ELINT: A Scientific Intelligence System

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During the initial phases of the Battle of Britain a German bomber, relatively safe under cover of darkness, flew over the blacked-out landscape heading for London. At a specific moment the bomber dropped its bombs, which accurately hit their target, and another successful German Luftwaffe attack was history. Electronic advancements by the Germans made this possible. British interception and analysis of this new electronic bombing device countered the Germans' success and continued to render less effective every subsequent electronic advantage the Germans developed. In a parallel manner the Germans developed a highly effective electronic intelligence effort directed against the Allied raids originating from Britain. This phase of electronic intelligence, utilizing electronic means to determine enemy electronic capabilities, began in England just before World War II and has been an ever increasing effort which today is called ELINT.

ELINT is a coined word for the process of electronic intercept and analysis of electronic intelligence - a process about which very little has been written. The intelligence officer, unless he is in the electronics field himself, has had little contact with ELINT. By directive ELINT is defined as: "the collection (observation and recording), and the technical processing for later intelligence purposes, of information on foreign, non-communications, electromagnetic radiations emanating from other than atomic detonation sources." In simple terms, ELINT is the detection and analysis of radiations from foreign electronic devices for the purpose of extracting information of value to intelligence.

Just as a flashlight radiates a beam of light observable to the human eye, electronic devices emit or radiate non-visible, non-audible radiations which are detectable and recordable, using electronic devices just as the human ear hears sound. This interception or collection of enemy radiations is the first stage of ELINT.

The formal definition restricts ELINT to "non-communication electromagnetic radiations other than atomic detonation sources." This means that ELINT is responsible for all radiations except those used in voice or other communications such as radio or telegraph and those resulting from atomic sources. What other kind of radiations are there? To name a few with which ELINT deals, there are radiations from missiles and missile guidance devices, radiations from developmental laboratories and field testing stations working on electronic devices, radar, navigational aids, anti-aircraft and aircraft gun direction, air-to-air or air-to-ground identification signals, and so on.

"Technical processing for later intelligence purposes" means subjecting the collected ELINT raw data, usually in the form of beeps on a magnetic tape or wire, to a detailed analysis by use of complex electronic equipment. This equipment permits the analyst to hear with his ears, to see on an oscilloscope, to measure very accurately, to photograph, to compare with standards and to investigate the intercepted signal in as many ways as are necessary to identify the characteristics of the foreign device. When the "technical processing" is completed the technical analyst can pass to the intelligence analyst detailed information on the location and capabilities of the foreign device. The intelligence community can then combine this information with other knowledge to estimate the over-all competence and possible intentions of foreign powers.

For a technical look at what ELINT really is let us turn for a moment to basic physics. Here we remember that electromagnetic energy, like light, travels in waves. These waves vary in length and form a spectrum. We are all familiar with the rainbow with its colors ranging from red, having waves of 760 millimicrons in length (400 million megacycles/sec), to violet, with waves of 385 millimicrons in length (800 million megacycles/see). This color spectrum is a part of the electromagnetic spectrum. The radio portion of this electromagnetic spectrum is used primarily for communications and military weapons. Currently the military weapons use radio waves varying from a few thousand cycles (waves per second) up to 100 kilomegacycles (one hundred billion waves per second). The following diagram illustrates the position of the radio and color spectrums in the over-all electromagnetic spectrum and an expansion of the radio spectrum showing the bands where different Soviet electronic devices radiate.

For a specific example of how ELINT works, let us take a simplified look at Soviet radar. Soviet radar devices radiate electronic impulses at certain frequencies and in definite beams searching the sky for long distances and great altitudes for any object that may be present. When these impulses strike an object they bounce off and return to a ground or airborne receiver which calculates the length of time between emission and reception and the strength of the signal received. From this, the Soviet radar operator can generally tell the size, speed, direction, altitude, and other pertinent information about the unseen object. Our Strategic Air Command, with its retaliatory mission, urgently requires every possible bit of information on Soviet radars - particularly on their location and capability. This is where ELINT goes to work. By intercepting, amplifying, recording and analyzing an enemy radar signal or pulse, we can learn all about it. By studying the type of radiation, its modulation (AM, FM, pulse) its pulse repetition rate, pulse duration, pulse shape, its radio frequency (position on the electronic spectrum), its antenna pattern characteristics, and so on, we can identify the radar, compare it with known information, ascertain its range, location, use, and other essential information required to evaluate its capability as a radar and its susceptibility to countermeasures.

This same process of ELINT pertains to any and all enemy electronic devices including airborne intercept devices used by guided missiles, guided missile launchers, fighter aircraft, longrange and short-range navigational aids, ground controlled intercept height finders, anti-aircraft and aircraft fire control radar, blind bombing devices, electronic radiations emanating from scientific laboratories or production plants, and so on.

What do these radiated signals sound like? Frankly they sound like noise or radio static during a thunder storm - in fact, before the more euphonious term of ELINT was coined, the British called it "Noise Listening" and, during World War II, had a "Noise Listening Bureau."

Although ELINT is a very complex field - constantly looking beyond present knowledge of electronics to fulfill its role of providing timely information on new foreign electronic developments, it need not be pushed aside as too complicated to be understood. Because of its complexity, some members of the intelligence community are inclined to throw up their hands and ignore this potential tool. However, ELINT is not too difficult to comprehend or use, nor is it an end in itself, but it can contribute essential, accurate information to the intelligence process.

Scientific intelligence and, in particular, ELINT, or electronic intelligence, had its start in England immediately before World War II. Early in 1939 the British Committee for the Scientific Study of Air Defense first drew attention to Britain's ignorance of new German weapons. One scientist, Dr. R. V. Jones, was appointed to look into the matter. Before he even started his task the war broke out and in June 1940, Dr. Jones, after considerable study, concluded that the Germans had developed a radio beam by which their bombers could operate over England regardless of weather, darkness, or cloud cover and still be most accurate in their blind bombing. This beam, just a little more than one-half mile wide, passed directly over London. Based on Dr. Jones' conclusion, steps were immediately taken to find any possible countermeasures. A Royal Air Force search aircraft was outfitted and it accomplished its mission of looking for and detecting this German beam. Technical analysis of this information provided the radio frequency and other characteristics of the beam, thus permitting the British to jam it and render it ineffective. Henceforth, many bombs intended for London fell harmlessly on the open countryside. This interception and analysis of an enemy electronic radiation (later known as Knicklbein) was the birth of present day ELINT. The Germans altered their beam system and soon began using a better system utilizing intersecting beams referred to as the "X" apparatus, which provided greater accuracy. These beams were at a different frequency than Knicklbein, requiring new search and analysis before the British solved this new threat and took countermeasures. With the "X" apparatus, the bomber flew along an electronic beam while its position along the beam was observed from a German radar station on the continent. When the bomber was over the target, it was told to drop its bombs. By now Britain's ELINT capability of intercepting and analyzing this electronic information was quite effective and continued to grow in scope and importance throughout the war.

During World War II the US made extensive use of electronic intercept devices in both the Pacific and European Theatres of Operation. Special USAF and Navy planes equipped with ELINT receivers ferreted out the secrets of German and Japanese antiaircraft radar and aircraft warning devices. From the use of such planes the word "ferret" was coined, a term presently applied to aircraft equipped to investigate enemy electronic radiations. Among the most deadly weapons directed against the Eighth Air Force were the German antiaircraft guns which were equipped with extremely accurate radar directors known as "Wurzbergs." The close formations of American aircraft made a juicy target for the more than 16,000 German antiaircraft guns. By use of radar intercept equipment (ELINT equipment) information was obtained which permitted the use of jamming devices, and thus the one-billion dollar investment of the Germans in their Wurzberg radars was literally ruined by the countermeasures made possible through ELINT. Knowing we had this capability, the Germans began a frantic search for non-jammable radar equipment, but the war was over before they succeeded.

Following World War II there was a period in which interest in ELINT, as in many wartime activities, tapered off. Some effort continued but the real push to provide intelligence on electronic advancements in other countries was not initiated until the USSR clamped down its Iron Curtain. Since that time, the collection and analysis of electronic signals radiating behind the Curtain has been the constant goal of ELINT. Since the birth of ELINT in 1940 the effort has grown in size, cost, importance, complexity, coverage, and capability, and, like most scientific efforts, is making yesterday's limits, today's capabilities.

Electronic intercept, to use one connotation of ELINT, provides factual information. Unlike the collection of much intelligence information where we are forced to rely on word of mouth, memory, or integrity of source, electronic radiations are intercepted and recorded by machine. If a signal is being radiated it can be recorded and later reported accurately even by someone who doesn't understand all that he is doing. Because of this factual nature, ELINT has provided substantiation of many intelligence estimates based on other intelligence processes.

During World War II, Air Force B-24 aircraft and radar equipped Navy Catalina aircraft were assigned the job of locating enemy radar in the Pacific. They spotted and pinpointed Japanese air warning sets scattered all the way from the Solomons to the China coast. A few days before the Leyte landing in October 1944 one of the ferrets discovered a new Japanese radar on Suluan Island at the mouth of the Leyte gulf. As this radar commanded the approaches to the Leyte coast line it was necessary to eliminate it and this was done on a commando raid by the US Rangers.

Currently, ELINT is providing the Strategic Air Command with the intelligence it requires on the location and range of Soviet radar. Through ELINT, information is acquired on the method, capability, and limitations of Soviet long-range navigation systems upon which their atomic bombers rely. Soviet missile tests are monitored by ELINT and the point may soon be reached where, by interception and analysis of the telemetering signal from Soviet missiles, we will acquire missile performance data vital to our National Intelligence Estimates. (Telemetering is the electronic system used in missile testing which records, codes, and transmits to ground test stations such things as missile speed, flight path, guidance, skin temperatures, and other behavior characteristics of the missile in flight.)

Since early in World War II the Army, Navy, and Air Force each have expended varying degrees of effort on ELINT, and in 1952 the Central Intelligence Agency entered the ELINT field. Although much of this individual endeavor was valuable, in 1954 better organization was given to ELINT - organization on a national level. The lack of proper dissemination of valuable intelligence produced by one organization but not always readily available to the others in the community was noted as a serious problem. When this situation came to the attention of the National Security Council a study was made, and National Security Council Intelligence Directive No. 17, entitled Electronic Intelligence (ELINT) was issued (in May 1955). NSCID-17 established the first national policy for ELINT and it is still the basic authority for the national ELINT program. It directed that:

> a. The US Communications Intelligence Board (USCIB) shall be the national policy body for ELINT.
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> b. The Department of Defense and the Central Intelligence Agency shall be responsible for their respective ELINT collection activities.
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> c. The technical processing of all ELINT shall be accomplished in a jointly-staffed center administered by the Department of Defense.

d. All data collected by the collection agencies shall be made available to the National Technical Processing Center (NTPC).

e. The NTPC shall effect the fullest and most expeditious processing possible and furnish the results to the interested agencies.

The present national organization for ELINT is rather complex, with many interlocking organizations and many formal and informal coordinating committees. The important consideration is that each of the services and CIA is free to run its own collection operations designed to furnish information it alone requires, but is expected to submit all collected data to the NTPC subject only to the minimum delays necessitated by prior exploitation for urgent tactical or operational purposes. One can immediately see the strong vertical organization for ELINT within each major component. It should also be appreciated that much horizontal collaboration is being accomplished by joint participation in such organizations as the KTPC and AFOIN-Z in an effort to coordinate individual activities into a national ELINT program.

In October 1953 a study was made of ELINT in CIA. This resulted in the appointment of an Agency ELINT staff officer and in the preparation of an Agency ELINT program which the Director of Central Intelligence approved on 29 May 1954.

Within the Agency ELINT is organized generally as follows. The Office of Scientific Intelligence develops targets and requirements for ELINT collection, furnishes scientific and technical guidance to Agency collectors, and performs the technical analysis and collation of ELINT with all source material n the production of scientific intelligence. The Clandestine Services conducts a continuing review of the potential and capabilities for -covert ELINT collection, implements specific clandestine activity in response to approved ELINT requirements, and coordinates US ELINT clandestine activities with foreign governments. The Office of Communications arranges for research, development, and procurement of ELINT equipment as required to support clandestine ELINT collection. The CIA ELINT Staff Officer advises the Deputy Director of Central Intelligence and appropriate operating components on the formulation, implementation, and coordination of ELINT plans, policies, and programs.

On the national level, much work has gone into summarizing what each organization requires in the way of information on enemy electronic developments. This sizeable task has resulted in a formal statement of the currently definable Specific ELINT Collection Requirements (SPECOR). This collection guide is based on the priority of the National Intelligence Objectives. It has been disseminated throughout the services and CIA field units for guidance as to what information the intelligence community requires and in what priority.

To realize the need for an adequate requirements system, consider that the ideal ELINT system is one capable of collecting all signals of interest and extracting all of the useful information from each signal. This is neither possible nor practicable, however. The questions of just what signals are of interest and just what information about them is needed must be answered in the light of the gaps in our intelligence. Thus, as in other branches of technical intelligence, ELINT is faced with the problem of relating scientific techniques to intelligence problems.

In general, ELINT targets fall into two major categories. The Army, Navy, and Air Force, charged with the military defense of our country, are primarily concerned with the location and capability of all enemy radar on a current basis. This is referred to as the Radar Order of Battle (ROB). The Air Force, for instance, must know where the heavy concentrations of enemy radar are so that its planes can either skirt the area or take proper countermeasures. The largest portion of intercepted enemy electronic information falls into this category of maintaining an adequate radar order of battle. CIA, on the other hand, is primarily interested in scientific break-through, or in not being surprised by new enemy electronic developments. This means that most ELINT effort is directed toward the interception and analysis of new and unusual electronic signals. Naturally in the course of searching for new and unusual signals, much order of battle information is received. This serves, in addition to supplementing the services operations, as a basis of comparison to determine what is new and unusual. The ELINT objectives of first priority to CIA relate to those signals which have yet to be intercepted or for which the radiating source has yet to be seen. Specifically, the targets are as follows:

a. Those non-communication signals which are, or are suspected to be associated with the Soviet or Satellite ability to deliver atomic or other weapons of destruction - that is, guidance or telemetry signals associated with missiles, airborne navigation, and bombing systems.

b. Those non-communication signals which are or are suspected to be associated with the Soviet or Satellite ability to defend their countries against the delivery of atomic or other weapons of destruction-that is, early warning, ground-control intercept, gap-filling radars, surface-to-air weapons systems, airborne weapons systems, ground surveillance systems, jammers, and so forth.

c. Those signals occupying an unusual portion of the radio frequency spectrum not normally associated with Soviet or Satellite equipment.

The equipment involved in ELINT is elaborate and complex. To make matters worse, the higher up the frequency spectrum you go the shorter your intercept range becomes, and the present trend toward higher frequencies means that ELINT equipment must get closer to the target or be designed with greater ranges, both of which approach the impossible.

ELINT equipment falls into two main categories: collection equipment (airborne, maritime, fixed station, or agent-carried) and analysis equipment (used on the ground to reproduce, readout, and analyze the collected information). Basically, the major components of an ELINT collection system are the antenna, receiver, recorder, direction finder, and analyzer. ((picture))

The antenna corresponds to the human ear. It is that component which first detects a signal. It is, of course, desirable that the antenna be very sensitive or, as we say in ELINT, have high antenna gain. This permits the maximum intercept range. The ideal antenna system would have the following characteristics:

a. a continuous and fixed broad area coverage,

b. very broad electronic spectrum coverage,

c. very high gain,

d. inherent capability for giving directional information.

These requirements are not all compatible. In practice it is necessary to compromise in order to gain a workable system. The decision as to which of the desirable characteristics can be safely compromised, and to what extent, is based on the frequency range of interest and also on the specific ELINT target under consideration. For instance, broad area coverage may be obtained by either of two means - a broad beam antenna fixed in space or a narrow beam, scanning antenna. The first method demands a sacrifice in gain. The second limits the time coverage of any part of the total area.

Following receipt of the signal by the antenna it is passed to a receiver. The function of the receiver is to convert transmitted information available at the antenna into a form that can be measured and recorded. Basically two general types of receivers are in use today - the superheterodyne and the crystal video. The operating characteristics of each receiver may be outlined as follows:

Superheterodyne - slow scan.

a. inherently high sensitivity,

b. good frequency resolution,

c. prohibitively long search time in many cases. Crystal video - wide open.

a. low sensitivity reducing maximum probable range,

b. frequency resolution problems,

c. search time considerably less than the superheterodyne.

From the receiver the signal goes next to the recorder where the signal is stored on magnetic tape or wire. There are two main reasons for recording signals. A permanent record of the signal is required for future analysis and for records, and on signals of short duration or higher complexity the operator may not have enough time or capability to evaluate the signal parameters before the transmission is ended.

Direction-finding equipment is sometimes utilized during the interception of the signal. It displays incoming signals on an oscilloscope or other azimuth-reading device giving the direction of the arrival of the signal.

Analyzers in the ELINT collection system are sometimes used during interception to provide a preliminary observation of the type of modulation and to measure the repetition rate, duration, and general shape of signal pulses. Signals are usually presented by a cathode ray tube (similar to a television screen), which provides a moving picture of the shape, size, and nature of the incoming signal pulse or wave form. The pictures are usually photographed as a permanent record. It should be pointed out that ELINT collection devices need not be huge in size, as are those used in ground, sea, and some airborne operations. Quite to the contrary, considerable use is made of miniature equipment no larger than a book. ELINT collection equipment is usually designed for the specific situation involved, whether it be a 60-foot parabolic antenna on the ground or a tiny, unassuming, hand-carried package.

The major components of an ELINT analysis system vary greatly with the purpose of the analysis. Order-of-battle analysis is often done automatically by IBM-type equipment. The analysis that CIA performs is not for order of battle but is to identify new and unusual signals. For this, man-operated equipment is required and an analysis position contains at least the following fundamental equipment: a tape transport used for duplicating or monitoring; a counter that measures and illustrates the modulation frequency; an ink-on-paper recorder to draw a continuous trace of the signal amplitude; an oscilloscope, which permits observation of the wave form; a vibralizer to display modulation frequency components versus time; filters to separate signals; a rapid-advance movie camera; and a host of other equipment to permit the analyst to scan great volumes of tape and film to separate that minute portion which, upon detailed analysis, may prove to be a new electronic development. ((picture))

It is hoped that this basic discussion of FLINT will provide a general concept of this complex scientific intelligence process. It should be realized that in the interest of readability many points have been simplified and technical details omitted so as not to confuse the non-technical reader.

If one considers that one-third of the cost of a modern fighter aircraft goes for electronic equipment and that most of the electronic devices which make up this equipment radiate signals, then one begins to understand how much there is to learn of Soviet capabilities by examining their use of electronics. This also applies to ground and sea weapons, including missiles. Recent news reports of Soviet developments in the scientific field demonstrate how heavily the Russians are relying on electronics and how advanced their development is. The Soviet earth satellites with their radiated signals are a responsibility of FLINT. FLINT must continue to intercept and to analyze Soviet electromagnetic emissions preferably in the research and development stages in order to keep abreast of Soviet electronic advancements and to attempt to predict future capabilities.

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