Stargazing

Alan Brunstrom of the European Space Agency explains the impact that space technology could have on the rail industry in signalling and telecoms.

Railways and satellites are not obvious companions, but an increasing number of rail companies across Europe are starting to explore the commercial and operational benefits of integrating space technologies into their systems.

The users range from rail operating companies and the banks which own the rolling stock, through to the organisations responsible for maintaining the rail infrastructure. Applications under investigation include train tracking and signalling, locomotive performance monitoring, communications for maintenance crews and the prediction, monitoring and alerting of landslides or subsidence.

It is significant that all of these applications are distinctly down-to-earth. In fact, when the European Space Agency introduced its Integrated Applications Promotion programme (IAP), the starting proposition was that the long-term growth of the space industry depends upon integrating space and terrestrial technologies to meet clear user needs, rather than the technology-push that has often characterised the industry in the past. This may simply be a cleverer form of sell but it offers real benefits to potential users – such as rail companies.

ESA is a not-for-profit organisation, jointly owned by 18 European states. It runs a great many programmes across virtually all aspects of space, with a total budget in the billions. Within this, the IAP has a budget of €56m to help fund feasibility studies and demonstration projects across a wide range of markets. The UK's Technology Strategy Board is the largest contributor to the programme and has the largest number of projects and participating industry consortia of any European country, and they are eager for more. ESA works closely with the TSB to identify potential topics for new projects, which may be addressed either by open competitions or through unsolicited bids by consortia of industry suppliers.

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The IAP programme is headquartered at ESA's main technical centre in the Netherlands (Estec) but the agency has recently opened a new centre at the Harwell Campus in Oxfordshire. This hosts an IAP ambassador whose primary focus is on transport, although all other market sectors are also catered for.

IAP is already funding one rail project in the UK. Following a preparatory study to identify the exact user requirements, the IRISS project (Intelligent Railways via Integrated Satellite Services) is working with East Midlands Trains. This is being observed by the Future Communications and Positioning Systems Working Group, which includes the Rail Safety and Standards Board, Network Rail and the Department for Transport.

The project's aims are to generate more fuel-efficient driving, better information to support decision making, improved reliability of trains and accurate, up-to-date timetable information. From a space perspective this is relatively straightforward: it combines the GPS satellite navigation with a low-earth orbiting satellite communications system.

The clever bit is the way in which this is integrated with not only the terrestrial mobile communications network (GPRS) but also the on-train systems and back-office utilities. The latter is provided with accurate train time, location and speed. Additional capabilities to be investigated include CCTV, on-train sensors and data records, fuel metering and passenger information systems. Some of these could be significantly enhanced by implementing broadband communications but these are more costly and represent an area for future exploration.

IRISS illustrates a cardinal rule of IAP: all of its projects must involve the use of at least two different space systems. There are four to choose from: satellite communications

(satcoms); satellite navigation (satnav or GNSS); earth observation (EO); and systems or technologies derived from human space flight (HSF). The underlying logic is simple: combinations of these different systems lead to capabilities that are greater than the sum of their parts. The extent to which this is true can be surprising. For example, most people have some understanding of the capabilities of GPS for positioning but few realise that the system also provides precise timing information, or that it can provide location in three dimensions. When this is combined with the capability for two-way communications it becomes very powerful: when that capability is extended into areas beyond the coverage of terrestrial services it can make all the difference to the viability of many applications.

A case in point is the extension of information management systems to areas of the rail network that do not have trackside fibre to support communications services. This obviously affects some rural lines in remote parts of the country. It can also affect maintenance gangs working in telecommunications 'not spots' in the middle of even the most highly developed areas, such as in deep cuttings.

If the work is relatively short term, then they may not be able to access the fibre network, so if they are in one of the innumerable coverage gaps that exist in the mobile phone networks even on open stretches of the main lines, the communications issue can be critical for both operational efficiency and safety. Yet there is a simple remedy in the form of the new generation of portable broadband satcoms systems, which are far less expensive to buy and use than their predecessors of even a couple of years ago. These systems need line-of-sight to the satellite but if that is a problem, it can be overcome by the addition of a short-range terrestrial radio net, which is a commonplace piece of kit used in many other markets (the media, aid agencies and peacekeepers, to name but a few).

ESA is considering the possibility of an open competition in another area of keen interest to the rail industry: the threat to transport infrastructure from landslides, subsidence and other forms of earth movement. Space systems have already demonstrated their capabilities in this area through a programme called GMES (Global Monitoring for Environment and Security), which deploys earth observation satellites to monitor even the smallest movements and changes in topography. Many of the key studies delivered by this programme have been published by the Terrafirma project (www.terrafirma.eu.com), which is a cooperative venture by ESA and the European Commission.

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The IAP interest is to take this work a stage further by integrating the EO capability not only with terrestrial systems and GNSS but also with satcoms. The aim would be to determine the extent to which it is possible to predict and pre-empt damage by close monitoring and the provision of alerting services.

This could be of relevance not only for dramatic events such as the rock falls that have affected the rail network in the Highlands of Scotland, but also for more widespread issues affecting the Victorian-era earthworks constructed in the shale and clay landscapes that predominate across most of England. In this context GNSS can provide information on very small soil movements in 3D, which in combination with EO could enable measurement down to a few millimetres. Satcoms would be used to deliver the data automatically from remote areas with no terrestrial telecommunications networks and perhaps also to contribute to an alerting service.

As most landslides are related to heavy precipitation and soil moisture levels, integration with a precise weather forecasting capability is implicit. This would likely include the gathering of data from weather stations placed in situ at the target sites; and with detailed geological surveys where these have not already been carried out.

The landslide example thus illustrates another tenet of IAP: that the satellite element is often only a small (but critical) part of a much bigger system. ESA believe that this is the secret to the future success of the satellite industry. Satellites happen to be particularly good at aggregating large numbers of users who are spread across wide areas. Each individual application may be quite small, but by finding their natural niches and aggregating them to achieve economies of scale, satellite systems become highly cost-effective.

The proof of this, however, is in the project – and ESA is actively looking for potential users in the rail industry who are interested in exploring what space might be able to do for them.

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FOR MORE INFORMATION

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