▲ 17 GAARDIAN units are currently deployed around the UK for measuring GNSS quality of service

Guarding against GNSS disruption

Andy Proctor* talks to *MITE* about the evolution of two GNSS jamming detection systems – GAARDIAN and SENTINEL – and reveals how the technologies might one day be deployed in a maritime scenario

Three years ago a research consortium was formed to develop a system capable of monitoring fluctuations in the local RF environment that would indicate the presence of GNSS jamming. Christened GAARDIAN [sic] the group was led by Chronos Technology, a company that delivers timing and synchronisation services and GPS solutions to the telecoms and defence industries among others, and funded by the UK's Technology Strategy Board (TSB) and the Engineering and Physical Sciences Research Council (EPSRC).

One of the major challenges in the early part of the GAARDIAN (an acronym aptly conjured up to mean 'GNSS Availability, Accuracy, Reliability anD Integrity Assessment for timing and Navigation') was handling the vast amounts of data that would need to be processed as monitoring was underway.

The hardware and software that eventually resulted employed special algorithms that reduced the quantities to a more manageable size. The probes were also conferred with 'semi-intelligent' decision-making circuits, which could ascertain whether or not a particular anomaly was a real problem.

Meanwhile the dual approach of using GPS and e-Loran came about because a verifiable reference point is needed. 'It is not inconceivable that a suitably high-power jammer could overload the GPS receiver in the probe. With e-Loran acting as a back-up, we can obtain a more accurate picture of the level of GPS degradation,' explains Chronos' Andy Proctor, responsible for the commercial aspects of the programme.

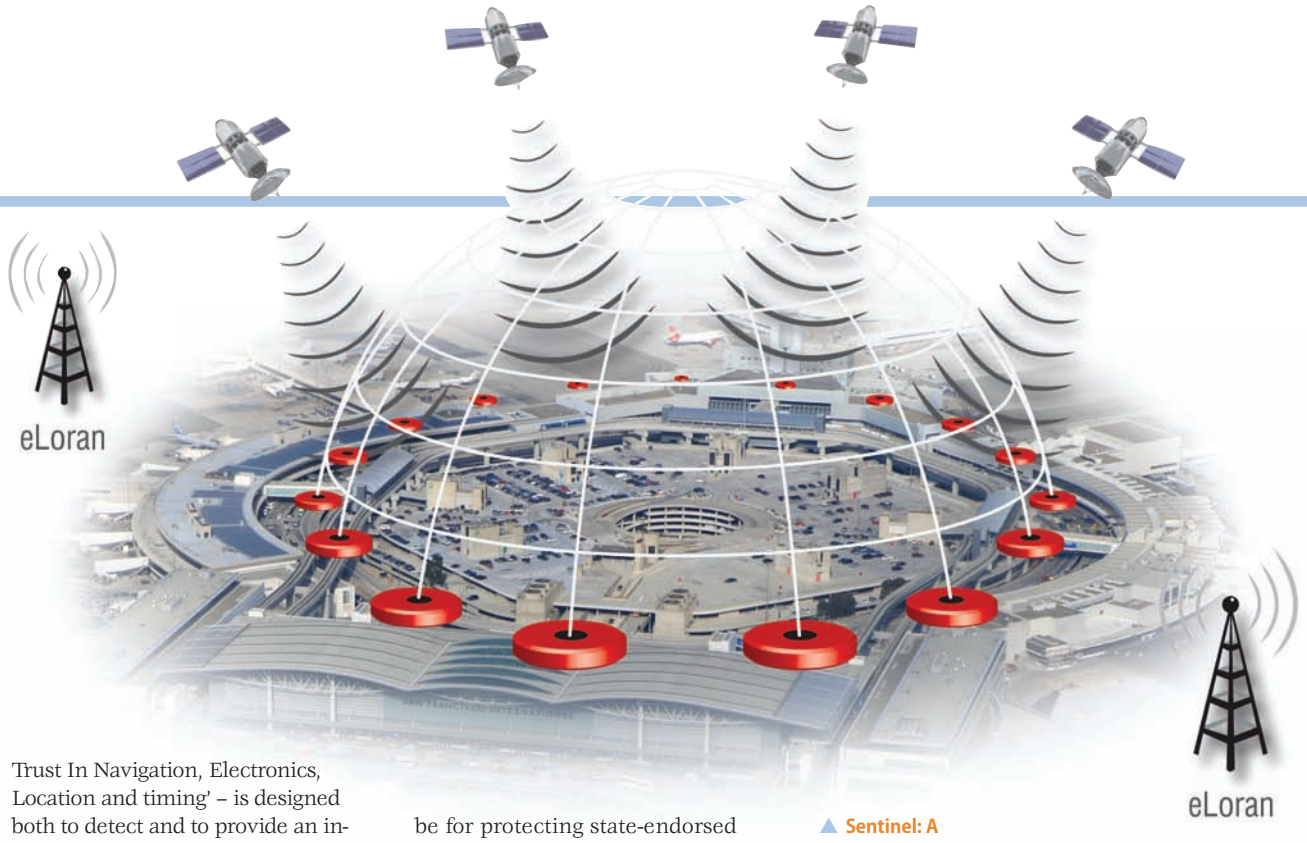
Doing as much number-crunching as possible on the probes at the point of reception is also important to reduce the bandwidth requirements for sending the data home to Chronos' servers at its headquarters outside Gloucester, England for further trend analysis.

The GAARDIAN probes are not small mobile devices. They are static monitors that require their own power-supply and feeds to GPS and e-Loran antennas. The 17 units currently deployed around the UK are sited at consortium locations including BT facilities and some of the General Lighthouse Authorities' and Ordnance Survey monitoring stations. Proctor elaborates: 'The current probes fit in a standard 19–inch server rack unit, primarily because that's a convenient form-factor. But they could equally be housed in a durable plastic box for outdoor locations. Data could feasibly be transmitted back via 3G modem rather than DSL.'

At HQ engineers can access the data from any probe through a web interface powered by GoogleMaps. The hope was that GAARDIAN would go some way to protect critical infrastructure, such as airports and harbours among others, from jamming. However, while it could alert authorities about possible disruptions, it was unable to pinpoint their source. Explains Proctor: 'The difficulty arises due to the various power levels used by different jammers. Low-power units may only impact a hundred feet or so, but a high-power device could have a sphere of influence of over half a mile. This challenge is being addressed in SENTINEL, the successor project to GAARDIAN.'

'We met with Association of Chief Police Officers and they gave us an insight to the criminal use of jammers and talked about a much more tactical kind of system. What we realised is GAARDIAN is good for wide area monitoring, for QoS, integrity etc, but SENTINEL will have to work in a localised manner. It also needed to discriminate between man-made interference, whether intentional or not, and natural disturbances caused by space-weather,' he continues.

SENTINEL – a shortened way of saying 'GNSS SErvices Needing



▲ Sentinel: A web of sensors allow GNSS signals to be monitored

Trust In Navigation, Electronics, Location and timing' – is designed both to detect and to provide an indication on location of the jamming source. An installation consists of a web of probes that effectively encircle the facility they are protecting. Then, should normal GPS operation be disrupted, it would be possible to triangulate the position of the jamming source. 'We can provide a circle of probability. From that, the authorities can be directed to an approximate location, narrowed down by using such things as hand-held GPS interference detectors.'

Chronos hopes that SENTINEL will provide a measure of confidence in the GPS signals being received by a user, whether for timing or positioning purposes. 'Maintaining trust in the system is important, because many kinds of national infrastructure – from finance to power generation – are all reliant on GPS for timing and synchronisation. It is more than just location, location, location.'

Proctor suggests that SENTINEL could be further modified to use eLoran as a backup source of accurate timing if GPS can no longer be trusted due to jamming or some other interference.

For now, the main target user group for the SENTINEL system are security related or those infrastructure operators for facilities that the government considers critical: power stations, airports and seaports and such like. The next tier down would be for protecting state-endorsed projects such as in GPS based pay-as-you-go road pricing. In Europe, one of the main uses of GPS jammers is to defeat such systems, notes Proctor.

Taking a wider perspective, the SENTINEL system does open up some interesting possibilities in the maritime context, for example protecting offshore oil and gas drilling operations. 'In modern offshore energy projects there are countless GPS dependencies, from the myriad of systems used on the drilling rigs themselves to the dynamic positioning and other advanced electronics found on offshore support vessels (OSVs). Together, these represent a single point of failure,' says Proctor. 'With GPS so embedded in the success of these projects, the financial implications of a serious outage would be considerable.'

And in today's world, the idea of a group of environmental protesters wanting to take direct action against Big Oil cannot be dismissed as entirely irrational. In fact sabotaging the GPS in the vicinity of a rig might not even require true direct action: a jammer (together with power-supply) on a small raft could be floated into the target area from a safe distance.

Position correcting services, such as those delivered by satellite or other means, employed by the offshore industry for making sure DP projects go exactly to plan are typically not designed to compensate for full-out localised GNSS disruption. In this sense, SENTINEL would act as an extra layer of protection.

But the possibility of protecting entire shipping channels is – for the time being – probably beyond the scope of the technology. As it stands the system depends on probes being static – for example fixed on buoys or other maritime fixed infrastructure. If these are positioned in sea lanes, then all is well and good. But it would not yet be possible to install a probe onboard individual ships. 'Their metal construction is very noisy from an RF perspective, so any probe could susceptible to the self-induced jamming effect of the vessel's superstructure,' says Proctor. 'Moreover, they themselves are moving, which, even accounting for dead-reckoning, brings many other variables into the equation. These fall outside of the SENTINEL project but have been identified as future work to be done.'

** Andy Proctor is divisional manager for GNSS applications and solutions at Chronos. To learn more about the company's GNSS and timing systems, visit: www.chronos.co.uk*

*** Both GAARDIAN and SENTINEL were funded by the UK's Technology Strategy Board (TSB) and the Engineering and Physical Sciences Research Council (EPSRC).*