Strategic Command, Control, Communications, and Intelligence

Charles A. Zraket

Strategic force relations between the United States and the Soviet Union are such that both nuclear attack and threats thereof have been deterred and will continue to be deterred—if the strategic balance does not tip markedly toward the Soviet Union. Success in reducing nuclear arms and stable force relations achieved through the maintenance of survivable forces on both sides can keep the probability of a general nuclear war or of gaining advantage through threats of attack extremely low. However, if the United States is to continue to reliably deter future provocation or attack, it must provide better and more enduring command, control, communications, and intelligence (C^3I) for itself and its allies.

Summary. Command, control, communications, and intelligence (C^3I) for nuclear forces are essential elements in the deterrence of nuclear war. The present C^3I system has vulnerabilities associated with its reliability, survivability, and endurance under attack, thereby weakening deterrence by increasing the ambiguity in our capabilities. Development of a reliable and enduring C^3I system would reduce this ambiguity. Its reliable, positive control of nuclear forces would give the national leadership more time to assess situations, ensure discriminate retaliation, and improve our ability to manage crises in general. These capabilities could help to stop a war rapidly should one start. A reliable and enduring C^3I system will be needed for a long time to come, even if a freeze on strategic nuclear forces is accomplished or other arms control successes achieved. Indeed, C^3I may be the best source today of confidence-building measures to reduce tensions and the threat of nuclear catastrophe.

Nature of C^3I

C^3I provides the means to make military forces controllable and effective. It includes the responsible officials who command and control; the facilities and equipment they use (command centers, control centers, and communications, surveillance, reconnaissance, and intelligence systems); and all applicable plans and procedures (*1, 2*).

In this article I focus on C^3I for strategic nuclear forces based in the United States and Europe and not on C^3I for general-purpose (nonnuclear) forces, although both share many components and must work as an integrated system. I summarize the weaknesses of today's C^3I, assess the usefulness and desirability of new techniques and systems, and suggest confidence-building measures.

The C^3I used in strategic nuclear operations involves many specific elements (Figs. 1 to 5) and the following generic functional elements:

1) Doctrines, plans, and procedures to maintain readiness and use forces.

2) Information gathering and assessment—tactical warning and attack assessment, force status and readiness, intelligence about adversaries, and information about what is happening around the world.

3) Communications linking national authorities with military commanders, commanders with their forces and with other forces worldwide, ourselves with our allies and adversaries, and government with the populace.

4) Systems to command and control forces and execute operational plans, including determination of the status of U.S., allied, and enemy forces worldwide, and systems to reconstitute forces and negotiate an end to a crisis or war.

C^3I systems are also used to help verify arms control agreements.

Physical C^3I elements are deployed worldwide. They include fixed, surface-mobile, and airborne command and control centers; surface, airborne, and satellite systems for warning, surveillance, reconnaissance, weather data, imagery, and intelligence; and surface, air, and space-based communications that carry the information to its many destinations. About 10 percent of the U.S. defense budget is allocated to C^3 (the intelligence budget is separate). About 2 percent of that amount goes to C^3 for strategic forces, the rest to C^3 for general-purpose forces.

Strategic Context

Measures of strategic balance typically involve comparisons of megatonnage and of the numbers of missiles, aircraft, submarines, warheads, launchers, and so forth. (Such measures are essentially not a true measure of the operational situation, because they are based on static elements.) C^3I systems cannot be compared in this way, since, by their nature, they involve the dynamics of crises and warfare. They thus add further uncertainty to a potential nuclear war situation, with their complex real-time assessment and selection and execution of responses. Here there are no real experts; we can analyze a situation only through scenarios and system analyses, using technical and operational data from tests.

To do such analyses we need to consider how much and what kind of positive control (explicit action by recognized authorities) of nuclear weapons are needed, how we can ensure discriminate retaliation if attacked, the desirability and feasibility of launch-under-attack (*3*) basing and doctrine, how we can improve the capability to sustain rational operations during and after attack, and how we can improve our ability to stop a war if deterrence fails.

Discriminate: Terminate

The crux of the strategic issue is the relation between deterrence and force employment. The United States can achieve reliable deterrence only if it can ensure that it can retaliate discriminately and end a nuclear war as quickly as possible. Without this, deterrence is at the mercy of provocative rhetoric, threats of mutually assured destruction (MAD), or suicidal attacks.

The decision to use nuclear weapons

Charles A. Zraket is executive vice president of MITRE Corporation, Bedford, Massachusetts 01730.

is the ultimate C^3I issue. International security requires capabilities beyond first-strike attack, launch-on-warning, launch-under-attack, and MAD, or we may not be able to act rationally during a crisis.

We need C^3I to strengthen deterrence and for stability in all threatening situations, including Munich-type confrontations. C^3I will be necessary for a long time to come—even with a "freeze" on strategic nuclear forces; even with success in Strategic Arms Reduction Talks or other arms control measures. Its importance will grow as delivery vehicles become smaller and more mobile and proliferate throughout the world. In the 1950's and 1960's the United States had nuclear superiority and C^3I was simple and straightforward. Today C^3I is highly complex, and it is the principal means of achieving safe, assured, selective control of nuclear forces.

Considerations of how nuclear forces could be employed are now as important in assessing the strategic balance as static indices comparing relative numbers of warheads, launchers, and megatonnage. C^3I has become a crucial element in deterrence because either side can destroy the other in retaliation to a first strike. The important variables now are each side's command authorities, C^3I systems, and perceptions. The potential dynamics dominate, not the numbers and kinds of weapons on hand.

To understand how C^3I relates to policy questions, we should look at the dirty business of the dynamics of nuclear war, even though the national objective is to avoid such a war. Because there is no real experience of strategic nuclear war, we can look at its dynamics, and the adequacy of C^3I to deter it, only through "thought experiments."

A Desirable C^3I System

To achieve reliable and selective control of strategic forces, C^3I must be reconstitutable, enduring, and worldwide. It must maintain some continuity of operations from normal tension to crisis to nuclear attack. It must have the capabilities to (i) maintain peacetime readiness and performance of command and control elements and strategic nuclear forces without serious accidents and without unnecessarily increasing tension around the world; (ii) function during crises, providing secure conferencing for national authorities and military commanders, tracking the status of nuclear forces worldwide, providing dependable intelligence, communicating to the nuclear forces, and permitting joint planning with our allies and coordination with the Soviet Union; (iii) prevent mistakes or unnecessarily dangerous events and expedite correct actions; (iv) ensure continuity of national command (*4*), positive control of nuclear weapons, and selective retaliation; (v) provide surveillance during and after an attack to assess our status and that of our adversary; (vi) integrate strategic offense and defense operations; (vii) be reconstituted with proliferated, prepositioned, and replenished C^3I assets; and (viii) help us coordinate with our allies to negotiate the end to a war.

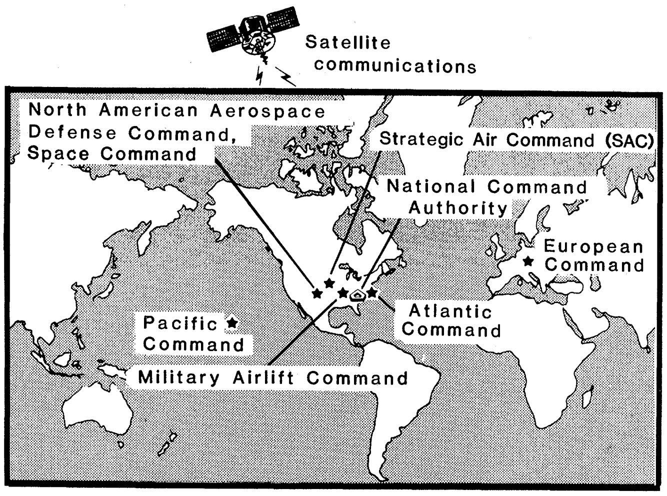
In summary, enduring C^3I should resist all but a heavy deliberate attack without serious damage. I discuss later the degree of endurance that is practical and desirable. To be selective, C^3I must provide timely intelligence, attack characterization, damage assessment, and targeting flexibility.

The assets of C^3I needed for selective retaliation and those needed to end a war are essentially the same: continuity of command, streamlined decision processes, communications among allies, commands to surviving and dispersed forces, and reliable surveillance and intelligence to assess the situation. Of course, communications with adversaries are also needed to end a war.

Vulnerabilities

C^3I could be crippled in several ways as part of an attack. Any of the following might be made unreliable or inoperative through physical or electronic attack or by collateral damage: military commanders' communications with command authorities; airborne C^3I systems; fixed command centers and satellite mission control centers; C^3I assets subject to jamming from enemy transmitters and to electromagnetic pulse (EMP) effects from nuclear explosions at high altitudes; and assets subject to collateral damage from dust, debris, fallout, fire and soot, and winds. We must also be aware that ambiguous information or difficulties in collecting intelligence may delay decisions or cause dangerous actions.

Operationally, "pathologies" may endanger the relation between C^3I hardware and software and the groups that operate the systems. Examples of the fragility of command and control in large-scale systems are familiar: failures of large-scale power grids, management of the Three Mile Island accident, and responses of C^3I to false alerts. There are dilemmas of scale—has complexity outrun our knowledge about how large systems break down? Is this true in complex worldwide C^3I systems, whose operators have not yet learned how to



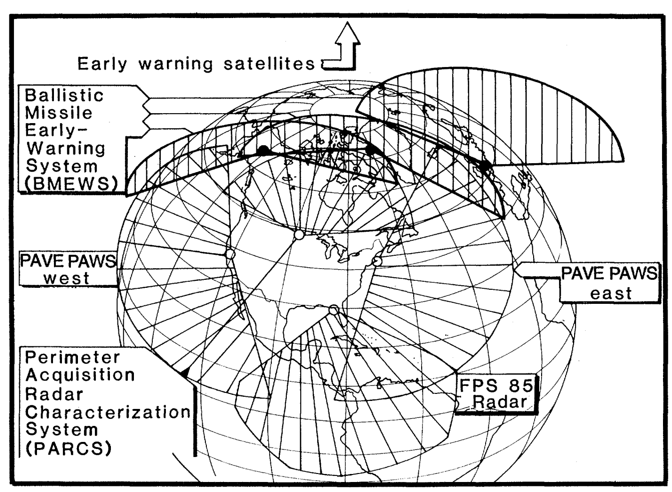


Fig. 1 (left). Strategic command structure. Fig. 2 (right). Warning systems for ballistic missile attacks.

deal with the possible fragility and uncertainties of such systems under stress or attack?

C^3I must avoid false alerts, yet it must reliably recognize a real tactical crisis or attack or lose credibility. It must be realistically exercised constantly to lessen uncertainties about how it will respond during crises.

There is one more important factor. Communications to nuclear forces from national and military commanders must be reliable and two-way, or reponses cannot be selective. Inherent in the deployment of land-based missiles, bombers, and submarines are differences in selectiveness and communications reliability. Submarines are difficult to use for selective targeting; each contains as many as 200 warheads, and the firing of a single missile can reveal the vessel's position. The land-based missiles are all within the continental United States, so their C^3I and personnel can be made highly reliable both operationally and politically—this is one of the reasons why the Soviet Union favors intercontinental ballistic missiles (ICBM's) for its nuclear forces. But existing missiles cannot be recalled once launched; bombers can.

Due to these uncertainties, the selectivity, reliability, and endurance of C^3I will always be in question. The design of an enduring system must address such weaknesses. The operational functions C^3I can reliably carry out depend on the potential scale of the attack (tens, hundreds, or thousands of nuclear weapons) and how long the capability can be kept coherent (hours, days, weeks, or months). The essential question in assessing C^3I is, how long to do what? It is not possible to answer this question conclusively.

Because of these uncertainties and weaknesses, some analysts believe that management of nuclear conflict is undesirable or impossible (*5*) and that the requisite C^3I should not be planned. The *Catholic Bishops' Pastoral Letter* properly expressed these concerns (*6*):

> A number of expert witnesses advise us that commanders operating under conditions of battle would not be able to exercise strict control; the number of weapons used would rapidly increase, the targets would be expanded beyond the military and the level of civilian casualties would rise enormously. . . .
>
> While not trying to adjudicate the technical debate, we are aware of it and wish to raise a series of questions which challenge the actual meaning of "limited" in this discussion.
>
> Would leaders have sufficient information to know what is happening in a nuclear exchange?
>
> Would they be able under the conditions of stress, time pressures and fragmentary information to make the extraordinarily precise decisions needed to keep the exchange limited if this were technically possible?
>
> Would military commanders be able in the midst of the destruction and confusion of a nuclear exchange to maintain a policy of "discriminate targeting"? Can this be done in modern warfare waged across great distances by aircraft and missiles?
>
> Given the accidents we know about in peacetime conditions, what assurances are there that computer errors could be avoided in the midst of a nuclear exchange?
>
> Would not the casualties, even in a war defined as limited by strategists, still run in the millions?
>
> How "limited" would be the long-term effects of radiation, famine, social fragmentation and economic dislocation?
>
> Unless these questions can be answered satisfactorily, we will continue to be highly skeptical about the real meaning of 'limited."

Before discussing how an enduring C^3I system can ameliorate the situation envisioned, I will summarize the current positions of the United States and the Soviet Union on C^3I (*7*).

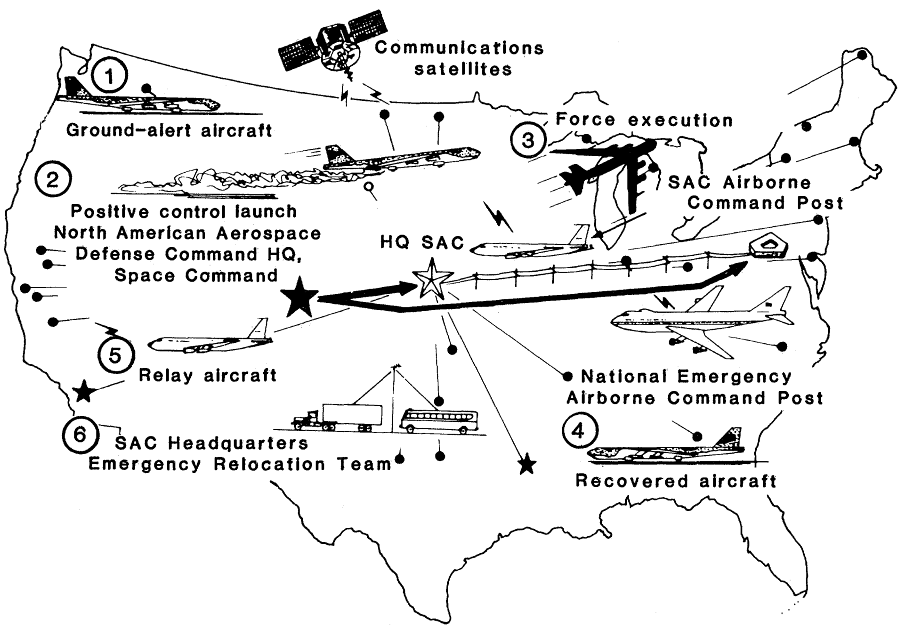


Fig. 3. Connectivity of C^3I to bombers.

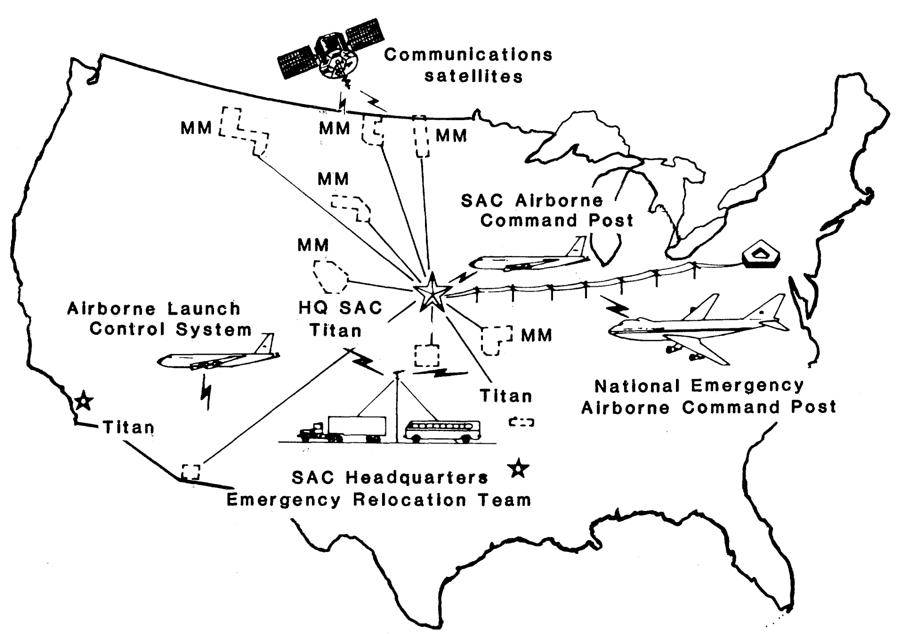


Fig. 4. Connectivity of C^3I to missile fields.

Peacetime and Crisis Operations

Both superpowers have, or are building, robust C^3 systems for close control and exercise of nuclear forces, secure communications for command coordination during crises, and survivable communications for release of nuclear forces in the event of attack. The United States has a worldwide C^3 system that continues to improve as new, more enduring systems are added (*8*); a radar and infrared tactical warning system against sea-launched ballistic missiles and ICBM's; worldwide surveillance of space (although inherent ground-based radar performance limits prevent real-time surveillance higher than a few thousand miles—for this, space-based surveillance systems are needed); and highly capable worldwide airborne and space reconnaissance and surveillance to collect deployment and technical data and to detect nuclear explosions. This last capability will be supplemented by the Nuclear Detection System (NDS) packages on the Global Positioning Satellite system (*9*), which will give yield, count, time, and location at ground control centers by triangulating data from three satellites. Height of burst can be calculated with a fourth measurement. NDS will become increasingly important for detecting nuclear explosions anywhere in the world. This would facilitate enforcement of a regime against the proliferation of nuclear weapons or at least their testing in the atmosphere.

U.S. surveillance systems should continue to emphasize collection of more operational data, more electronic countermeasures protection, more survivability of collection assets, and more real-time integration of air- and space-based surveillance platforms with ground-based data-fusion centers in order to obtain timely data and to increase confidence in our actions during crisis. The United States should also increase testing, by operational commands, of each C^3I system and should do more testing under realistic conditions to increase confidence in the system's safety and readiness. This will help to overcome some of the concerns about the impact of automation on the relation between C^3I systems and their operators.

The Soviet Union depends on strategic warning through human and communications intelligence. It has focused on air defense, ballistic missile defense, and space surveillance and antisatellite capabilities over the homeland and against low-altitude satellites; on war-fighting capabilities; and on counter-C^3I—jamming, exploitation, and destruction. The Soviet Union is dedicated to providing a C^3I continuum from peace to war-fighting and damage limitation, and its homeland system seems more robust than ours (*10*, pp. 16–23).

Because Soviet ICBM's provide a counterforce to our ICBM's, the United States has emphasized tactical warning and attack assessment and their influence on timely actions to ensure the survival of its forces. U.S. readiness is therefore continuously high. We can further improve the usefulness of our warning system in response to a severe crisis by formulating a series of layered warning actions; the first set could involve prudent preparatory measures, say in putting various C^3I assets on higher alert status, without provoking alarm or unwanted responses that immediate actions by strategic forces might provoke. In this way, political decision-making can initiate alerting procedures rather than the other way around. This set of warning system actions would require survivable forces as a precondition.

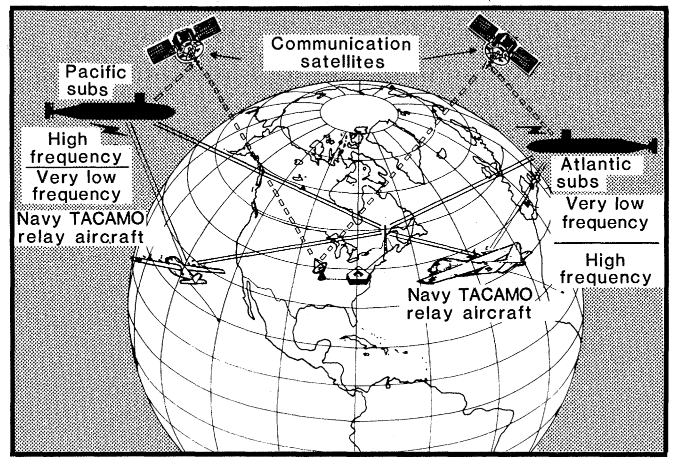


Fig. 5. Connectivity of C^3I to missile-armed submarines.

The United States will have no credible, prompt counterforce to Soviet ICBM's until the MX ICBM or the new Trident submarine D-5 missiles or both are deployed (*11*, p. 6 and pp. 16–19). Thus the Soviets can continue to depend mostly on strategic warning and can maintain lesser readiness in its nuclear forces, especially if they continue to intensively exercise those forces and their C^3I from the national command authorities on down and to provide more C^3I survivability and endurance.

When and if the United States deploys a credible counterforce to Soviet ICBM's—and as nuclear weapons proliferate around the world—we can expect the Soviet Union to pursue more aggressively the same kinds of worldwide crisis C^3, tactical warning and surveillance, and reconnaissance as the United States, especially in space. In fact, they seem to be starting to do this. Their technical capabilities in this area are suspect but may improve as they exploit opportunities for importing technology from the West.

In their public statements, the Soviets show increasing concern about America's growing capabilities in space, especially the shuttle and its potential use as a platform for surveillance and the launching of satellites. They sense a need to upgrade their surveillance from space and of space for intelligence, warning, and antisatellite purposes. These concerns may push them to maintain higher states of readiness in their strategic forces and to take a more aggressive counter-C^3I posture against the United States.

Survivable, Enduring C^3I

As noted earlier, the United States is now upgrading its strategic C^3I systems. The objective is to provide more survivability and endurance in the next decade and to give the President and his commanders less ambiguous data and more time to assess the situation before acting irreversibly. The 10-year investment in strategic C^3I will be the same as for a major strategic weapon system: about \$40 billion.

Endurance in strategic C^3I is the most difficult capability to implement technically and operationally, although today's command and control centers, communications terminals and relays, and surveillance assets can be greatly improved in their hardness, mobility, camouflage, redundancy, electronic robustness, and reconstitutability. For example, electronic robustness to resist EMP can be achieved in essential systems at moderate cost (*12*). Proper design must include backup power, redundancy, protection, electromagnetic shielding, and filtering of unwanted signals. Such measures are being used in essential C^3I systems. There are great uncertainties over the effects of EMP because of the lack of empirical data, which makes it difficult for any attacker to depend on such effects for success. Although EMP is a problem to be worked on, I do not believe that at present it has a crucial impact on strategic relations.

We have asked, "how long to do what?" The determinate issue is C^3I survivability and endurance in postulated "limited" nuclear wars (*6*), characterized by drawn-out exchanges of tens to hundreds of weapons rather than thousands and ranging from strikes against cities to countermilitary strikes against fuel storage and industrial sites, ports, air bases, weapons sites, and C^3I systems. We do not know enough to assess the operational impact of all nuclear effects in exchanges of tens or hundreds of warheads in wars lasting weeks to months. The effects include direct and collateral damage from immediate and delayed radiation, blast, ejecta, dust, debris, fire, soot, and winds. Nor do we know whether C^3I will be targeted or what proportion of an overall attack may be directed at C^3I targets. Given published Soviet doctrine, however, and its lack of emphasis on selective control, targeting of C^3I must be considered likely (*10*, pp. 2, 3, 9, and 10), thereby making its survivability and endurance thresholds crucial to control of escalation.

To be survivable and enduring, C^3I must be made more redundant, mobile, and reconstitutable in all its elements—command and control centers, communications, and surveillance. It is plausible that an improved C^3I system would be able to operate under a heavier attack than today's system (a few hundreds rather than tens of attacking weapons), would remain coherent for hours to a few days, would be more robust against jamming and EMP, and would be significantly less prone to collateral damage. Such a system can therefore be built strong enough to deter an attack on it short of deliberate, all-out war. C^3I can thus be a practical means of strengthening deterrence of nuclear attack.

Short-term endurance to ensure positive control of weapons and selective retaliation is a feasible goal for the C^3I system. Long-term endurance and reliability in a large-scale exchange are impossible to achieve because of nuclear devastation of the environment due to direct effects and climatic phenomena (*13*) and because the C^3I elements would probably be targeted heavily in such an attack. This weakness can be borne, however, since enduring, selective C^3I is needed only in more limited attack situations, including terrorist and third-party attacks. To deter large-scale attacks, including attacks on C^3I, only an assured retaliatory capability is needed, not an enduring, discriminate one. The Single Integrated Operational Plan for strategic operations need only be capable of being executed, not replanned in detail.

Published Soviet doctrine also emphasizes a preemptive strike during or after a severe crisis (*10*, pp. 4–5). The United States can strengthen deterrence of preemptive strikes by providing reliable C^3I during crises, buying time for an assured, discriminate retaliatory capability. This can help create long-term stability, making hair-trigger responses unnecessary.

Thus, we see that U.S. C^3I can be a major stabilizer. It can deter the Soviets if it is designed to operate during an attack, if it is tested to ensure that it works, and if the Soviets are convinced that the United States has no Achilles' heel—that an aggressor cannot prevent us from acting (*14*). Implementing enduring C^3I therefore seems more rational and safe than arguing that it makes nuclear war more real. Far from promoting the efficacy of limited nuclear wars, it is a way to deter them—or stop them as soon as possible if deterrence fails. Only when the endurance thresholds being sought exceed practical operational levels does the value of C^3I become dubious compared to investment in conventional forces.

North Atlantic Treaty Organization

Nuclear forces of NATO are important to extended deterrence in Western Europe. Their current C^3I can be complicated, overlapping, and sometimes duplicative, especially during crises. The situation is dominated by U.S. control of most of NATO's nuclear weapons and the C^3I to release them and by the large nonnuclear threat of the Warsaw Pact forces, including chemical warfare against air bases and missile sites.

The United States also collects much of NATO's intelligence about what is happening in the Warsaw Pact, including indications and warning of any attack on Western Europe. This is crucial: during crises, the potential use of nuclear weapons depends on tactical indications and warning. We must distinguish between the quick-reaction nuclear systems like the Ground-Launched Cruise Missile, Pershing II, and Quick Reaction Alert aircraft—all generally long-range with high-yield weapons, supporting a selective strike plan against Eastern Europe targets as an extension of the U.S. strategic war plan—and short-range, low-yield weapons designed for responsive nuclear defense in Western Europe.

For quick-reaction, long-range systems, the problem of C^3I in maintaining the readiness of forces and controlling their release is roughly the same as for the U.S.-based strategic forces, but is complicated by the dual-channel request and release procedure of NATO and the United States. This complex procedure makes survivability and mobility of nuclear forces and their C^3I even more crucial.

In the case of battlefield nuclear weapons, the needs of C^3I exacerbate problems posed by the weapons' nature and by Europe's geography and demography. Because the towns of northwestern Europe are close together, determinate factors are (i) the kind and size of nuclear weapons needed to reduce collateral damage and (ii) accurate real-time tactical warning and intelligence to pinpoint spatially and temporally the areas under attack. Response by battlefield nuclear weapons requires accurate intelligence about the attack, highly reliable, integrated communications for releasing weapons, and coordinated support logistics and C^3I down to the battalion level.

The response may have to take place in hours. Current security conditions in Western Europe would pose a great problem in keeping the preparations secret so as not to cause a preemptive Soviet nuclear strike against all of NATO's nuclear forces.

Western Europe has a plethora of communications systems to handle C^3I needs: U.S. military command and battlefield communications, NATO integrated communications, and the military communications, postal, telephone, and telegraph facilities of each country. The survivability and interoperability of all these communications systems need to be greatly improved. Better protection against conventional attacks and sabotage is also needed for all C^3I assets.

Management of nuclear weapons in Western Europe thus poses some basic requirements with respect to C^3I. Command and control centers and communications need to be survivable and enduring. Logistics support is needed to maintain readiness. Real-time, accurate integrated warning, surveillance, and intelligence data are needed to target weapons. Today's weaknesses of C^3I in these areas exacerbate the inherent problems of defensive deployment and use of battlefield nuclear weapons in Europe.

The combination of problems may make it extremely difficult to provide reliable C^3I for nuclear weapons at the battlefield level. For this reason priority must be given to improving the electronic and physical endurance of C^3I and to developing and deploying new conventional weapons systems by using emerging technologies in missile automation, materials, guidance, ordnance, propulsion, stealth, basing, shelters, electronic warfare, and tactical target surveillance and acquisition. Only in this way can dependence on nuclear weapons and their necessarily vulnerable C^3I be reduced and NATO's nuclear threshold raised.

Arms Control Implications

Given the vast nuclear forces in the world today and the time needed to reduce them, the relation between potential use of these forces and deterrence is the crux of the strategic nuclear issue for the foreseeable future. An enduring C^3I system will make this relation explicit and help to ensure a discriminate retaliatory capability, imposing more positive control on weapons over the long term.

Nuclear force relations will be stabilized further if improved C^3I is augmented by (i) continued modernization of nuclear forces (*11*, pp. 10–22) to ensure greater survivability and dispersion and (ii) mutual reductions in the number of warheads. These improvements will provide a framework for effective arms control agreements, will help achieve less ambiguous deterrence, and will lend support to the idea that the prime purpose of nuclear weapons is to deter others from striking first with either nuclear or overwhelming conventional forces.

Finally, new C^3I measures offer the best means today to reduce tensions and the threat of nuclear catastrophe. Balanced arms reduction is of course desirable, but halving today's number of nuclear weapons would still leave great destructive forces and the immense discontinuity between peace and nuclear war. At reduced force levels, verification of treaties becomes more difficult and treaty violations have a higher payoff, thereby threatening stability.

Measures related to C^3I can be taken to help relieve these tensions. Inevitably, this would involve giving away information or refraining from an action in return for something equivalent. Such exchanges in the past have resulted in two-man control of nuclear weapons firing, naval maneuver limitations, and prior notification of military exercises in Europe and of satellite and test missile launches. Some new or modified measures could include the following:

1) Strengthening confidence in warning systems by using well-defined warning actions to reduce the impact of false alerts and by agreeing multilaterally that national warning systems (and other essential C^3I systems, such as space-based communications and reconnaissance systems) are to be treated like national technical means for arms control verification; that is, that they are not to be attacked or tampered with. With adequate verification capabilities, the disabling or malfunction of part of a warning, communications, or reconnaissance system could then be treated as probably being due to an equipment outage, sabotage, or a terrorist attack on a surface component, precluding the need for rapid and massive force alerts (except in severe crises).

2) Implementing techniques for facilitating worldwide communications during a crisis. An example is the establishment of compatible communications and protocols with adaptive high-frequency networks in each nation's C^3 system. High-frequency systems are used by most countries and do not have the same security problems as common use of satellites, for example. Also, modern high-frequency technology is much more reliable than heretofore and can provide worldwide connectivity during crises if designed to do so, in conjunction with crisis control procedural measures.

All such measures will become more critical if and when nuclear weapons proliferate further and U.S. and Soviet forces are reduced. A great deal of homework in understanding the kinds of measures that can be effective must be done, however, before operative measures can be formulated, agreed to, and implemented. For example, the current debate on the military use of space for strategic defense could become more useful if the focus shifted to an assessment of the contribution of space-based C^3I systems to strategic stability and of the impact of their loss on the strategic balance and on verification of arms control treaties. Such an analysis would provide a positive approach to arms control in space and would identify other ways in which C^3I can contribute to strategic stability.

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