RADAR

Radio waves can be used for purposes other than communicating between two distant points. By means of radio wave reflections, or echoes, from distant objects it is possible to accurately determine the distance to the object, its relative position, and its speed and direction of travel (if moving). Radar--Radio Detection and Ranging--was an experimental curiosity in the 1930's, but was pressed into wartime service in the 1940's, where it quickly provided the critical service of aircraft and ship detection. By the end of World War 2, radar technology had advanced to the point where radar had become vital to all ground, ship, and air operations. Following the war, many civil applications were found for radar, primarily air traffic control, air navigation, ship navigation, weather monitoring, ground mapping, and spacecraft operations. Other applications include search and rescue, iceberg patrol, and altimeters. Military applications are so pervasive today, that all weapons platforms rely on radars, other sensors, and their accompanying computer processing to protect themselves and to detect and attach the enemy.

The technology to perform these functions has evolved from a simple pulsed radar to the advanced multimode, doppler radar capable of precision tracking of multiple targets. Simple pulsed radars usually had antennas that moved mechanically to position the radiated beam, only had visual displays for the operator to view, and were generally stand-alone units not integrated with other systems. The modern multimode radar, under digital computer control, can automatically switch between general surveillance, target acquisition, target track, missile guidance, and navigation mode. Doppler refers to the shift in the radio frequency of the signal returned from a target that is moving; the processing of such a signal provides a powerful capability to discriminate and characterize a moving target, especially a small target "hidden" in a background of ground clutter and noise. Modern radars usually have array antennas, which means no mechanical motion, only an electronic repositioning of the beam. A variety of displays, both pictorial and numeric, are available, and the system is usually computer-coupled into the other major systems of the platform, ie; fire control and navigation.

Industry leaders in radar design and manufacturing are found in West Europe and the US. British, Dutch, Swedish, Italian, and French radars are excellent by modern standards. They are being marketed world-wide, including NATO, other developed countries, and many developing nations. Civilian versions of military radars, such as airport control radars, merchant ship navigation radars, harbor surveillance, weather radars, ground mapping, geodetic survey, and spacecraft control, are widely sold. US manufacturers participate heavily in this market, of course.

Military radars are vulnerable to attack by modern "smart" weapons designed to home on the transmitted radar signal, which acts as a powerful beacon. They are also vulnerable to electronic countermeasures designed to confuse or disrupt the radar. Numerous techniques have been developed to reduce these problems, such as reducing the ON time, adaptive adjustment of the antenna pattern, reducing transmitted power, or modifying the signal waveform itself to provide some immunity to jamming or deceptive practices. The radar's own integrated computerized processor will often recognize a developing problem, and automatically initiate an action to counter the debilitating effect.

The basic technical trends being incorporated into modern radars fall into the following categories:

a. Comprehensive processing to extract all possible information from the returned signals. Digital computers, optical processing devices, and advanced mathematical alogrithms are the key to these processors.

b. Attempts to "reduce the signature", or develop a quiet radar, are directed toward the stealth programs and other efforts that require covertness. To reduce peak power, yet maintain the average power, continuous wave (CW) signals or extremely fast pulse rate signals are employed. Such techniques can reduce the power by a factor of 1000 or more, without sacrificing performance. This reduced power greatly protects a radar from enemy detection.

c. Jam-resistent features, such as frequency hopping and spread spectrum coding, are extremely complex modifications to the signal waveform for the purpose of overcoming interfering signals. This is a new, but very promising, technology and is not widely implemented at present, but the technology is available world-wide.

d. Small size and low weight are premium features for modern radars. Many airborne and spaceborne applications benefit from these features, but the most stringint need for miniaturization is in aerodynamic, tactical missiles having self-contained radar guidance systems. These radars usually operate at higher frequencies, such as EHF or optical.

Most modern electronic equipment, including radars, are specifically designed for easy maintenance by low-skill technicians. Modular packaging, plug-in units, and automated diagnostic checks simplify the process of repair. Therefore, many countries that lack a highly skilled work force are able to effectively use advanced electronic equipment in their armed forces. The result is that LDC's can frequently maintain a military capability level well above what might otherwise be expected.