Innovative Space Instrumentation Concepts Open up New Remote Sensing Markets

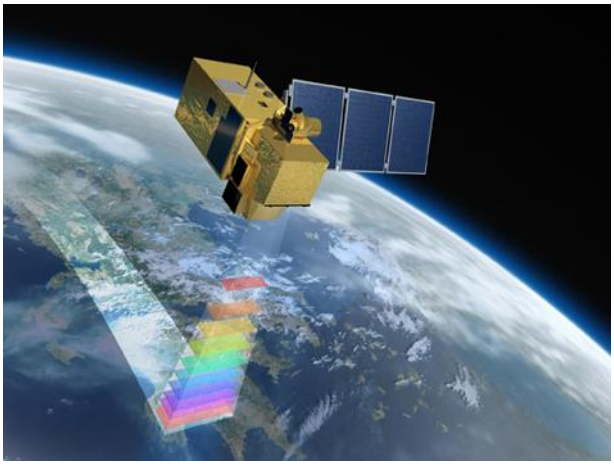
Human civilization is having a dramatic impact on Planet Earth and for several decades there has been a growing need to minimize the negative impacts of man's activities alongside supporting sustainable improvements in social and economic well-being. The scale of the challenge requires us to understand what is happening to the planet on a range of scales, from the local to the global, and Earth observation provides a unique capability to provide knowledge across this range.

From the first Earth observation (EO) satellite launch in 1960 to the upcoming launch of a whole fleet of new EO satellites in the Copernicus programme[1], the remote sensing technologies used to observe the Earth have been increasing rapidly in range and technical sophistication. While the public may be most familiar with optical imaging capabilities such as Google Earth[2], a wide range of other sensing modalities are used to monitor and measure the Earth, mainly in the radio-wave, microwave, infrared, and optical parts of the electromagnetic spectrum. Between them these sensing modalities are rapidly increasing our understanding of Planet Earth and the impact human civilisation is having.

The UK Centre for Earth Observation Instrumentation (CEOI) has been driving the next generations of technology in this field for many years. CEOI's activities have so far focused on the early stages of instrument development, supporting projects to develop new instrument concepts, prove technical capabilities, and raise technology readiness levels. In addition to projects which increase instrument performance, there is a strong focus on reducing the size, weight and cost. The EO instrument is only one element of an EO mission and the reduction in size and weight can enable several instruments to be flown on the same satellite, or dramatically reduce the cost of launching the satellite.

As with all such programmes, progress is often both evolutionary and revolutionary and CEOI is supporting the evaluation of a range of innovative new mission and instrument concepts that could transform our ability to understand what is happening to Planet Earth. These include:

- The Wavemill mission concept for a hybrid interferometric SAR instrument, measuring ocean dynamic properties such as ocean currents.
- New Doppler radar concepts to provide information about the three dimensional nature of clouds and precipitation microphysics
- A geosynchronous radar mission giving real time data on events on land (e.g. landslides),



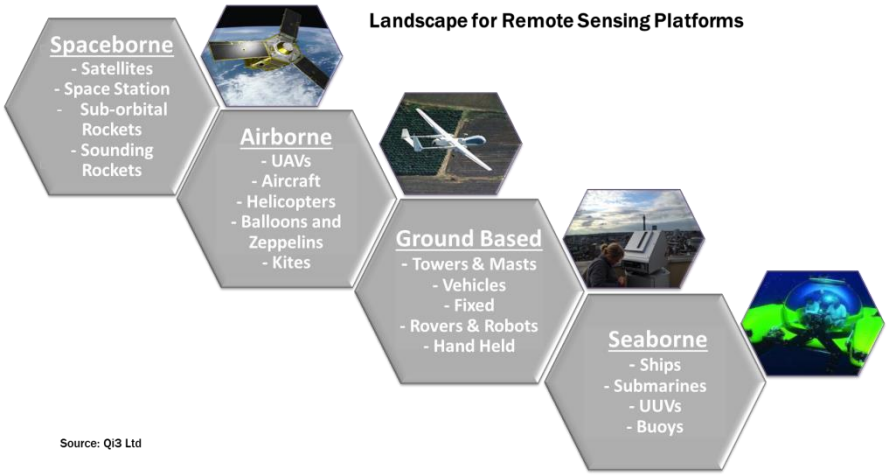
[1] *Copernicus, previously known as GMES (Global Monitoring for Environment and Security), is the European Programme for the establishment of a European capacity for Earth Observation http://www.copernicus.eu/.*

[2] *Trade Mark of Google Inc.*

and in the atmosphere (for weather forecasting).

- Miniature laser heterodyne radiometer for monitoring atmospheric gases such as CO_2, CO, NO, O_3.
- Low cost THz sounder for measuring gases in the upper atmosphere, especially the concentration of key gases such as atomic O, OH, H_2O, NO.
- Novel multi-wavelength photon counting lidar system which will give more accurate and informative data on forest canopies.
- Methane emission imager using discrete shortwave infrared spectral bands.
- Ultra-compact air quality mapper using an artificial neural network and differential optical absorption spectroscopy.

In addition to improving the performance of remote sensing instruments in space, the work of CEOI in reducing size and weight is opening up new markets and applications for these instruments. Satellites are only one of several platforms on which remote sensing instruments can be deployed. There are a range of airborne, ground based and seaborne platforms that can be used depending on the application.



This change is already happening in ground based remote sensing applications. Optical absorption spectroscopy instruments, originally developed to understand atmospheric chemistry with observations from space, have now been deployed on the ground to measure city-wide air quality. And new laser heterodyne radiometers with very high sensitivity can be built into instruments that are able to detect explosives at a distance of tens of meters, giving the security forces valuable new tools in the fight against terrorism.

Aircraft based applications for remote sensing, such as gravity gradiometry and ground penetrating radar, have been around for over 10 years. But now aircraft as a platform are being challenged by the rapid development in unmanned aerial vehicle (UAV) capabilities, which is allowing their transition from military to civilian applications. UAVs have significant advantages over aircraft in cost, deployability, and use in 'dull, dirty and dangerous' applications. Combining UAVs with the next generation of smaller, lighter, remote sensing instruments for EO will open up a wide range of new applications and markets. It is highly unlikely that UAV based remote sensing instruments will replace satellite based ones, as each platform has significant advantages and disadvantages. When these are mapped, it is surprising how complementary they are to each other, opening up the likelihood of them working together collaboratively to meet future applications and market needs.

As human civilisation has an increasing impact on Planet Earth and globalisation more closely entwines our futures, EO instrumentation, whether deployed on satellites, UAVs, or ground based installations, is likely to be used in an increasing range of applications. Emerging markets include Fire & Rescue, precision farming, disaster monitoring, inspection of critical infrastructure, geo-physical surveys, and environmental monitoring. Future markets are likely to arise in the fields of civil development, natural resources, disasters, environment, energy, and people.

The Centre for Earth Observation Instrumentation (CEOI) is working with the Satellite Applications Catapult[3] to identify the priority future markets which can benefit from Earth observation data. The CEOI is funding a wide range of innovative new instruments that measure our weather, our atmosphere, the icecaps, and many other aspects of the natural environment. Many of these are finding fascinating new applications in everyday life.

Further information about these projects and others funded by the CEOI can be found at www.ceoi.ac.uk. You can also contact CEOI Director, Professor Mick Johnson: Tel: +44 (0)1438 774421 or email: mick.johnson@astrium.eads.net for more technical information on the projects and Robin Higgons: Tel +44 1223 422404 or email: robin.higgons@qi3.co.uk for information on new applications and markets.

[3] The Satellite Applications Catapult is a new type of independent innovation and technology company, created by the Technology Stategy Board to foster growth across the economy through the exploitation of space. They help organisations make use of and benefit from satellite technologies, and bring together multi-disciplinary teams to generate ideas and solutions in an open innovation environment.