Then and Now
Signal Processing and Antennas

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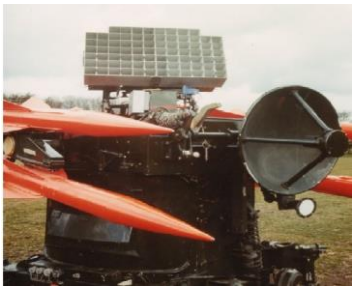
Rapier Low Level Air Defence System

- Technology for solid state sources for wideband microwave p-t-p links developed at STL in the 1960s and 70s
- Rapier entered service in 1972. The array antenna and the drive unit were built by Paignton from STL designs
- New receiver system developed for Rapier enabling low angle target elevation to be determined simultaneously with azimuth and velocity
- The first digital “3D” radar at the battlefield scale



Rapier entered service in 1972 and variants are still in service today. STL with STC Paignton provided key improvements to the S-band Radar system made by Decca, later Racal.

First was the solid state drive unit which used technology originally developed at STL in the 1960s and 70s for wideband microwave p-t-p links.

This unit was produced in large numbers by STC Paignton

Working closely with the Engineering team at Paignton the S-band array antenna was developed into a highly successful product whose electronic performance was exceptional and was achieved in a most difficult environment.

Drawing on the beamforming techniques invented for the Doppler MLS receivers and the flexibility of the newly emerging VLSI components a completely new receiver system was developed for Rapier. It enabled multiple beams to be formed in the receiver so that low angle target elevation could be determined simultaneously with azimuth and velocity.

Only limited numbers were made but this was almost certainly the first digital “3D” radar at the battlefield scale.

Navstar Global Positioning System

- STL enters UK Navstar programme in 1977, capitalising on extensive expertise
- Beats incumbents to win main contract in 1978
- First 2D fix achieved in Dec 1978
- Eight STL designed receivers were built by STC Defence systems
- Units provided 3D position to ~3m and velocity to 0.1m/S, matching the competition
- Concurrently STL won the competition to build the Navstar airborne anti-jammer antenna

The STL designed Navstar receiver as supplied. Trialled in Tornado, Type 42 and Submarines

The STL designed GPS adaptive antenna under test in the specially shaped anechoic chamber

Today GPS (Global Positioning System) is an everyday part of our lives. It provides location and direction in our phones and cars and its precise timing plays a major role in the internet and in finance. It works by receiving coded signals from a number of satellites. When decoded the receiver knows the distance to each of them and can work out its position with high accuracy.

In 1977 ITT DCD was the supplier of the key satellite modules but when ITT Avionics lost out in the user equipment programme ITT urged STL to enter the UK programme which was about to be launched. Following the MLS programme we had extensive navigation system and signal processing know-how and didn't need much urging!

We won a design study and then, in May 1978, won the main contract to build 8 full performance receivers, beating the incumbents, Decca and Plessey. We also built a basic receiver to work with the early satellites and in December 1978 Philip Hargrave made our first 2D position fix.

The 8 STL designed receivers were built by STC Defence systems. We had an amazing team lead by Bob Hall with Peter Jones leading on software. The two computers were LSI 11-23s with very limited memory, programmed with Coral66. One controlled the receiver and the other provided the navigation solution.

The units were integrated with inertial systems to eventually provide 3D position to ~3m and velocity to 0.1m/S; as good as anything from the USA, and gave the Airforce and Navy the opportunity to independently assess Navstar's performance.

What happened to all this know-how in Signal processing and Antennas?

- 40 years on large numbers of radars of all types use array techniques and DSP and the massive flexibility provided by ultra fast processors
- What STL achieved then in adaptive array signal processing (AASP) was way ahead of the curve
- Multiple input-multiple output (MIMO) beam forming and smart antennas are now emerging as a core technology for 5G systems
- Large numbers of the Navstar Antennas' direct descendants are flying today, made by Raytheon UK
- A much smaller GPS receiver was designed by STC Navigation systems
- The multiple beamforming technology was sold to Ace-Axis for applications in cellular radio systems
- Knowledge of GPS signal and the understanding of propagation effects like multipath was applied to GPS simulator design, a product line which is still in existence today

40 years on large numbers of radars of all types use array techniques and DSP and the massive flexibility provided by ultra-fast processors.

What STL achieved then in adaptive array signal processing (AASP) was way ahead of the curve. It was possible because of the integrated nature of the STL operation with people who understood antennas, signal processing and microwaves working together in one laboratory.

Multiple input- multiple output (MIMO) beam forming and smart antennas are now emerging as a core technology for 5G systems. Development of the AASP technology under Nortel progressed significantly but its demise dispersed the expertise.

With the expertise in antennas and beamforming we won the MoD contract for a Navstar (GPS) adaptive antenna to counter jamming. This technology was transferred to Paignton and sold to Raytheon UK and large numbers of its direct descendants are flying today.

A much smaller GPS receiver was designed with digital signal processing and VLSI and ~50 were sold by STC Navigation systems. The multiple beamforming technology was sold to Ace-Axis for applications in cellular radio systems.

The knowledge of the GPS signal and the understanding of propagation effects like multipath was applied to GPS simulator design, a product line which is still in existence today.