Chapter IV

CIA's Analysis of Soviet Science and Technology

Clarence E. Smith

This paper offers a general assessment of CIA's overall contribution to the analysis of Soviet capabilities in science and technology during the Cold War. It is by no means intended to be definitive, or even complete, with respect to all the activities associated with CIA's scientific and technological capabilities, analysis, and resulting reporting. It is, however, intended to cull some of the key events and selected activities that may contribute to reaching such a judgment.[1]

This paper is about technical intelligence (including collection, processing and analysis) and specifically about its emergence as an integral part of the assessments process concerning the Soviet Union throughout the Cold War. Although the focus is on CIA, it must be understood that technical intelligence—as a new, distinct discipline—was integral to the Intelligence Community as a whole, as well as to the military services, nonintelligence elements of the Department of Defense, other federal government agencies, and related private sector entities.

The period following World War II saw unparalleled growth in technological developments, and nowhere was this truer than in the East-West competition during the Cold War. New and technological capabilities on both sides offered opportunities for new weapons and new collection techniques. The prospect of new Soviet capabilities led US policymakers to demand that we understand not only the new technologies (for our own purposes) but also the extent and nature of Soviet capabilities. Urgent new collection requirements necessitated new, more sophisticated means of collection, which in turn required new technical analysis techniques and capabilities. The data acquired by

[1] I use the term S&T when referring to scientific and technical intelligence, or capabilities associated with its collection or analysis, whether CIA's or elsewhere in the US Intelligence Community. S&T, even at CIA, was accomplished in many organizational elements, not only within what we know as the Directorate of Science and Technology. When I mean the directorate itself, I refer specifically to the DS&T. Only some 10 percent of the documents declassified for this conference are assessments of scientific and technical subjects. Many of the reports relevant to making final judgments remain classified because sensitive collection methods and analytical techniques could damage current national security interests. Thus, more than with political, military, and economic intelligence issues, CIA's scientific and technical analysis available for scrutiny is included primarily in broader National Intelligence Estimates. Nevertheless, there is sufficient information available to support my general hypotheses. Fourteen of the recently declassified documents released in connection with the conference were especially useful in preparing this paper. That said, this paper draws more on inference and personal insight than is the case in other disciplines.

these new collection systems often helped clarify gaps in our intelligence. Thus, the need for scientific and technical intelligence on the Soviet Union generated a whole new set of requirements for new sources and methods, many of which remain current today.

With this as background, it is the premise of this paper that the development of technical intelligence capabilities at CIA led to significant successes in the analysis of Soviet S&T capabilities. A corollary to this development was that it led to major bureaucratic and organizational changes within CIA and the wider Intelligence Community. The major expansion of CIA's technical intelligence capabilities provided unique advantages to the United States and its allies in waging and winning the Cold War.

Overview

The emergence of the Cold War accelerated the development of ever more technically advanced weapons and generated early recognition of the need for additional technical intelligence. For US policymakers this meant obtaining data on Soviet weapons developments and operational concepts, identifying important new systems and, most important, developing the technical means for collecting and processing such data.

US intelligence on Soviet nuclear weapons development played an especially important role in the initial extension of technical intelligence into the Cold War. In this regard, the transfer of the Manhattan Project intelligence group from the Department of State to the new CIA enabled the Agency to build its scientific and technical intelligence capabilities. The complexity of the technical structure of the Soviet nuclear weapons development program and the many distinctive observables associated with it provided a nearly ideal, classic technical intelligence challenge to US analysts. In particular, the Soviet program demanded technical data that could be obtained only by new collection techniques.

By the 1950s, it was clear that the USSR possessed both nuclear weapons and the means of long-range delivery. But key questions remained for US policymakers. How far advanced and how effective were these capabilities? Could they be used against the continental United States as well as its allies? The answers to these questions were fundamental to US strategic deterrence.

Technical intelligence was the primary tool US officials used to address these questions. Because the USSR, Eastern Europe, and China (and later their surrogates such as Cuba and North Korea) were "denied areas," they posed difficult challenges to traditional forms of human and military reconnaissance collection. These countries were highly efficient police states that severely restricted internal movement and contacts with foreigners; they also had effective, modern air defenses. This meant traditional means of espionage and reconnaissance were limited in providing the needed information, much less access, by the West to Soviet Bloc weapons designers and remote test sites.

To counter this, CIA and the Intelligence Community developed new and innovative collection approaches, including overhead systems to collect images. These new systems allowed US analysts to discover the physical characteristics and locations of weapons, test ranges, operational sites, and support structures. Signals intelligence (SIGINT) collectors in these new systems eavesdropped on military exercises and administrative communications. Telemetry collectors intercepted and recorded the instrumentation signals transmitted by weapons undergoing tests; blast-detection sensors assessed the power of a detonation. Signal and power collectors measured emitter specifications, and there were a host of other collection techniques. S&T collection assets were deployed, both in the air and in space, under sea, and on the periphery of the USSR and were placed clandestinely within the USSR itself.

The lack of hard intelligence facts and having few human intelligence resources within the Soviet Bloc were the key drivers in developing both US aircraft and satellite imaging and signals intelligence collection systems. In addition to the actual technical collection, however, there was a parallel development in the analytical field as US analysts sought to make sense of the raw data. The challenge to the Intelligence Community was not only to create new collection methods but also to be able to derive useful information from the resultant data. The CIA's Office of Scientific Intelligence, and later the Directorate of Science and Technology (DS&T), was in the forefront of the development of both the new technical intelligence collection systems and the expanded analytical capabilities.

The intelligence reports and estimates available for this conference cover the period from the early 1950s through the mid- to late 1980s, and the effect of advancements in technical collection and analysis is readily apparent. There were no disagreements within the Intelligence Community on Soviet capabilities as surveyed in National Intelligence Estimate (NIE) 11-5-59, *Soviet Capabilities in Guided Missiles and Space Vehicles*, but by October 1964 (in NIE 11-8-64) debates had emerged over both the capabilities and the number of deployed sites for Soviet intercontinental ballistic missiles (ICBMs). These disagreements primarily resulted from having more data which meant more opportunities to have different interpretations of the available information. Similarly, in the defensive missile area, Intelligence Community analysts using the same data now disagreed in NIE 11-3-65 over whether and how the Soviets were upgrading their surface-to-air missiles (SAMs). These strategic offensive and defensive missile concerns stayed in the forefront of the intelligence debate well into the 1970s.

Technical Intelligence Issues

In the course of the Cold War, any number of issues arose that had to be addressed urgently by means of technical intelligence. In time, the Intelligence Community acquired an infrastructure of techniques, tools, facilities, and technical specialists that was able to respond to new questions as they arose. Some of the key issues are not surprising:

- Soviet nuclear weapons developments dominated in the early years, shifting later to matters of weapons and material inventories, compliance with testing agreements, and the transfer of nuclear technology to potential proliferators.

- Soviet ballistic missile development and deployment stayed high on the priority list throughout, but also underwent many changes of focus—counting numbers, determining characteristics, and monitoring for compliance with arms control agreements.

- The Soviet space challenge began with a burst of publicity and quickly became a matter of US military concern but did not materialize as a real threat issue.

- Soviet air defenses, antiballistic missile (ABM), and SAM missile upgrades became entangled with one another throughout the period, producing great concern and posing one of the most severe challenges to US technical intelligence.

- Chemical and biological warfare concerns emerged (and continue to this day), plagued by uncertainties and posing extraordinarily difficult intelligence problems, primarily because of the type of collection access required.

- Arms-control monitoring emerged as a highly defined issue and intelligence problem with the early nuclear weapons testing agreements and leapt to the forefront with the negotiation and conclusion of agreements with the Soviets covering reduction of arms and forces and qualitative constraints.

- The proliferation of weapons of mass destruction appeared comparatively recently, with much of its urgency arising from the demise of the Soviet Union and the end of the Cold War.

- Terrorism—at the end of the list but currently of dominant concern—has posed substantially different problems for which the intelligence infrastructure, built in the course of dealing with the foregoing issues, is largely inappropriate.

Two other issues generated attention. These were (1) the assessments of existing and emerging Soviet scientific and technical capabilities (such as stealth and supercomputers), and (2) the detailed characterization of the Soviet research and development cycle that led to the fielding of advanced (and sometimes unexpected) Soviet weaponry, achievements in space, or scientific breakthroughs.

CIA and Technical Intelligence

As early as 1946, when the Central Intelligence Group (CIG) was established, the need for scientific intelligence was recognized. Its importance was further emphasized in the 1948 report of the Eberstadt Task Force of the Hoover Commission, which stressed the likely overriding importance of scientific and technical intelligence and the need for a central authority responsible for assimilating all scientific information from abroad as well as competent to estimate its significance. The report concluded that "failure to properly appraise the extent of scientific developments in enemy countries may have more immediate and catastrophic consequences than failure in any other field of intelligence.[2] Recognizing the importance of scientific and technical intelligence, CIA in 1948 created the Office of Scientific Intelligence (OSI), an organization that brought together the collectors and the processors of intelligence information.

Concern that other countries might develop nuclear weapons and an awareness that advanced knowledge was the only practical shield against a surprise attack fed a sense of urgency among US policymakers. Concern extended to biological and chemical warfare and to the likely development of guided missiles, which would increase the danger of surprise attack on the continental United States. Despite such concern, little real progress took place until President Harry Truman's 23 September 1949 announcement of the first Soviet nuclear explosion. The next month the Director of Central Intelligence (DCI) created the Scientific Intelligence Committee (SIC) to coordinate the entire US scientific intelligence effort.

The required coordination, however, did not come easily. CIA chaired this new committee, charged with responsibility for scientific and technical intelligence, including all research and development up to the initiation of weapons systems series production. This concept was opposed by the US military, which sought to distinguish between basic scientific capabilities and weapons systems applications and keep the latter to itself.

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[2] Department of State, *Foreign Relations of the United States: Emergence of the Intelligence Establishment*, 1945-1950 (Washington, DC: US Government Printing Office, 1996), p. 1012.

There was some support for CIA's having this responsibility even within the defense establishment itself, however. The Research and Development Board in the Department of Defense, for example, was extremely dissatisfied with the intelligence support it received from the military intelligence agencies and supported the SIC as its primary source of intelligence support. Because of OSI's competence in Soviet nuclear capabilities, the military also accepted the Joint Atomic Energy Intelligence Committee (JAEIC) as a subcommittee of SIC, to be concerned with that subject exclusively. Shortly thereafter, other subcommittees were established on biological warfare, chemical warfare, electronics and guided missiles, and later on aircraft and antiaircraft weapons systems.[3]

The services did not give up, however. During the early 1950s, there was a long struggle within the SIC between its military and civilian members: Army-Navy-Air Force versus CIA-State-Atomic Energy Commission. In August 1952, the original directive establishing SIC (OSI's lifeline) was rescinded. A new directive dissolved the SIC and all of its subcommittees except the JAEIC. It was retained as a subcommittee of the interdepartmental Intelligence Advisory Committee itself. The intelligence agencies of the Department of Defense were given primary intelligence production responsibility with regard to weapons, weapon systems, and military equipment and techniques, including intelligence on related scientific research and development. The new directive assigned to CIA's OSI primary responsibility for scientific research in general, fundamental research in the basic sciences, and medicine (other than military medicine). The Defense Department agencies as well as CIA were now given responsibility for atomic energy intelligence, the original basis for CIA's scientific and technical effort.

The new directive had a negative impact on the morale of OSI. In reaction, it began to devote less attention and energy to asserting CIA's authority to coordinate scientific intelligence and more to developing its own capabilities for research in all fields of scientific intelligence, including weapon systems development in anticipation of a day when a new DCI would value such independent capabilities.

While OSI refocused its efforts in the Directorate of Intelligence (DI), there was a similar growth in electronic intelligence (ELINT) collection capabilities within CIA's Directorate of Plans, later to be known as the Directorate of Operations (DO). (In this paper, the term ELINT includes both radars and Foreign Instrumentation Signals, or FIS. Also "telemetry" and FIS are used interchangeably, although the latter is a more encompassing term. FIS are electromagnetic emissions associated with the testing and deployment of non-

[3] Several noted scientists in the Boston area, involved in US weapons-system developments and very concerned about the lack of US intelligence on corresponding Soviet developments, approached CIA/OSI in late 1950 and offered to assist. This group included the men who became the first three Presidential Scientific Advisors: James Killian, George Kistiakowski, and Jerome Weisner. They constituted what was known as the Boston Scientific Advisory Panel and were very valuable to OSI.

US systems that may have either military or civilian applications, and include telemetry; beaconry; electronic interrogators; tracking, arming, fusing and command signals, and video data links.)

CIA's ELINT efforts furthered its scientific and technical credentials through the 1950s. With the advent of the U-2 and later technical collection programs, it continued to grow. By the time S&T activity was first consolidated at CIA—in a Directorate of Research in 1962—there were well-established organizational units dedicated to scientific and technical intelligence in both the Directorate of Plans and OSI.

It was the creation of CIA's DS&T by DCI John McCone in 1963, however, that finally brought together all the key scientific and technical functions from the DI, the DO and the short-lived research directorate. From that point, true synergy began with respect to scientific and technical collection and analysis at CIA. And it did so—with Albert (Bud) Wheelon as the Agency's first Deputy Director for Science and Technology (DDS&T)—at a moment in history when decisive action was required.

A tremendous breadth of technical disciplines was drawn together in the new directorate. The DI's OSI, concerned with basic scientific research conducted by foreign countries, became a part as did a computer services group from the DI. The Office of ELINT came from the Directorate of Plans. The Development Projects Division, which had been responsible for developing the U-2, the SR-71 and the CORONA overhead systems, now joined the new directorate as did the Office of Research and Development, charged with applying new technologies to intelligence, and the Foreign Missile and Space Analysis Center, a group established to monitor foreign missile and space programs.

Wheelon did not merely create a new organization, however. The usefulness of the U-2 airborne reconnaissance program against the Soviet Union was reaching its end, and new ways to gather intelligence over denied areas were needed. New intelligence technologies would have to meet the urgent requirement for reliable and comprehensive intelligence collection. The new DS&T was focused on tackling this challenge, and Wheelon became one of the earliest proponents of CIA's participation in using outer space as a venue for future intelligence collection. Wheelon greatly enhanced CIA's S&T capabilities with the integration of system development, collection operations, data processing and intelligence analysis.

Throughout the rest of the Cold War there were bureaucratic adjustments in the S&T directorate reflecting changing capabilities and requirements in order to integrate intelligence analysis better across multiple disciplines. In the mid-1970s, for example, the Office of Weapons Intelligence returned to the DI, and the Foreign Broadcast Information Service (FBIS) and the National Photographic Interpretations Center (NPIC) were moved to the DS&T. Major modernizations enhanced NPIC's ability to meet the demands of real-time imagery and enabled FBIS to respond effectively to the growing importance of open-source collection. New leadership came to the directorate in the person of R. Evans (Evan) Hineman, who was intimately involved in the earliest days of technical analysis and later served as Associate Deputy Director for Intelligence. He became DDS&T in July 1982 and held the position until September 1989, directing and guiding key modernization programs during the last decade of the Cold War.[4]

Collecting, Processing and Analyzing the New Data

The overriding problem in the early years of technical intelligence was simply gaining access to information about Soviet facilities and activities. Because of the closed Soviet society and the extensive controls on movement and access, clandestine operations launched from outside the Soviet Union had a long history of being foiled.

Nuclear issues dominated US concerns from the time of the Soviets' first atomic weapons test in 1949, but during the 1950s, new and somewhat different problems began to compete for US intelligence attention. These included Soviet bacteriological warfare and chemical warfare developments and Soviet aircraft and electronics innovations.

In the early years, before the United States acquired hard intelligence on Soviet developments, US reports on a number of Soviet scientific and technical subjects were simply derivative. For example, the basic data in a 12 October 1949 memorandum on Soviet capabilities in air-to-air guided missiles and related proximity fuses were only extrapolations of information on missiles that were under development by the Germans. Once in operation, however, US technical intelligence could exploit technical data generated during the course of Soviet weapons development or manufacture. Such data appear in many portions of the electromagnetic spectrum (visual, radio and radar signals, infrared emanations, etc.), acoustic phenomena, nuclear radioactivity, forensic samples, and material and actual equipment available for analysis. Each required a different kind of access ranging from actual physical presence in a laboratory or plant to detection from many thousands of miles distant from a specific target.

On the one hand, the United States would collect whatever it could with the access available so long as there was some hope that the collected data would shed light on the matter of concern. On the other hand, the nature of the data required would dictate the kind of access. The US focus was on Soviet air, space, naval, and defensive systems (although selected ground forces systems were sometimes assessed) and on sensors, nuclear weapons,

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[4] Hineman was a member of the Science and Technology Panel at the Princeton Conference.

and chemical/biological weapons. In time, it became apparent that to acquire all the key performance characteristics of any of these systems, we would need a suite of new intelligence collectors and analytic tools.

Technical intelligence was the primary tool used to address these questions. The Intelligence Community was obliged to invent new and innovative approaches to collection via remote sensors, the most well-known of which were the U-2 and OXCART manned aircraft, ELINT (i.e., radar and FIS) operations, satellite imaging, and SIGINT systems. These systems revolutionized intelligence collection.

Following the unique manned aircraft reconnaissance programs, satellite imagery provided the foundation whereby compliance with highly complex arms control provisions could be adjudged by even the most paranoid elements of national security establishments. It was quite an accomplishment.

Other collection operations were mounted on the periphery of the Soviet Union. The Berlin tunnel is an early, somewhat bizarre example of a SIGINT collection operation. More important in the long run were facilities established close to Soviet borders so as to collect signals generated at installations (targeted by means of overhead imagery) within the USSR. Electronic collection aircraft flew and ships sailed along the periphery for this same purpose.

Operational support to the Directorate of Plans/Operations—America's "spies"—was yet another dimension of technical collection that contributed significantly to human-source penetration of Soviet strategic programs. The S&T has been nothing short of artistic in devising disguises, secret caches, hidden pockets, and concealment devices to store or transport sensitive or compromising material. Its contributions in the field of clandestine communications—keeping an agent's transmissions safe and secure—have encompassed both secret-writing systems and advanced electronic communications measures. In the full array of "gadgets" required to keep CIA's agents in the field effective and anonymous, the engineers and artisans of the S&T had no peers. The scope, scale, sophistication, innovation, daring, and, ultimately, the successes of CIA's S&T as a collector was unprecedented. The CORONA program, the first space-based reconnaissance program, was at the time so inconceivable that it provided an intelligence windfall for years before the Soviets took defensive measures against it. The *Glomar Explorer*, a ship built specifically to raise a sunken Soviet submarine from the bottom of the Pacific to salvage communications equipment and nuclear components, was a feat beyond the imagination of the Soviets until the story was disclosed in the US press. These are but two examples of a highly successful technical collection program.

A significant and critical counterpart of technical collection was the ability to apply new analytical techniques to emerging collection capabilities such as telemetry and precision parametric measurements analysis from ELINT, as well as systems and processes to deal with film and then digital satellite imagery. When Soviet designers flew aircraft or missiles, they placed sensors on critical components and radioed their status to the ground so that analysis could identify problems in the event of a flight failure. While the Soviet designer had the key to which sensors were being monitored by the hundreds of telemetry traces, US intelligence analyst had to unscramble them and make sense of the reading. The challenge to the US technical community was to deliver identifiable, useable data.

The wide distribution of collection system elements and the huge amounts of data collected required a system with the capacity to pass vast amounts of data, and containing data links able to ensure the security of the information carried, able to maintain connection with a range of collection platforms and data processing facilities, and able to serve a number of data recipients. The development of these links enabled the control of collection operations as well as the retrieval of the information collected. Getting the diverse sorts of data into a form suitable for interpretation and analysis depended on major advancements in computer technology. As collection systems became more capable, the need for speed and automated handling of overwhelming quantities of information also became critical. Meeting this major technological challenge led over time to the ability of US analysts to support near-real-time delivery of data and reporting.

Not all collection systems were developed and managed by CIA. Other parts of the Intelligence Community operated aircraft, satellites, maritime resources, ground-collection sites, data links, and processing facilities. All of them tended to operate with some independence but did a remarkable job of delivering vast amounts of needed data in processed form to the many different US intelligence analysis and production organizations.

Technical Intelligence—ELINT

To illustrate CIA's particular accomplishments, consider two of the specific aspects of technical intelligence where the Agency made significant contributions to an understanding of Soviet scientific and technical capabilities: (1) the collection and analysis of ELINT (including both radar emissions and FIS), and (2) overhead reconnaissance (both manned and satellite).

In the early days of the Cold War, concern over Soviet advances in electronics led to the inclusion of an electronics intelligence unit in the Agency's embryonic technical intelligence complex. ELINT, associated with radars, generally fell into two major categories. One involved intercepting and analyzing radar signals in order to identify radar sites and establish the general characteristics of Soviet radar systems (i.e., to establish a radar order of battle). This was the focus of the military services, which were primarily concerned with the location and capability of all enemy radars.

CIA was primarily interested in the other category: identifying Soviet scientific breakthroughs, analyzing Soviet weapons systems, and endeavoring not to be surprised by new developments. Specifically, CIA's interest was in electromagnetic emissions, preferably in the research and development stages of new programs, recognizing that not only ground-based radars but most airborne electronic equipment radiated signals that could be intercepted and used to evaluate capabilities.

In May 1954, DCI Allen Dulles approved a CIA ELINT program that was divided between the OSI for requirements and guidance and the Directorate of Plans for covert collection. OSI was to develop targets and requirements for ELINT collection, provide guidance to collectors, and perform technical analysis with which to produce finished scientific intelligence. Other CIA components responded by both independently (and covertly) collecting ELINT data and coordinating the collection of ELINT with foreign governments. CIA's ELINT objectives related both to new and unusual signals and, as a first priority, to those signals yet to be intercepted. The new targets were:

- Non-communications signals associated with the Soviets' ability to deliver atomic or other weapons of mass destruction, such as missile guidance or telemetry signals;

- Non-communications signals associated with the Soviets' ability to defend against the delivery of weapons of mass destruction, such as ground surveillance systems and surface-to-air weapons systems; and

- Those signals occupying an unusual portion of the radio frequency spectrum.

The need for an extremely precise signal collections capability resulted in the "precision parameter measurements system." It involved either measuring radar signal characteristics to a very high order of accuracy or measuring the radar's operation so as to determine its detection and tracking characteristics. The results were profound, giving the United States insights into Soviet radar developments that provided the basis, not only for defensive countermeasures (of value to reconnaissance and combat systems alike), but for offensive countermeasures as well.

CIA made the first serious attempt to measure the radiated power of radars for intelligence purposes in 1958 against the Soviet early warning radar known as Bar Lock. The system was considered a threat to the U-2 reconnaissance aircraft. Bar Lock signals were easily intercepted by a series of specially configured C-119 aircraft flights through the

Berlin air corridors. The Bar Lock project, while not entirely successful in power measurement, suggested solutions to many technical problems. It opened the way for additional collection and experiments and the development of new measuring equipment.

Precise knowledge of the radiation parameters of Soviet air-defense radars and SAM systems was needed to develop electronic countermeasures (ECM) systems to protect the Strategic Air Command's B-52 bombers as well as the OXCART reconnaissance aircraft being developed by CIA to replace the U-2. The OXCART program also needed information on the detection and tracking capabilities of the Soviet air defense system because the OXCART aircraft was being designed as a stealth aircraft. The trade-offs between stealth and flight performance of the OXCART created demands for precise ELINT data far beyond what could then be collected. CIA's Office of ELINT (OEL) created a new organization and special programs to develop new techniques that would go well beyond the routine monitoring of Soviet radars with the conventional ELINT equipment used by the National Security Agency and military services. The new CIA organization also established specific projects and developed laboratory-type instrumentation dedicated to measuring the exact radar radiation parameters needed by ECM and stealth design groups in CIA and Department of Defense (DOD). Full cooperation was offered at the highest DOD level, and arrangements were made to use military vehicles and ground sites as needed for specific projects.

During this early period, the capabilities of CIA's OEL to carry out power-pattern measurements were unique; there was no other comparable program in the US Intelligence Community or in the ELINT organizations of allied countries. Even the radar design-and-development laboratories had produced no similar self-contained airborne measurement systems. Because of OEL's unique capabilities, the US Air Force Air Proving Grounds Command and other groups arranged to use the OEL system to compare the patterns of simulated Soviet radars with those of the real ones operating in the USSR. One of the earliest benefits of this effort was that it revealed the Soviet's low-altitude radar coverage was far better than estimated. As a result, Strategic Air Command made changes to wartime penetration routes for its bombers. Another by-product of this activity was to incorporate electronic countermeasures into the OXCART aircraft's defenses to complement its speed and altitude advantages. Earlier in the OXCART program, designer Kelly Johnson and his team at Lockheed believed the OXCART's "stealth" characteristics (speed and altitude) were adequate SAM deterrents, but the power and beam measurements systems revealed the need for additional ECM equipment on the aircraft.

Similar efforts were directed against several different Soviet antennas to determine pattern measurements that would reveal their maximum beam power, total radiated power, the antenna gain, and variations in gain around the antenna. This intelligence discipline became important during the Vietnam War. Recorded antenna patterns were used to develop guidance systems for new anti-radiation missiles designed to home on to and destroy target radars. The Wild Weasel program—deploying an aircraft specially modified to identify, locate, and suppress or destroy ground-based air defense systems that used sensors radiating electromagnetic energy—owes much to this capability.

By the time of the launch of early Soviet satellites, it was known that their missile and satellite telemetry data could be intercepted and used for assessing system performance. Over several years, this capability, FSI, approached in quality and sophistication the status of a major scientific discipline and produced intelligence that had a major impact on US government decisionmaking.

To put this massive CIA effort into perspective, a 1969 internal study on ELINT noted that, of all signals intercepted and data collected:

- Only 1 percent dealt with performance and characteristics of the Soviet missile programs; the other 99 percent dealt with ground control, electronic warfare, etc.;
- Of the total, only 5 percent resulted in reports of technical information of S&T value;
- 94 percent dealt with electronic order of battle;
- The remaining 1 percent were "unusual" signals.

Reconnaissance of Denied Areas

ELINT, the second example of CIA's contribution to an understanding of Soviet S&T capabilities, involved the development of overhead reconnaissance for technical collection, using both manned aircraft (the U-2 and the OXCART [A-11]) and by satellites, the CORONA and follow-on systems.

First, reconnaissance aircraft and then satellites had a profound impact on US strategic decisionmaking. The data derived from these systems gave decisionmakers access to information of great breadth and unquestionable objectivity. The pace of development was driven by the urgent demand from US leaders for both higher resolution and more rapid delivery of overhead imagery, and for more effective SIGINT.

In the 1970s, the improved reconnaissance satellite capabilities became an indispensable tool for monitoring arms control agreements. These overhead technical collection systems, referred to as "national technical means," gave the US an excellent understanding of Soviet capabilities. DCI Richard Helms, in a 1978 interview with David

Frost regarding CIA's "triumphs" said, "The CIA was in the vanguard of that quantum jump in the use of intelligence derived from photographs, satellite electronics, overflights—a whole series of technological achievements."[5]

Developing the U-2

By early 1954, the threat associated with the growing Soviet nuclear capability and long-range bomber force received increasing attention by US policymakers. In response to a suggestion by President Dwight Eisenhower, a Technological Capabilities Panel headed by James Killian of the Massachusetts Institute of Technology was established to deal with the threat of surprise attack. The panel had three subcommittees, one of which—chaired by Edwin M. Land of Polaroid Corporation—focused on intelligence. Noting the difficulty of collecting intelligence within the USSR, the panel stressed the need to use science and technology to improve our intelligence "take."

Before this committee came into existence the US Air Force had a number of scientists and engineers from various universities and private industry helping resolve the problem of how to get better information on targets within the USSR. A number of these discussions focused on high-altitude reconnaissance aircraft. Such aircraft subsequently became one of the key recommendations of the Technological Capabilities Panel.[6] The Panel's recommendation resulted in the investigation of several possible systems, ranging from the use of existing aircraft to the search for a new, high-altitude reconnaissance aircraft. One was a Lockheed-proposed system designed by Kelly Johnson, the CL-282 (hereafter referred to by its more commonly known name, the U-2). The Air Force initially rejected the proposal, viewing the U-2 as essentially a sailplane that did not meet the specifications for a military combat aircraft. By mid-August 1954, however, Land's subcommittee (called the Project Three Study Group) was enthused about the U-2's potential for reconnaissance missions. At the end of August, Land discussed the U-2 with DCI Allen Dulles's Special Assistant for Planning and Coordination, Richard Bissell. At the time, it was not clear to Bissell why he had been briefed. In retrospect, one can surmise that Bissell was the best Technological Capabilities Panel point of contact at CIA for several reasons: his outstanding professional credentials, his acquaintance with James Killian, and his direct access to DCI Dulles.

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[5] "An Interview with Richard Helms," *Studies in Intelligence*, 45th Anniversary Issue (Fall 2000), p. 109.

[6] The Report to the President by the Technological Capabilities Panel of the Science Advisory Committee, Vol. II, *Meeting the Threat of Surprise Attack* (Washington, DC, 14 February 1955), p. 151. This declassified Top Secret report can be found in the records of the Dwight D. Eisenhower administration for 1952-61 in the Office of the Special Assistant for National Security Affairs, NSC Policy Papers, Box 16, Folder NSC 5522, Technological Capabilities Panel, Dwight D. Eisenhower Presidential Library, Abilene, KS.

By October 1954, the Project Three Study Group had drafted a complete proposal for a system based on Kelly Johnson's U-2 aircraft and wanted CIA to manage the program. Dulles discussed the concept with the Secretary of the Air Force's Special Assistant for Research and Development, Trevor Gardner. Dulles was reluctant to have CIA undertake the project, but the Project Three committee members took their case directly to President Eisenhower. Early in November 1954, Land and Killian met with the President to discuss high-altitude reconnaissance. Killian gave this account of that momentous meeting:

> Land described the system using an unarmed plane and recommended that its development be undertaken. After listening to the proposal and asking many hard questions, Eisenhower approved the development of the system, but he stipulated it should be handled in an unconventional manner so it would not become entangled in the bureaucracy of the Defense Department or troubled by rivalries among the services.[7]

On 5 November, Land wrote the DCI urging that CIA undertake the U-2 project with Air Force assistance. Land stated that the committee believed the DCI must always assert first rights to pioneering in scientific techniques for collecting intelligence, choosing such partners as needed to assist in the projects.

At a meeting on 24 November attended by the Secretaries of State and Defense and senior Air Force officials, Dulles and Deputy DCI Gen. Charles Cabell put forth a new proposal: a request to undertake the U-2 project. It was to be sent to the President. Dulles received verbal authorization to send it forward and Eisenhower concurred with the program proposal emphasizing that the project was to be managed by CIA. The Air Force was to provide the assistance needed to get the U-2 operational. With the decision made to proceed with the U-2 project, Dulles and Bissell turned to Arthur Lundahl, Chief of CIA's Photo-Intelligence Division, who immediately developed an expanded capability to handle the U-2's imagery product. By summer 1956, the Photo-Intelligence Division was in "new" quarters—the Stuart Motors Building just off New York Avenue in Washington—and ready for the photography analysis from the U-2. The program moved rapidly forward, but the Air Force continued to try—unsuccessfully—to get agreement that it would run the project once the planes and pilots were ready to fly. Eventually, President Eisenhower stepped in and settled the issue; he did not want uniformed, armed forces personnel flying over the Soviet Union. The CIA would continue to manage the U-2 program.

With the U-2 operational in 1956, there were three intelligence problems of primary importance where gaps in our knowledge had serious national security implications. First was the longstanding nuclear threat posed by the Soviet Union, second was clear evidence

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[7] James R. Killian, Jr., *Sputnik, Scientists, and Eisenhower: A Memoir of the First Special Assistant to the President for Science and Technology* (Cambridge, MA: MIT Press, 1977), p. 82.

of a Soviet long-range intercontinental bomber, and third was the great uncertainty regarding Soviet progress in developing long-range guided missiles. There just was not much hard data on any of these problems.

Approximately 19 months after program approval, on 20 June 1956, the first operational U-2 mission flew over Poland and East Germany. Upon landing, the film was taken to the United States for processing. The pictures were considered to be of good quality. Later, on both 4 and 5 July 1956, the U-2 over flew the Soviet Union itself. A new era in reconnaissance had arrived. For the nearly four years following, the program provided an impressive amount of information to US analysts. One of the U-2's early contributions to US intelligence was the information it provided showing there was no "bomber gap." This meant the requirement to build an even larger US bomber force was not justified by the existing Soviet threat. Another major contribution of the U-2 program was to increase the capabilities of the US deterrent force. Overhead photos were invaluable in determining the precise location of targets and information on Soviet air defense systems.

The U-2 also provided imagery of the major Soviet missile test ranges, resulting in significant new information on the existence and status of Soviet missile programs and revealing several "surprises." One was the fact that the USSR's Tyuratam test range had a significantly larger launch complex than expected. Another revealed a very large research and development complex at Sary Shagan. Although it was previously suspected as a location for ABM research, US analysts were not prepared for its huge size evidenced by dozens of facilities—including large, heretofore-unknown radars—spread over an area approximately the size of New Jersey.

While the driving force behind the U-2 was to obtain imagery, its potential to collect SIGINT was also soon realized and the U-2 became a dual-use reconnaissance platform, capable of collecting both imagery and ELINT. Special ELINT carried on many missions allowed CIA to analyze signals from Soviet electronic defenses and obtain information important in developing countermeasures and in planning routes for possible US bomber missions might take if necessary.

Adding the OXCART

In the fall of 1957, a little more than one year after the U-2 began flying over the Soviet Union, Bissell called for an operations analysis that would begin the design of a less vulnerable airplane. The study indicated that supersonic speed greatly reduced the chances of detection, so the idea was to design a vehicle that could fly at extremely high speed at great altitude and that could incorporate the best radar-absorbing capabilities. Designers from both Lockheed Aircraft Corporation and the Convair Division of General Dynamics set to work. Meanwhile Bissell, recognizing the magnitude and complexity of the project, assembled a small panel of distinguished scientists with Edwin M. Land as chairman to provide assistance. Over the next two years the panel met about six times, with the Lockheed and Convair designers attending some of the sessions. Assistant Secretaries of the Air Force and Navy, with technical advisors, also attended some of the sessions, and jurisdictional and bureaucratic feuds were reduced virtually to nil.

Late in November 1957, the panel agreed that it appeared feasible to build an aircraft meeting these more demanding requirements, and presented the findings to President Eisenhower. He approved the project and made funds available. Within a year, the two proposals (Lockheed's and Convair's) were complete and the President was again briefed. He gave final approval to the plans, paving the way for full development of an operational aircraft. The two proposals were submitted for review to a DOD/US Air Force/CIA selection panel on 20 August 1959. The panel selected the Lockheed design. In September, the Eisenhower administration authorized anti-radar studies, structural tests and engineering designs and on 30 January 1960 approved the production of 12 aircraft.

Manned reconnaissance made multiple contributions to US intelligence, primarily through photographic intelligence but also through ELINT. CIA developed two very different reconnaissance aircraft with unique and highly unprecedented capabilities. By-products were a very important aspect of the development: advances in aerodynamic design, engine performance, countermeasures, and so on. The product from these advances also produced the National Photographic Intelligence Center, established by the National Security Council on 12 January 1961. The new aircraft also laid the groundwork for the next and most significant new contribution to technical intelligence: satellite imagery.

CORONA and Satellite Film

CIA's participation in and successful management of the U-2 and OXCART programs resulted in its playing a similar role in the early satellite-film-return program called CORONA. Following a presidentially directed review of satellite reconnaissance in December 1958, Killian and Land assumed key roles in advocating future satellite reconnaissance. Killian, then President Eisenhower's new Special Assistant for Science and Technology and Chairman of the President's Science Advisory Committee, and Land met with the President on 7 February 1958. Eisenhower agreed to proceed with a film-recovery satellite as a separate, covert project to be run in a manner similar to that of the U-2. CIA's Richard Bissell would again serve as project manager, assisted by elements of the US Air Force.

The CORONA program, which began as a short-term, interim system, suffered through adversity in its formative years, then survived in glory throughout almost a decade. The technological achievements engineered in it advanced satellite reconnaissance efforts in eight years from a single panoramic camera system having a design goal of twenty to twenty-five feet ground resolution and an orbital life of one day to a twin-camera panoramic system producing stereophotography at the same ground resolution, to a dual-recovery system with an improvement in ground resolution to approximately seven to ten feet, with double the film payload. Finally, with the J-3 system, CORONA had a constant-rotator camera, selectable exposure and filter controls, a planned orbital life of eighteen to twenty days, and was yielding nadir resolution of five to seven feet.

CORONA progress was marked by a series of notable firsts: it was the first to recover objects from orbit, the first to deliver intelligence information from a satellite, the first to produce stereoscopic satellite photography, the first to employ multiple reentry vehicles, and the first satellite reconnaissance program to pass the 100 mission mark. By September 1964, CORONA had photographed all 25 of the Soviet ICBM complexes then in existence. Its value to US intelligence is epitomized by the fact that the Intelligence Community could, with confidence, make the following statement in a 1968 intelligence report: "No new ICBM complexes have been established in the USSR during the past year."[8]

CORONA also played a critical role in regional crises. For example, CORONA's coverage of the Middle East during the June 1967 Arab-Israeli war was invaluable in estimating the relative strengths of the opposing sides after the short combat period. Again in 1970, CORONA was called on to provide proof of Israeli-Egyptian claims with regard to cease-fire compliance or violation. CORONA was also critical in continuous monitoring of Cuba, Cubans in Angola, and Vietnam. Because Soviet arms and practices were a common theme in each instance, the information that was gleaned about Soviet systems for strategic purposes—which included the Soviet missiles in Cuba—often had tactical benefits as well.

Most important, CORONA lifted the curtain of secrecy that screened developments within the Soviet Union and China (and their allies such as Cuba and North Korea), explored and conquered the technological unknowns of space reconnaissance, and opened the way for even more sophisticated follow-on space systems. This pioneer program in satellite reconnaissance deserves a special place in history, for it provided confidence in the ability of US intelligence to monitor Soviet compliance that enabled President Richard Nixon to enter into the Strategic Arms Limitation Talks and later to sign the Arms Limitation Treaty.

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[8] Kevin C. Ruffner, ed., *CORONA: America's First Satellite Program* (CIA History Staff, Center for the Study of Intelligence, Washington, DC, 1995), p. 37.

Analytic Issues and Capabilities

By the late-1950s, the number and scope of major technical intelligence challenges facing the Agency had grown immensely. Concerns emerged about Soviet technological advances, the testing of Soviet thermonuclear weapons and, increasingly, Soviet ballistic and defensive missile developments and the Soviet space challenge. A primary response by CIA was to establish close relationships with contractors deeply involved in similar US programs, such as the Livermore and Sandia National Laboratories and various private corporations, notably TRW Incorporated. Each relationship entailed unique arrangements that allowed unusually broad access to intelligence information, wide contractor latitude in the definition of studies performed, and the inclusion of a broad tutorial role for the contractors in enhancing the capabilities of CIA analysts. These connections played a large role in developing unique technical intelligence capabilities within CIA itself.

US analysts of weapons systems, in addition to seeking help from the academic disciplines of science and engineering, had several core capabilities that set them apart. They were subject-matter experts, thoroughly familiar with programs of the type they were to assess, such as radar, aircraft, ICBMs, or nuclear weapons. They maintained close ties to US industry and its research and development activities. Thus, when looking at new or unfamiliar Soviet programs, they could draw on overall US experience or on relevant Soviet experience and bring insights from US development processes for similar weapons capabilities.

In addition, technical analysts were adept at team-research management. Just as it took many collectors to provide data on a specific Soviet system's characteristics, it took many technical specialists to compile all of the characteristics for a single weapon system. In the case of the Moscow Anti-Ballistic Missile system, for example, dozens of analysts were involved in assessing acquisition and engagement radars, interceptor vehicles, nuclear warheads, launchers, and command and control systems. Analysts had to be innovative and given to "out of the box" thinking as they confronted complex programs being developed by an adversary striving for technological surprises and also trying to not only minimize the information available to US analysts but to mislead them if possible.

The analytical issues addressed by the S&T encompassed the discovery and assessment of hundreds of weapons and technology programs during the course of the Cold War. Many were controversial within the Intelligence Community, as four decades of declassified NIEs illustrate. Here are some examples that give a sense of the variety of the topics and challenges Soviet developments provided US analysts:

- **SS-8**: Determining whether it was a new large missile or one smaller than the SS-6.

- **SS-9 MIRV**: Determining whether the multiple warheads on the SS-9 could be independently targeted, as well as the implications of a first strike against the US missile deterrent.

- **SS-18 throw-weight**: Assessing to what extent the large throw-weight would allow payload fractionation (additional Multiple Independently Targetable Reentry Vehicles MIRVs) without reducing the counter-silo capabilities of a single MIRV.

- **SS-NX-22**: Determining the target-discrimination capability, reaction time and effectiveness of an advanced antiship missile intended for use against US surface combatants.

- **Nuclear yields**: Assessing the results of weapons tests and correlating the size and yield of the device with a strategic delivery system.

- **SA-5 high-altitude capabilities**: Determining whether unusual tests of the SA-5 portended an ABM capability.

- **Range of the Backfire bomber**: Determining the extent to which the Backfire presented a threat against the continental US.

- **Foxbat radar**: Assessing the acquisition range and antijamming capabilities of the MIG-25 system.

- **Alpha-class submarine**: Assessing the capabilities of the world's fastest and deepest diving new submarine.

- **ASW detection technology**: Determining the extent to which ship-born acoustic sensors or bottom-laid arrays and their associated signal-processing capabilities would permit the location or tracking of US submarines.

- **Soviet reconnaissance satellites**: Determining the resolution capabilities of imaging satellite systems.

- **BMEWS battle management capabilities**: Analyzing whether the ballistic missile early warning radars being built on the periphery of the USSR possessed additional, sophisticated capabilities that might facilitate the accelerated deployment of a future ABM system.

- **Enigmas**: Identifying bafflers such as the "Caspian Sea Monster," a huge and strange-looking seaplane under development that turned out to be a giant surface effects system that rode over water on a cushion of air.[9]

- **Collection target planning**: Deciding where to place collection devices for the most effective gathering of sensitive information.

Analysts in the S&T were predominately focused on the qualitative aspects of Soviet strategic systems. Using an array of data from diverse technical collectors, human sources, and occasionally open sources, they would derive the capabilities of weapons and model them on computers. In modeling flight vehicles, for example, new data would be incorporated—the telemetry from a flight test or new external characteristics from photography—and the models refined until they conformed as closely to observed test results as possible. It became possible, for example, to run simulations of Soviet weapon system performance using data inputs collected from the Soviet's weapons systems themselves. Eventually, high confidence statements about a system's performance and limitations could be derived for use by US policymakers.

Differing Judgments

CIA's technical intelligence and analysis were not without controversy. They were subject not only to differing interpretations of the same facts but to interagency "feuds" over who was responsible for reporting what. The military, understandably, was not altogether taken with CIA's technical intelligence efforts insofar as they addressed military matters. For its part, the Agency established a number of panels consisting of the S&T experts from World War II to oversee its activities and conclusions. These panels, as well as other Intelligence Community panels charged with the coordination of diverse community views and chaired until the late 1970s by CIA officers, played an important role in enabling the Agency to exercise its "central" role in intelligence. During the long Cold War, many contentious issues regarding Soviet weapon-system appraisals emerged as the result of differing outcomes of technical intelligence efforts by the various Intelligence Community members. Foreign weapons appraisals and technical intelligence collection initiatives associated with them were often contentious. Differences most frequently arose between the Agency and the military service responsible for providing intelligence on the weapon system involved. CIA considered itself to be "objective" and "unengaged" in its analysis and was inclined to ascribe extraneous motives to the service involved. From their point of view, the services saw the Agency analysts as ill informed concerning military realities. Neither was entirely wrong.[10] The fact is, CIA's central role in intelligence did not

[9] Although it took many years to resolve, by the late 1960s we were able to conclude that the Soviets had two different classes of such vehicles being studied.

make it the dominant player in these technical intelligence efforts. Any appraisal of the Agency's contribution to understanding Soviet technical capabilities and programs must take the military view into account. Nevertheless, it should be clearly understood that despite this general contentiousness, the Intelligence Community as a whole made a large contribution to intelligence achievements in characterizing Soviet technical capabilities and programs.

The SS-8 Controversy

One example of how the Intelligence Community handled strong differences of opinion is that involving the Soviets' SS-8 ICBM. Was it a new, large missile or a missile smaller than the SS-6? In February 1961, the Soviets began testing a new ICBM, followed in April with yet another new ICBM. The Intelligence Community quickly assessed the first—designated SS-7—as smaller and more portable than the SS-6, and using "storable" propellants. The second new missile, designated the SS-8, almost immediately posed a dilemma. One group, primarily the Department of Defense, hypothesized that the SS-8 must surely be a move to develop a missile larger than the SS-6. The other group, particularly CIA, could reach no firm conclusion regarding the missile. Over the next two years, many hours were spent evaluating the telemetry, trajectory data, and optical data collected during reentry. This data, as interpreted by some analysts, seemed to support the "big missile" theory. Other analysts, led by CIA, continued to note additional data suggesting a smaller vehicle.

The issue regarding the size of the SS-8 was potentially momentous. Nikita Khrushchev, the Soviet premier, had stated that the Soviets had an ICBM that could carry very large bombs. The only candidate at this time was the SS-8. A July 1962 NIE (NIE-11-8-62) said that information was "inadequate to determine whether the missile employed is even larger than the SS-6 or whether it is smaller than the SS-7." By early 1963, the Intelligence Community had reached a standoff, and a Memorandum to Holders (of the previous estimate) stated the SS-8 could either be:

- A small ICBM with a warhead of about 3,500 pounds (near SS-7 size), or;
- A large ICBM with a warhead of about 17,500 pounds (nearly three times the size of the SS-6).

[10] Although there are few independent CIA technical reports available—most are subsumed in broader estimates of the 1960s and 1970s—S&T analysts always had final approval of performance and characteristics judgments contained in those estimates.

During the next six months, three major meetings convened to examine the pertinent intelligence data in minute detail. The first meeting, held under the auspices of the Guided Missile and Astronautics Intelligence Committee of the US Intelligence Board, met for three days in Huntsville, Alabama, but could not resolve the issue. The second meeting, held in the summer of 1963 in Los Angeles, was chaired by Marvin Stern and consisted of a group of five other eminent civilian scientists. After a week of detailed reviews, the panel arrived at conclusions that "began" to resolve the issue. The panel members said they did not believe the SS-8 was as large as the Air Force suggested, even though they agreed that a Soviet requirement for a large vehicle probably existed. They also cited indications the payload could be only 4,000-5,000 pounds.

The third meeting took place in September 1963 with the Hyland Panel (chaired by Dr. Lawrence Hyland, General Manager of the Hughes Aircraft Corporation), a group that had been advising the DCI for a number of years. Its session was timed to occur just before formal consideration of a new strategic weapons estimate. The focus of the meeting again was the SS-8. Stern briefed the panel (using his own panel's report), the Air Force, CIA, and other agencies. The result was concurrence by the Hyland Panel in the finding that the SS-8 was small. The Army, by now, had also decided the SS-8 was small, and the forthcoming estimate reflected these views. But there was not unanimity. Thus, in October 1963, the next NIE (11-8-63) stated, "We believe that the SS-8, which we previously considered might be a very large missile, is comparable to the SS-7 in payload capacity." The Air Force and the Defense Intelligence Agency (DIA), however, did not concur and had a footnote placed in the estimate indicating their view that no confident determination regarding the SS-8's delivery capabilities could be made at that time. They said available evidence did not permit excluding the possibility that the SS-8 might carry a nose-cone of 10,000 pounds or more.

The SS-8 controversy began to die down in the preparation of the 1964 estimate. While both the Air Force and DIA continued with essentially the same argument, the issue was "put to bed" when the Soviets introduced a new ICBM in the October Revolution parade in November 1964. A comparison of the size and shape of the "new" ICBM, called SASIN by NATO, made perfectly clear both that it could only be the SS-8 and that its reentry vehicle weights could only be between 3,000 and 4,000 pounds. The "big missile" advocates acknowledged the evidence, and the next NIE (11-8-65) and all subsequent estimates indicated no disagreement regarding the size of the SS-8.

SAM Upgrade

In the period from 1969 until the signing of the ABM Treaty in Moscow in 1972, the Intelligence Community faced yet another challenge: that the Soviets might somehow give ABM capabilities—through SAM "upgrade"—to their extensively deployed air defenses and thereby significantly affect the strategic balance between the United States and the USSR. CIA's view on this likelihood was expressed in fairly straightforward and simple terms in NIE 11-3-71 of 25 February 1971:

> The Soviets for years have demonstrated conservatism in assessing their own defense requirements and in designing systems to meet those requirements. With this conservative outlook, conscious of the shortcomings and ephemeral nature of any defense which SAM systems might provide against missiles, and uncertain about the effects of being detected in a treaty violation, Soviet leaders are unlikely to view the upgrading of SAMs as a viable means of altering the strategic balance.

Although the inherent ABM potential of Soviet SAMs might be utilized *in extremis* in an effort to reduce the destruction caused by a US missile attack, the uncertainties involved in such a step—even with upgraded SAMs—make it very unlikely that the Soviets would adopt this procedure. In view of these considerations, we believe that a program of SAM upgrading for ABM defense is not likely to be undertaken by the Soviets.

The most immediate problem posed by a SAM upgrade in negotiating the existing ABM treaty hinged on the matter of verification.[11] How could the United States be assured that the Soviets were not evading compliance with treaty limitations by upgrading their SAM systems to provide an ABM defense beyond the levels allowed? This was the challenge for CIA, which looked hard at its ability to detect signs of a SAM upgrade through national technical means of verification. In particular, CIA was convinced that it could detect both the testing of SAM systems in an ABM mode and any significant change in operating radars or in the patterns of deployment. CIA's beliefs were challenged, however, when the limits of its knowledge of the SA-5 system were raised. Since the United States had not identified a single signal intercept from the SA-5 radar, conclusive proof that the system had no ABM capabilities could not be stated with certainty. This became increasingly important as its deployment was approaching 100 complexes throughout the Soviet Union.

Verification that a SAM upgrade was not occurring became an important consideration in the initial US arms-limitation proposals. In the course of the negotiations that led to the ABM treaty, both sides had to undertake "not to give missiles, launchers or radars other than ABM interceptor missiles, ABM launchers, or ABM radars [any] capabilities to counter strategic ballistic missiles or their elements in flight trajectory and not to test them in ABM modes." The belief that CIA could monitor compliance with such an undertaking rested in its concept that no country would be willing to risk its fate when it had to rely on

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[11] It is important to understand that the role of the Intelligence Community was to *monitor* activities related to treaty compliance; *verification* was a political determination that factored in the results of monitoring.

an untested defense. Thus, CIA argued that it would detect evidence of the Soviet test programs necessary to prove the effectiveness of upgrading SAM systems for ABM purposes if the Soviets intended to deploy and rely on such a defense.

Summary and Conclusions

The growth of CIA's scientific and technical intelligence effort produced a remarkable change in collection and analysis procedures. CIA gradually developed the organization, capabilities, and talent to identify the intelligence questions that had to be answered, to establish the data essential to answering these questions, to define ways to capture the data, and to process the data so that analysts could have hard facts in helping them resolve the problem at hand. Developing these capabilities constituted CIA's greatest contribution to US understanding of Soviet technical capabilities.

Without diminishing the contributions of the National Security Agency, the military services or the national laboratories, two developments that can be credited primarily to CIA's DS&T were of seminal importance to the assessment of the Soviet strategic threat. The first is the creation of both airborne imagery collectors and space-based imaging satellites. The second is the art of signals analysis (specifically radar systems emissions and FIS). Both were critical to addressing policymaker questions of how many, how capable, and where located. Ultimately, they made arms control agreements feasible.

First, the U-2 photography, then satellite imagery provided sufficient breadth of coverage to locate and count Soviet strike forces with relatively high confidence. Data from imaging satellites provided the basic order-of-battle inputs for the calculus of deterrence, the fundamental military strategy used by the United States during the Cold War. As film-return satellite systems were phased out and near-real-time systems introduced, the United States became increasingly confident of its ability to discern major Soviet military buildups and to give warning to policymakers and US commands. The ability of the United States to minimize the likelihood of the Soviets inflicting a "Pearl Harbor" brought with it an era of international stability despite the large numbers of nuclear weapons possessed by both sides. Thus, major strategic rivals armed with vast nuclear capabilities were able to coexist—in conflict without combat—during half a century of political and economic competition.

Telemetry and performance-measurement analysis is an arcane art form, and nowhere was it practiced more imaginatively than in CIA's S&T. It was the most productive of the sources needed to assess the qualitative capabilities of aerospace vehicles. The Soviets never understood the extent to which the S&T excelled at this. As a result, from performance data collected on a wide array of flight systems came the analysis of range, fuel utilization, maneuverability, throw weight, MIRV potential, and other answers to the question of "how capable." The results were used to design US countermeasures, to calculate deterrence in qualitative and not just numerical terms, and to construct the qualitative constraints of arms limitation proposals.

In general, it can be said that CIA's contributions in producing intelligence on Soviet technical capabilities and programs came not just in the form of reports on those topics but, more important, in providing leadership in building and operating the range of capabilities that enabled such reporting. Most of the critical questions regarding Soviet systems were answered. CIA contributions were successful enough to enable the negotiation of strategic arms limitations relying heavily on the US Intelligence Community to monitor compliance with their provisions. The trust of the national security elements of the US government in the ability of the Intelligence Community to do this job is a testament to the value of the contribution it made.

A final note by the author: CIA may not have had all the details of every Soviet development right, but, writ large, I believe CIA and the Intelligence Community did a good job. The question remains whether this contribution, however successful, made any difference in a larger sense to the outcome of the Cold War. I don't know exactly how it affected the outcome, but it should be noted that the United States did not blunder into nuclear war because of ignorance of Soviet technical capabilities.

In my opinion, CIA gets high marks, not only for what it learned about what the Soviets were doing but, perhaps more important, for putting in place a key national asset of integrated scientific and technical intelligence collection and analysis. This is not to imply that CIA's success was achieved in isolation. It could not have been done without the support and cooperation of the military services, other government agencies, and industry. CIA's early partnership with the US Air Force was especially important in this regard and set a precedent for later cooperation.

I believe strongly that something special was achieved at CIA for the nation during the Cold War with respect to S&T collection and analysis. All who took part are to be applauded for their efforts. But if you were to ask me about CIA (and the Intelligence Community's) capabilities to do the same today, I would have to say the end of the Cold War has ushered in the atrophying of a once-unique capability. I do not believe we could do it again without a major redirection of focus and resources. Much of the capital—human and otherwise—has been depleted.

The end of the Cold War was truly the end of an era. Many of the capabilities have been dismantled, the collection priorities—and resources to meet those priorities—have shifted, and even though we continue to make technical breakthroughs to collect information against hard targets like terrorism, drugs, and weapons of mass destruction, we no longer have the large, reconstitutable, all-source, government-industry analytic capability that made the results of scientific and technical collection and analysis of Soviet capabilities a valuable source in the winning the Cold War.

The fragmentation of our former unique, critical capability with respect to FIS analysis is a good example. Former Secretary of Defense William Perry recently endorsed the statement, "A continuing decline in Foreign Instrumentation Signals collection, processing and analysis capabilities will have a negative impact on US weapons design, combat effectiveness, survivability, defense policy, and treaty monitoring well into the next century [sic]."[12]

Returning to the era of the Cold War, however, I believe one can sum it up by saying that the country that may have had the most effective human intelligence capability lost the Cold War to the country that had the best technical collection and analytic capability, and CIA was a leader in this area.

Discussant Comments

A panel moderated by Gerald Haines, then-Chief Historian of the Central Intelligence Agency and former Chief of the National Reconnaissance Office's history program, discussed Clarence Smith's paper and provided views on CIA's analysis of Soviet science and technology issues during the Cold War. The panelists were R. Evans Hineman, Vice President for Intelligence at Litton Industries and former Deputy Director for Science and Technology at CIA, Julian Nall from the Institute for Defense Analysis and former National Intelligence Officer for Science and Technology, and Frank N. von Hippel, Professor of Public and International Affairs at Princeton University.

R. Evans Hineman discussed the Directorate of Science and Technology's analysis of the Soviet ICBM force and its counterforce capabilities against the US Minuteman and Titan systems and the Soviet development of the Backfire bomber. According to Hineman, determining the accuracy, as well as the numbers of independently targetable reentry vehicles, and the warhead yield capabilities of Soviet ICBMs was critical to US policymakers. Hineman outlined the effort by the Intelligence Community to answer policymakers' questions on these issues. According to Hineman, the Soviet ICBM—the SS-9—was a large vehicle, capable of delivering a large yield warhead across continents. SS-9 testing began in 1963 and the United States carefully monitored its guidance system, performance, and reentry vehicle performance. US intelligence data revealed that the SS-9 was optimized for "warhead packaging" rather than accuracy. In other words, according to Hineman, they were relatively blunt, large vehicles that would be affected by atmospheric

[12] Letter to the editor, William Perry, *Studies in Intelligence*, Vol. 43, No. 2 (1999), p. 91.

density, uncertainties, and unpredictable winds. US analysts believed from the data collected that the number of SS-9 missiles deployed was so small that only a fraction of the US force of Minutemen would be at risk. Hineman went on to point out that when Soviet testing of the SS-9 Mod 4 began, the potential existed for tripling the number of US silos at risk.

Hineman then outlined the differences that existed among the intelligence agencies and the military departments over the accuracy of the SS-9 and whether or not the SS-9 Mod 4 was a multiple independently targetable reentry Vehicle (MIRV) or simply a multiple reentry vehicle (MRV) system. With respect to the Mod 4, CIA took the position that the test data showed it was a MRV, not a MIRV, system. The US military, according to Hineman, disagreed. (Note: Hineman stressed that at no time did he see or sense any pressure on the analysts to bias the data.) He said the argument remained unsettled until the Soviets began testing the next generation of ICBMs in 1973. These missiles clearly had the capability to hit multiple, independent targets, had greater accuracy and MIRV capabilities, and posed a threat to US ICBM silos.

Hineman then contrasted CIA's and the US Air Force's analysis of the Soviet Backfire Bomber. Hineman argued that CIA's analysis, based heavily on technical data from Soviet test flights, showed the Backfire to be a medium-range bomber, not capable of intercontinental two-way bombing missions. The Air Force, according to Hineman, basing its analysis on imagery, claimed that the Backfire was an intercontinental, long-range bomber capable of reaching the United States. When in 1977 the Soviet Union began testing a new bomber aircraft called the Blackjack and resembling the US B-1, all parties agreed that the Backfire was intended as a medium bomber.

Hineman then discussed the Soviet space program. The Apollo Manned Lunar Landing Program of the Kennedy administration, he said, was launched in response to the Soviet space program. Hineman said the United States detected the construction of a very large launch facility at the Tyuratam launch complex in Kazakhstan and monitored Soviet progress on their large space booster rocket, known as the N-1. Hineman related how concerned American scientists successfully launched Apollo 8 in December 1968, several months prior to the failed first attempted launch of N-1.

Hineman claimed that US monitoring of the Soviet Zond program, which was designed to beat President Kennedy's goal to place a man in the vicinity of the moon, resulted in a NASA decision to fly Apollo 8 earlier than planned. Hineman also described how unmanned Zond flights 7 and 8 succeeded in circumnavigating the moon following the Apollo 9 lunar landing in July 1969.

The next commentator, **Julian Nall**, discussed the successes and failures of CIA's analysis of the Soviet ABM program following Nikita Khrushchev's boast in the early 1960s that the Soviets could "hit a fly in the sky." Nall briefly outlined CIA's collection efforts against Kapustin Yar, Tyuratam, Moscow, and Semipalatinsk. A U-2 flight, according to Nall, over Kapustin Yar and its down-range site Sary Shagan revealed a building that looked like a "chicken house over on the Eastern Shore of Maryland, except that it was 880 feet long." Nall explained that it turned out after much analysis that the building was an electronically sterical radar, subsequently dubbed Hen House by US analysts. U-2 photography provided excellent photographs that enabled CIA analysts to determine the actual physical characteristics of the Soviet equipment. According to Nall, US intelligence also used the moon to pick up ELINT radiation from Hen House.

Discussing Tyuratam, Nall stated that the Intelligence Community was looking for an ICBM site or an ABM system. When it tracked what was believed to be the launch of a Soviet antimissile system, CIA analysts discovered, after consulting with experts from Bell Telephone Laboratories, that what they were picking up in the collection data was the missile tank breakup as it hit the atmosphere and skipped along like "a flat rock on water."

Turning to Moscow and Semipalatinsk, Nall discussed how the Intelligence Community detected the so-called Dog House radar. Using satellite imagery, the Intelligence Community detected a huge facility near Moscow with a receiver 350 ft. long and about 300 ft. high, about the size of a 30-story building. It looked, according to Nall, like an A-frame doghouse and turned out to be part of an early warning radar system. Nall said that satellite imagery of Semipaltinsk provoked similar discussions and arguments among Air Force and CIA analysts regarding a possible ABM program as well as arguments over exactly what was being built. Nall stressed that having more detailed data did not usually end the debate.

Frank von Hippel, the final commentator, questioned the Agency's record on nuclear test ban verification issues. According to von Hippel, who praised CIA's verification of arms control agreements, the Agency and the Intelligence Community refused to believe hard evidence provided by academic seismologists that seismic wave transmission characteristics of the earth's crust under the Soviet nuclear test site at Semipalatinsk were quite different from those under the US-Nevada test site. This led the Reagan administration, von Hippel argued, to falsely accuse the Soviet Union of blatantly violating the test ban treaty provision forbidding the testing of high yield nuclear explosives over 150 kilotons. Von Hippel also claimed that the Intelligence Community misled the Clinton administration in 1997 when it accused Russia of conducting a nuclear test in Novaya Zemlya, its Arctic test site. In von Hippel's view, academic experts clearly showed that the readings were from an earthquake under the sea more than 100 kilometers from the test site. von Hippel concluded that the Intelligence Community's track record on test ban verification was mixed at best and that any future DCI should insist on external peer review of the Intelligence Community's analysis of nuclear test ban verification issues.