# Future radar developments

## by Hugh Griffiths

The subject of radar has been around for getting on for a century—since Hülsmeyer's *Telemobilskop* in 1904, which was arguably the first radar—and can thus claim to be a rather mature subject. It might be tempting to imagine that such maturity implies that there is little research left to be done. After all, radar is subject to the laws of physics; the detection performance of a radar can readily be predicted using the radar equation, and at first sight it would appear that increased performance can only be gained by 'brute force' methods such as higher transmit power or a larger antenna aperture.

But this is far from the truth. Radar is a 'systems' discipline, so it benefits from parallel advances in technologies such as computing, semiconductor devices and antenna arrays. Equally important are advances in the understanding of propagation, clutter and target characteristics. The past couple of decades have witnessed tremendous progress in (for example) synthetic aperture radar imaging, ultra-wideband radar, and stealth and counterstealth technology, and major advances continue to be made in these areas.

Much of this was illustrated at the IEE International Radar Conference, RADAR 2002, held in Edinburgh in October, and which provided a showcase for new work from all over the world. The event forms part of a series of international radar conferences, originally established as a co-operative initiative between the IEE and the IEEE nearly 40 years ago, and in which conferences are now held internationally on a five-year cycle.

One particular highlight included a session on bistatic and netted radars. It has been observed[1] that bistatic radar is a subject in which interest seems to vary cyclically on a period of approximately 20 years. The very first radars, before the advent of transmit-receive switches, were of necessity bistatic. The 'first resurgence' occurred in the late 1950s and early 1960s, and led to the development of semi-active homing missiles; the 'second resurgence' took place in the late 1970s and early 1980s, and resulted in a number of practical systems, and some of the first experiments using 'illuminators of opportunity'. The present 'third resurgence' is due, amongst other reasons, to an interest in the technique as a counter to stealth technology, and has led to the development of several systems using VHF or UHF broadcast transmitters as illuminating sources. The present interest is also fuelled by the inexorable advance in signal processing power, the ever-greater increase in spectral occupancy (which from the point of view of bistatic radar using illuminators of opportunity is a positive factor), and the advent of GPS, which is able to solve many of the location and synchronisation problems.

Another highlight included several papers on developments in clutter modelling and in the understanding of clutter phenomenology. A contribution by Ward and Tough reported on advances in understanding of the causes of sea clutter 'spikes', suggesting that there are in fact three different scattering mechanisms, and proposing two developments of the widely-used compound K-distribution model to take this into account.

Other advances reported at the conference include developments in the use of radars at the extremes of the conventional radar spectrum (low-frequency—UHF, VHF and HF—radars, and millimetre-wave radars), ground-penetrating radars for the detection of buried objects such as landmines, and advances in the use of space-time adaptive processing (STAP), which is now moving from being the (rather theoretical) subject of computer simulations to one which is now applied to real experimental systems and data. Several authors reported advances in phased array techniques. A particularly interesting development is the concept of spatial diversity, in which a phased array radar may radiate different signals for different purposes in different directions, relying on adaptivity both on transmit and receive, in spatial, spectral and waveform coding domains. In this way the radar can perform multiple tasks in parallel and is no longer constrained to look in one direction at once.

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A contribution by Watts and co-workers tackled the very important issue of specification and measurement of radar performance, pointing out that modern adaptive multi-mode radars cannot realistically (or cost-effectively) be proved against their specifications solely in experimental trials. This means that it is instead necessary to develop simulations of the radar and its environment, that are understood and trusted by both the manufacturers and the procurers of the radar, and which can be used as the basis for acceptance of the radar equipment. This represents both a leap of faith and an enormous challenge, but will be essential if modern radar systems are to be procured and accepted in an efficient and timely manner.

The paper in this issue (see p. 263) by Merrill Skolnik—very much one of the *doyens* of the radar world—echoes many of these themes. Dr Skolnik, who was formerly Superintendent of the Radar Division of the Naval Research Laboratory in Washington DC, USA, has had a distinguished career that has spanned over five decades, and has authored and edited two textbooks on radar which have a natural place on the bookshelves of radar engineers all over the world. His contribution therefore provides a rather special insight into the future development of the subject.

So radar is certainly alive and well. Continuing advances in technology, and particularly in processing power, will allow corresponding advances in radar systems, and in our ability to model and predict their performance. The IEE's Professsional Network in Radar, Sonar and Navigation will play its part in allowing engineers worldwide to exchange ideas, and to present and discuss these advances. To access this PN, please visit http://www.iee.org/OnComms/pn/radar/

### Reference


1 WILLIS, N. J.: 'Bistatic radars and their third resurgence: passive coherent location', IEEE Radar Conference, Long Beach, USA, April 2002.



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