

## **A one-day workshop on Radio Frequency Communications, NOCS, 7<sup>th</sup> October 2008**

The workshop was chaired by Gwyn Griffiths (NOCS) in the morning and Bernie McConnell (SMRU) in the afternoon. The aims of the workshop were to facilitate information exchange and to establish informal links between engineers to make better use of the pool of expertise within NERC on RF communications. This was the second in a series of technology workshops under the banner of the Oceans2025 programme.

The workshop began with people introducing themselves and briefly describing their expertise. See appendix for a list of attendees.

### **Satellite Communications**

Mike Prior-Jones (BAS) led the first session covering satellite communications. Iridium is the most widely used system at present and the current constellation of satellites is expected to last until at least 2014. The company hopes to begin launching new satellites in 2013. The system works well for ships, buoys, floats and AUVs, although cheaper airtime and higher data rates would be welcome. A major drawback for marine mammal use is the time taken to establish a connection from a cold start. This needs to be reduced from tens of seconds to a few seconds. Several people complained about the difficulty of getting technical information out of Iridium. This is due in part to the fact that Iridium is widely used by the military and security services. Jon Campbell (NOCS) suggested contacting [NAL Research](#) in the US (suppliers of Iridium airtime and hardware) to see if they had any interest in developing a modem specifically for animal tracking.

Mike Prior-Jones described Iridium's OpenPort product that is aimed at ship operators seeking a cost effective voice and data system. This is achieved by combining a number of Iridium modems into a single compact unit and operating them in parallel.

Jon Campbell described the RUDICS service that allows Iridium dial-up connections over the Internet rather than the public telephone network, which may reduce instances of lost calls.

The Met Office is using Iridium drifters manufactured by Metocean, and POL use Iridium modems in their Myrtle pop-up capsules.

Jeff Pugh (POL) showed an Inmarsat BGAN system made by Hughes that offers broadband connection speeds from virtually any land based location. This is a portable system rather than a mobile system. Inmarsat do offer a marine version (called FleetBroadband) that uses an actively steered antenna, although an omni-directional antenna may be available soon. POL use the BGAN system for some of their land-based tide gauges which will form part of tsunami monitoring systems. Costs are £1 – 2.5k for the BGAN set then 5MB/month for around \$170/month. Since it uses geostationary satellites it is less power efficient than LEO systems such as Iridium.

Chris Balfour (POL) and Robin Pascal (NOCS) spoke of their mixed experiences with Orbcomm. The airtime costs are reasonable (£35/month for around 1.2MB/month), but the communicators are tricky to use and some brands have proved unreliable. The system is best suited to platforms that stay within 2000km of a single ground station. It also suffers from interference from other VHF transmissions in the same band.

Discussion then turned to Meteosat that offers free airtime for small amounts of approved data. The maximum data rate is around 4kB/hour and the system is most suited to fixed locations.

Phil Lovell (SMRU) led a brief discussion on the status of the ARGOS system, which seems to be declining in usage as some applications switch to Iridium. Seimac are soon to discontinue making transmitters, but a new smaller (sugar-cube size) model should be available soon. Better numerical models are now available for reducing position errors.

Mike Prior-Jones volunteered to produce a paper comparing the main available satellite systems in terms of costs, power requirements, latency, antenna size etc.

## **Ground-, Water-, and ice-penetrating radio**

Keith Jackson (SAMS) gave a short presentation on current injection radio and his plans to investigate its effectiveness for through-water communication. Possible applications mentioned were data retrieval from shallow landers or networks of bottom instruments and communication between networks of small buoys. The work at SAMS is at an early stage and it may turn out that the power required to communicate over useful distances is too great. However, the system's simplicity means it would be very cost effective to implement. Gwyn Griffiths mentioned Wireless Fibre Systems who offer an underwater radio system based on inductive techniques. Also Offshore Hydrocarbon Mapping is a company using high power (sub-1Hz) inductive techniques to survey sub-bottom oil reservoirs. They might be able to provide data on background noise measurements.

## **Terrestrial radio**

The afternoon session on terrestrial radio commenced with Phil Lovell describing how SMRU have developed a system for attaching transmitters to seals using a PIC to control a Siemens GSM modem and running off a single 3.6 V lithium D-cell. They have recently started using FTP to transfer data rather than SMS messaging, as this is more robust. Cold start-up times are around 10 seconds, but can be greater than 90 seconds when first registering with another Service Provider (i.e. roaming to another country).

Lance Thompson (SMRU) spoke about designing ARGOS antennas for use on seal tags, and the far more difficult task of designing tri- or quad-band GSM antennas. Seals can dive to 2000m so antennas must be able to survive this. Steve McPhail (NOCS) reported similar problems in obtaining reliable antennas for the Autosub AUVs, especially the new 6000m rated one. Coaxial underwater connectors had also caused problems.

Lee Fowler (NOCS) described a 0.5W UHF/VHF beacon he had developed for the PELAGRA snow-catching float. The nature of the instrument necessitates the use of a whip antenna but despite various designs it has proved impossible to increase the range beyond 4.8 km.

Mike Prior-Jones demonstrated an HF radio system. This can work over several thousand km but is worse near the poles and equator. Mike is applying new signal processing techniques to improve the performance, and is hoping to achieve data rates comparable to the 2400baud offered by Iridium. Globe Wireless has a chain of coastal HF stations offering cheap email services to shipping up to hundreds of km from shore. Field parties in the Antarctic use 20W HF sets with a range of up to 2000 km.

Steve McPhail described Autosub's 2.4GHz WiFi system that allows high-speed communication with the support ship when the sub is on the surface. They would like to increase the range beyond the current 2 km but this is technically illegal (although easily achieved by boosting the power output at both ends). WiMAX is a hybrid of GSM and WiFi that uses a base station (that could be on a ship) to reach up to 30 km.

Bluetooth is used by SMRU to download data from peripheral sensors in seal tags where they get a range of 10 cm in water and tens of metres in air. POL use Bluetooth to download data from instruments in glass spheres. For through water communication lower frequencies give greater range.

Taimur Khan (SMRU) explained the use of Zigbee to monitor social networking in animals such as seals or sheep. Small, primitive tags may be used to record interactions with other tags. The tags use [Meshnetics](#) modules and employ a "seal2seal" self-organizing protocol developed by SMRU. This was compared to the Ocean Tracking Network used to track salmon acoustically.

Mike Rose (BAS) and Matt Mowlem (NOCS) then discussed the potential for swarms of UAVs and drifting buoy networks. Recent proposals had been let down by the lack of a proven communications link able to operate very close to the sea surface. This was identified as a key problem that has yet to be solved.

### **Discussion and recommendations**

Bernie McConnell rounded off the workshop by asking how we could build on the momentum established by this meeting. NERC is seeking to encourage networking between its various branches, and it was even suggested that the underlying message was “collaborate or die”!

The following actions were agreed:-

1. Jon Campbell will write up notes from the workshop and these will be circulated to Phil Williamson at NERC and to Jackie Pearson for inclusion in the Oceans2025 newsletter.
2. Further technical workshops should be held and Mike Rose volunteered to host one on batteries and other power sources at BAS in spring 2009. Other topics suggested were biofouling and best practice for embedded systems.
3. We should attempt to coordinate proposals that have a high technical/engineering content, by for example providing letters of support to teams in other NERC institutes.
4. Jon Campbell agreed to oversee the setting up of an on-line forum for NERC technologists.
5. Mike Prior-Jones will produce a paper comparing all the available satellite systems in terms of costs, power requirements, latency, antenna size etc.



**The workshop team at NOCS, 7<sup>th</sup> October 2008  
(Photo: Barry Marsh)**

**Appendix below:**

## Appendix

### Websites of possible interest

NAL Research supply Iridium airtime and hardware

<http://www.nalresearch.com/>

AST satellite airtime and hardware supplier

<http://www.satcomms.com/>

Trident Sensors (Bill & Helen) supply Iridium trackers, antennas etc.

<http://www.tridentsensors.com/>

Metocean produce Iridium drifting buoys

<http://www.metocean.com/>

Underwater radio modems

<http://www.wirelessfibre.co.uk/>

Offshore Hydrocarbon Mapping

<http://www.ohmsurveys.com/>

<http://www.globewireless.com/>

HF buoy tracking for fishermen

<http://www.marineinstruments.es/>

<http://www.satamatics.com/>

<http://www.inmarsat.com/>

### Attendees

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...plus a few who were unable to make it:-

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