK/SSTL mission (launched 2014) to trial novel technologies in orbit.

The potential for challenge prizes

- A prize on adapting modern miniaturised electronics and system-on-a-chip technologies to make them truly spaceworthy (for instance, radiation hardened and certified to survive repeated heat cycles and high g-forces). This could involve both technology demonstrator satellites and testing (or modelling) on the ground.
- A prize on developing electric propulsion so it can work before a spacecraft’s solar arrays are deployed, avoiding the need for (heavy and bulky) backup chemical propulsion systems.
- A prize on improving technology for deploying, manipulating and aligning spacecraft systems (such as antennas, solar arrays or reflectors), allowing them to be folded up tightly during launch, taking less space and reducing weight.
- A prize in designing low-cost and low-weight fast data transfer for nanosatellites using laser communications. Nanosatellites and distant probes in the outer solar system currently have very slow connections.

Prepared for the Nesta Challenge Prize Centre by Olivier Usher. Last updated 26/04/2016.