Emerging Technology Systems and Arms Control

Robert Lempert, Ike Y. Chang, Jr., Kathleen McCallum
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Robert Lempert, Ike Y. Chang, Jr.,
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PREFACE

The Strategic Arms Reductions Treaty (START) and the Conventional Forces in Europe (CFE) agreements call for unprecedented cuts in strategic nuclear and conventional forces. But in contrast to earlier attempts to restrict technology development in previous arms control agreements, these two treaties will have no significant limitations on emerging technology weapons systems. This report examines whether the decision to set aside emerging technology restrictions may undermine the benefits of START and CFE over the lifetimes of these treaties.

The United States and the Soviet Union may continue further arms control negotiations after the current treaties have been completed. In particular, the two countries committed themselves at the June 1990 Summit to negotiations on a follow-on to START. This report examines how emerging technology systems might influence the approach the United States and the Soviet Union pursue in negotiations toward START II or CFE II treaties.

The research supporting this analysis was completed during the summer of 1990, at a time of excellent U.S.–Soviet relations and exceptional progress in arms control. The pace has slowed since then due to a deterioration of the Soviet internal situation. The reader should also note that some of the specific weapons systems discussed here, such as NLOS, have been cancelled and others have a doubtful future. This has little impact on the analysis, since similar systems can certainly take their place in the next decade or so.

This research was performed for the Office of the Under Secretary of Defense for Policy. It was carried out in the Applied Science and Technology Program of the National Defense Research Institute, RAND's federally funded research and development center supported by the Office of the Secretary of Defense and the Joint Staff.
SUMMARY

The United States has signed the Conventional Forces in Europe (CFE) treaty and the Strategic Arms Reduction Treaty (START). These two arms control measures call for unprecedented cuts in the strategic nuclear and conventional forces of the United States and the Soviet Union. Unlike earlier attempts to restrict technology development in previous arms control treaties, however, START and CFE place no significant restrictions on the deployment of emerging technology weapons systems. In past agreements, such limitations were often included as a means of inhibiting the development of destabilizing systems and enhancing arms race stability.

START and CFE do not include significant restrictions on emerging technology systems in part because the United States has found itself ahead of the Soviet Union in virtually all areas of key military technologies and has little desire to have its advantage constrained. In addition, during the negotiations the Soviet Union was more interested in using arms control to normalize its relations with the West and reduce the burden of its military spending than it was in using negotiations to restrict the modernization of U.S. weapons. However, weapons technology may advance considerably during the lifetime of these treaties since START has a specified duration of at least 15 years (and provisions for extension) and CFE is meant to be of unlimited duration. It is important to ask whether the relative absence of restrictions on emerging technology systems could undermine the ability of these treaties to achieve their objectives. The United States and the Soviet Union may also choose to pursue strategic and conventional arms control negotiations toward a START II or a CFE II treaty. If so, how might emerging technologies affect the approach the two countries take toward such negotiations?

With the profound recent changes in Soviet relations toward the West, one of the key new roles of arms control is to help manage a transition to a more stable balance of military forces at lower levels and to help lock-in the benefits of these changes against a potential reversal in Soviet behavior. It is this latter goal that can be most severely affected by emerging technology systems. Any new agreement should seek to meet specific objectives—such as stabilizing reductions—in a manner that ensures that a new Soviet leadership cannot take advantage of the absence of constraints on emerging technologies to rebuild its military capabilities without explicit treaty violations.
START WILL NOT BE SIGNIFICANTLY AFFECTED BY EMERGING TECHNOLOGIES

We will argue in this report that the absence of significant restrictions on new technology systems will not be damaging to START. The treaty’s chief goal is to create a more stable strategic nuclear balance at lower levels of forces than at present. Today’s emerging technology systems do not pose a significant threat to this goal. The balance is robust and, with two exceptions, there are no emerging technology systems that could pose a threat to this goal over the nominal 15-year life of the treaty. The exceptions are new types of ballistic missile defenses and long-range, conventionally armed standoff weapons such as conventional cruise missiles. The large-scale deployment of a new type of strategic missile defense by one side in violation of the ABM treaty and without a prior agreement to do so could put pressure on the other to end its compliance with START. The difficulty posed by conventional cruise missiles is that they can be converted into nuclear-armed systems. At present, only the U.S. deploys such systems and their numbers are small compared to the number of nuclear weapons allowed by START. However, this problem could be of much greater consequence in the future.

CFE MAY BE VULNERABLE TO EMERGING TECHNOLOGY SYSTEMS

We will also argue that the effect of unconstrained emerging technology systems on CFE is potentially profound. The goal of CFE is to establish a stable balance of conventional forces and eliminate the capability for launching large-scale offensive operations in Europe. The current balance of forces in Europe is undergoing rapid change, technological as well as political. A number of emerging technology systems, particularly precision-guided munitions and deep-strike systems, may change the nature of conventional warfare. There is not yet a clear consensus as to whether and under what conditions these new weapons promote or detract from stability. The expected Soviet withdrawal from Eastern Europe will create a buffer zone between East and West and CFE will equalize the sizes of both sides’ conventional forces between the Atlantic and the Urals. This will dramatically change the context in which these new weapons are evaluated in ways that are not yet entirely clear. These technologies may yet pose a problem to the long-term viability of the CFE treaty. For now, however, the large U.S. lead in these systems and the treaty’s usefulness as means of managing the withdrawal and
reduction of the Soviet armies now in Eastern Europe, serve to justify the U.S. decision to set aside restrictions on these systems.

EMERGING TECHNOLOGIES MAY CHANGE THE U.S. APPROACH TO START II

Emerging technology systems will likely become more important in the follow-on, "START II" strategic nuclear arms control negotiations to which the two sides committed themselves at the June 1990 Summit. The Soviets may be less interested in accepting an agreement that leaves the U.S. ability to deploy new systems unfettered because the Soviets will be less in need of arms control to prove their good intentions to the West. In addition, the United States may find it important to restrict some new systems that may threaten to undermine U.S. treaty goals. START II would be more susceptible to emerging technologies than START I because the former will likely mandate smaller forces. Also, systems that may not be feasible during the nominal lifetime of START I may become so during the lifetime of START II.

Even if the United States does acquire an interest in restricting the development and deployment of some new systems in a START II, it may find it difficult to do so. Achieving meaningful restrictions on many of the systems that could threaten first-strike stability or lead to an arms competition under START II—such as ballistic missile defenses (beyond the restrictions of the Antibalistic Missile [ABM] treaty), systems that can threaten ballistic missile submarines, low-observable cruise missiles for short-warning attacks, and systems that can detect mobile missiles from airborne platforms—could be extremely difficult, even if highly intrusive inspections are available for verification.

Additionally, the increased deployment of long-range, conventionally armed, standoff weapons could undermine the ability of a START II to mandate firm limits on the total number of nuclear weapons that are deliverable by either side. Because it is not possible to prevent the platforms that carry these weapons from being nuclear capable or prevent the conversion of these conventional weapons to nuclear ones over a few days' to weeks' time, nuclear arms control treaties may become less able to restrict those forces that either side might take into a crisis or war. The United States and the Soviets may accept this shortcoming, and view START II as a vehicle for limiting only certain types of nuclear weapon delivery systems (such as ballistic missiles) rather than as a means for limiting the total number of deliverable nuclear weapons. Otherwise, the United States will have
to accept limits on conventional as well as nuclear weapons, or possibly adopt negotiated limits on nuclear warheads or fissionable materials in addition to restrictions on nuclear delivery vehicles and weapons loadings.

EMERGING TECHNOLOGIES MAY CHANGE THE U.S. APPROACH TO CFE

The effects of emerging technologies could have an equally significant impact on the U.S. approach to a CFE II treaty. Either the United States or the Soviet Union may determine that emerging conventional weapons systems will significantly enhance the capability for large-scale offensive operations. If so, opportunities to restrict these new systems appear limited. It should be possible to limit deep-strike missile delivery systems, but strict ceilings on deep-strike–capable aircraft and cruise missiles will be difficult. It is also not likely that effective restrictions can be constructed for the key components of the broad class of systems that support non-line-of-sight combat and that distinguish them from less-capable variants: the surveillance and target acquisition sensors, the computation and communications systems capable of providing real-time targeting data, and the weapons with highly capable terminal guidance. Because of these emerging technologies, the United States may find it advantageous to move the focus of a CFE II away from ceilings on particular systems, and move toward other forms of arms control, such as confidence-building measures and limits on military manpower.
ACKNOWLEDGMENTS

Grappling with the possible impacts of emerging technologies is always a challenging endeavor, especially in a time of great political change such as our own. It is a pleasure to thank our RAND colleagues James Bonomo, Paul Davis, Maurice Eisenstein, Joel Kvitky, Tim Webb, and Dean Wilkening, who through their many comments and criticisms helped us clarify our thoughts as this work developed. We are also indebted to Richard Kugler and Roger Molander for their careful and thoughtful reviews. Despite their best efforts, the remaining errors and faulty estimations are, of course, our own.
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# GLOSSARY

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<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AFATDS</td>
<td>Advanced Field Artillery Tactical Data System. A U.S. Army artillery fire-control system.</td>
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<tr>
<td>ATACMS</td>
<td>Army Tactical Missile System. A ballistic missile that can be launched from the MLRS and that can carry smart submunitions.</td>
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<tr>
<td>ATF</td>
<td>Advanced Tactical Fighter. A low-observable air superiority aircraft currently under development.</td>
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<tr>
<td>E.175</td>
<td>A UAV built by E-Systems, Inc., for reconnaissance and strike missions.</td>
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<tr>
<td>GACC</td>
<td>Ground Attack Control Center. A command center to coordinate air-to-ground attacks by U.S. Air Force aircraft.</td>
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<tr>
<td>JSTARS</td>
<td>Joint Surveillance Target Attack Radar System. An airborne, ground-surveillance radar system carried by an E-8A aircraft; intended to detect moving targets.</td>
</tr>
<tr>
<td>LANTIRN</td>
<td>Low-Altitude Navigation/Targeting Infrared for Night. A system to give tactical aircraft an all-weather, day and night, navigation and targeting capability.</td>
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<tr>
<td>LRCCM</td>
<td>Long-range Conventional Cruise Missile.</td>
</tr>
<tr>
<td>MLRS</td>
<td>Multiple Launch Rocket System. A mobile rocket launcher developed by the U.S. Army.</td>
</tr>
<tr>
<td>MR-UAV</td>
<td>Medium-Range Unmanned Air Vehicle.</td>
</tr>
<tr>
<td>MSOW</td>
<td>Modular Standoff Weapon. An air-launched weapon that can carry antiarmor submunitions.</td>
</tr>
<tr>
<td>SICBM</td>
<td>Small Intercontinental Ballistic Missile. A proposed mobile ICBM.</td>
</tr>
<tr>
<td>Skeet</td>
<td>A smart, antiarmor submunition.</td>
</tr>
<tr>
<td>SR-UAV</td>
<td>Short-range Unmanned Air Vehicle</td>
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<td>Acronym</td>
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<tr>
<td>TLAM</td>
<td>Tomahawk Land Attack Missile. The long-range cruise missile currently deployed by the U.S. Navy.</td>
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<tr>
<td>TRS</td>
<td>Tactical Reconnaissance System. An airborne, high-resolution, ground-surveillance radar system mounted on a U-2 aircraft.</td>
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<tr>
<td>UAV</td>
<td>Unmanned Air Vehicle.</td>
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1. INTRODUCTION

The United States has recently signed the Conventional Forces in Europe (CFE) treaty and the Strategic Arms Reduction Treaty (START). These arms control measures call for unprecedented cuts in strategic nuclear and conventional forces. START would reduce the long-range nuclear arsenals of the United States and the Soviet Union by roughly 30 percent. CFE would set common ceilings, based on the NATO and Warsaw Pact groupings, on the levels of conventional forces in Europe. These ceilings would cut certain forces of the Western powers up to 25 percent and those of the Soviet Union up to 50 percent.\(^1\) Yet, despite these cuts, neither treaty puts any significant constraints on weapons systems based on new technologies. Curiously, the first treaties to produce significant quantitative reductions in the standing forces of the post-Cold War era also seem to give little attention to one of arms control’s traditional goals—restricting development of new types of weapons.

Slowing the advance of new weapons technology has been a critical goal of arms control since its inception. During the first two decades of the nuclear era, what arms control there was focused exclusively on limiting the technology of nuclear weapons and the spread of nuclear materials. The abortive Baruch Plan of 1946 would have created an international agency under the auspices of the United Nations with monopoly control over nuclear materials and nuclear research and development activities. The Test Ban treaties of 1962 and the 1970s and the Non-Proliferation Treaty of 1968 continued in this vein of limiting the advance of nuclear technology, and in the latter case the spread of nuclear materials. Since the late 1960s, arms control between the United States and the Soviet Union has principally sought to limit the offensive systems that carry nuclear weapons and the defensive weapons that intercept them. The SALT II treaty placed some restrictions on testing and modernization of ballistic missiles. For many proponents of arms control, such limitations were important in preventing the development of systems considered destabilizing and in slowing what they saw as an arms race driven by an action-reaction cycle.

\(^1\)In particular, the treaty requires NATO to reduce its tanks, armored combat vehicles, and artillery pieces by 24, 13, and 11 percent, respectively. The Soviets are required to cut these categories by 36, 33, and 51 percent.
Despite this long-standing interest, the United States and the Soviet Union have in large measure abandoned efforts to further limit each other's emerging weapons technologies in the most recent negotiations, apparently for several reasons. The United States has found itself ahead in virtually all areas of key military technologies and has had little desire to see limits on the systems these technologies enable. The Soviet Union, seeking a more constructive relationship with the international community, and requiring aid from the West and reductions in its military burden to help rescue its crumbling economy, has become more eager to bring arms control negotiations to a speedy resolution than to use arms control to restrain new American military technologies. Both sides have an interest in reaching agreements as quickly as possible so that START and CFE can play a part in managing military balances that are rapidly being restructured as a consequence of the 1989 revolutions in Eastern Europe. The demanding process of negotiating limits on emerging technology systems would have delayed the completion of the treaties.

The U.S. and Soviet decision not to pursue emerging technologies in START and CFE are sound, since the current political needs are vital. But because these treaties are meant to hold for many years (CFE will be of unlimited duration, START has a specified duration of 15 years with provisions for extension), it is important to ask whether the omission of such restrictions will pose problems for START and CFE during their lifetimes. There has also been much discussion of the treaties that may follow the completion of START and CFE. If the United States and Soviet Union do choose to pursue strategic and conventional arms control toward a START II and a CFE II, how might emerging technologies affect the approach the United States takes toward such negotiations? This report will address these two important questions.

The first question focuses on the problems unrestricted military technologies can pose for CFE and START. In the past, when a treaty did not restrict new technology systems, signatories could often legally obtain capabilities that are similar to or supersede capabilities restricted by the treaty. The classic example of this problem is the Washington Naval treaty of 1922 in which the United States, Great Britain, Japan, and France agreed to limit the number and size of the battleships they could deploy. The parties were motivated by the widespread perception that the battleship-building competition between Britain and Germany had been an important source of tensions that led to the outbreak of the First World War [Barton and Weiler, 1976]. But the treaty did not restrict submarines and aircraft carriers, and did not prevent the proliferation of these new, more effective,
weapons in the years before World War II. A more modern example is the 1972 Antiballistic Missile (ABM) treaty, which banned the testing of antiballistic missile systems outside of designated test ranges. The treaty explicitly defined what types of present-day systems it covered. It was, however, sufficiently vague about its restrictions on future systems to allow proponents to argue in the 1980s that the ABM treaty did not prohibit testing of the particular types of new technology systems they wished to deploy.

The potential of new technology systems to undermine a treaty will remain a problem, even though the thrust of arms control has been changing over the last few years. Now, as before, the military goals of arms control are to increase stability, reduce military spending, and decrease the level of destruction if war does occur. However, the political dimension of arms control has shifted. Previously, arms control served as a vanguard of political change. Negotiations were a tool for promoting communication between the Soviet and American governments and for establishing rules for their competition. Today arms control is only a part of a deepening relationship between the Soviet Union and the West, a relationship in which the economic and political dimensions might before long supersede the military dimensions. From the point of view of the United States, arms control is now a means to manage the already occurring reduction and withdrawal of forces, to ensure continued transparency in the military operations of both sides, and to make Soviet rearmament more difficult if there is a reversal in Soviet behavior [Nye, 1990]. It is this last goal that could be most severely affected by emerging technology systems. An agreement should help lock-in the diminishing threat of the Gorbachev era by requiring reductions that would take time for any new Soviet leadership to restore and by requiring inspection procedures that would provide clear warning if the treaty limits were violated.

We will argue in this report that the relative absence of restrictions on new technologies will not be damaging to START. Today's emerging technology systems do not pose a severe threat to the increased stability at lower and equal levels of forces that are the treaty's chief goals. The strategic nuclear balance is robust, and there do not ap-

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2 Neither the submarine nor the aircraft carrier was unknown in 1922. The former had been used extensively in the First World War. The latter saw less service, but did demonstrate its potential on several occasions, including the Allied invasion of the Soviet Union in July 1918. In fact, the promise of airpower as a naval weapon helped ease the way for limits on battleships [Sherry, 1987]. Airpower proponent Billy Mitchell, fresh from his demonstration sinking of the battleship Ostfriesland, was a member of the American delegation to the Washington conference.
pear to be any new systems that could be deployed in the next 15 years that will significantly reduce the ability of either side to deploy a secure retaliatory force within the confines of the treaty limits. An exception would be the widespread deployment of highly capable ballistic missile defenses. If either the Soviet Union or United States deployed large-scale strategic defenses in violation of the ABM treaty without a prior agreement to do so, the other could be under pressure to abrogate START. Long-range, conventionally armed, standoff weapons, such as conventional cruise missiles, will offer the potential for a quick, overt breakout from the treaty ceilings on warheads, and thus threaten the ability of the treaty to enforce equal force levels. Currently, only the United States deploys such systems, and the numbers involved are small compared to the warhead levels legally allowed by the treaty. Thus, this problem does not appear to be serious. It has the potential, however, to be troubling in the future if the forgiving Soviet attitude toward U.S. systems changes, or if the Soviets begin to deploy such systems of their own.

We will also argue that the effect of unconstrained emerging technology systems on CFE is potentially profound. The goal of CFE is to establish a stable balance of conventional forces and eliminate the capability for launching large-scale offensive operations in Europe. The current balance of forces in Europe is undergoing rapid change, technological as well as political. A number of emerging technology systems, in particular precision-guided munitions and deep-strike systems may change the nature of the conventional battlefield. There is not yet a clear consensus as to whether and under what conditions these new weapons promote or detract from stability. The expected Soviet withdrawal from Eastern Europe will create a buffer zone between East and West and CFE will equalize the size of both sides' conventional forces between the Atlantic and the Urals. This will dramatically change the context in which these new weapons should be evaluated, in ways that are not yet entirely clear. The new technologies may yet pose a problem to the long-term viability of the CFE treaty. For now, however, the large U.S. lead in these systems and the treaty's usefulness as means of managing the withdrawal and reduction of the Soviet armies now in Eastern Europe will serve to justify the U.S. decision to set aside restrictions on these systems.

The second set of questions this report will address is the effect of emerging technology systems on the U.S. approach to future strategic and conventional arms control treaties with the Soviet Union. Will new systems come into being which the United States may want to control? What choices will the United States face if, as is certainly
possible, the Soviets regain their interest in trying to restrict new U.S. systems?

Negotiating successful restrictions on emerging technology systems has always been difficult. Often, one side will have a clear advantage in a particular technology area and will not be interested in limiting the options it can pursue. But even when there is mutual interest in restricting an area of technical advance, an acceptable agreement can be hard to achieve. For example, it is difficult to define systems not yet deployed with sufficient precision to restrict them without also including similar systems which one or both sides may wish to protect. An example of this problem is the 1987 Intermediate-Range Nuclear Forces (INF) treaty, which placed a worldwide ban on ground-launched ballistic and cruise missiles with ranges between 500 km and 5500 km. The treaty aimed to eliminate the nuclear missiles the Soviets and Americans had deployed in Europe during the late 1970s and early 1980s. However, to make the treaty easier to verify, the United States accepted a ban on all future ballistic and cruise missiles with these ranges that carried weapons of any sort. The effect was to ban not only nuclear systems but a number of new conventional weapons then under development. One system in particular, the ground-launched Tacit Rainbow defense suppression missile, had to be redesigned so its range fell below the minimum banned by the treaty.

Emerging technology systems are likely to be even more difficult to limit in future arms control treaties than was the case in the past. One reason is that in some areas the United States will resist limiting its new systems in return for Soviet concessions since the United States will increasingly see these systems as having uses that extend beyond deterring just the Soviet Union. The United States will continue to pursue emerging technology systems, albeit more slowly, as a hedge against Soviet retrenchment. The United States will also view advanced military hardware as being crucial outside the context of the U.S./Soviet competition. As the Gulf War made clear, many Third World countries are acquiring sophisticated equipment and sometimes large armies. The United States will need even more advanced systems to limit the force sizes needed to deter or fight such nations and reduce U.S. casualties in any engagements. The possession of advanced military technology is also a currency of political power and the United States will continue to find it important to maintain its standing as the nation with the world's best military technology. The stability of some areas of the world important to the United States, such as the Middle East and East Asia, may depend in part on a continued perception of U.S. military strength.
In addition, the special nature of today's new systems makes them uniquely hard to define, identify, and restrict. The most important areas of technology that influence the design of modern weapons are the broad array of disciplines dealing with the manipulation of information. For instance, 15 out of 20 of the critical technologies listed in the 1989 Department of Defense Critical Technologies plan depend in whole or in large part on advances in these areas. Carl Builder comments on this trend by differentiating between what he calls the technological era and the information era [Builder, 1989]. In the former, the vanguard of technical change was the introduction of new "gadgets," such as airplanes, atomic bombs, or missiles. In the latter era, which began in the 1970s, the vanguard of change became systems that better handle information. This trend is of course not universally true. A prime example of a new gadget is the National Aerospace Plane, which would be a qualitatively new type of vehicle whose success will depend largely on new materials for its engines, airframe, and fuels.

Nonetheless, most of today's emerging military technologies are not new types of systems but are rather traditional systems with radically better performance achieved by the way in which they handle information. The new generation of smart conventional weapons, for instance, includes missiles fired from aircraft and from the ground. They differ from their earlier counterparts in their potential for highly accurate terminal guidance systems and in their connection to an extensive communications network designed to gather information from a multitude of sensors that can create a picture of the battlefield and can pass targeting information to the weapons before they are fired. Many of today's important weapons development programs—the B-2 and Advanced Tactical Fighter (ATF) low-observable aircraft, Advanced Medium-Range Air-to-Air Missile (AMRAAM) fire-and-forget missiles, and numerous communications systems—will produce systems similar in kind but different in quality from their existing counterparts.

This trend is important for arms control because it stresses factors that treaties traditionally ignore—those qualitative aspects of a system not readily ascertained by an observer, especially when the aspects represent sensitive performance data that cannot be revealed without compromising the military effectiveness of the system. Treaties traditionally focus on limiting the readily observable features of a system, such as the number deployed, its size, its range, or whether or not it has been tested. For instance, SALT and START have attempted to decrease the counterforce capabilities of the U.S. and Soviet arsenals. Although the accuracy of ballistic missiles is an
important component of such a capability, accuracy has never been
expressly restricted in treaties because the accuracy of the other
side's forces cannot be measured in a manner suitable for treaty moni-
toring. In addition, no adequately verifiable way has been found to
limit accuracy indirectly, such as through limits on new types of
guidance systems or insisting on blunt (low ballistic coefficient) re-
entry vehicles that would be inherently inaccurate. Many emerging
technology systems focus on capabilities that present the same
problems. As the effectiveness of weapons systems come to rely
increasingly on externally immeasurable qualities, it will become
increasingly difficult for arms control to define certain systems for
limitations without including numerous other systems that the treaty
intends to treat differently.

We will argue that today's emerging technology systems could have a
substantial impact on a START II or CFE II treaty if either the
United States or Soviet Union regains an interest in limiting such
systems. This could happen if the Soviets determine that proving
their own good behavior is no longer worth signing treaties that leave
advanced U.S. technologies uncontrolled. The United States could
rekindle an interest in limiting technologies if the Soviets show the
potential to develop new systems the United States perceives as
dangerous. An interest by either party could have serious adverse
consequences for a future treaty, because many of the new systems
would be difficult to control.

The increased deployment of long-range, conventionally armed,
standoff weapons could undermine the ability of a START II to place
firm limits on the total number of nuclear weapons deliverable by ei-
ther side. In general, it is not possible to prevent conventional
weapons from being converted to nuclear ones over a few days' to
weeks' time. Thus, nuclear arms control treaties may become less
able to restrict all the potential nuclear forces that either side might
actually take into a crisis or war. The United States and the Soviets
may accept this shortcoming, and view START II as a vehicle for lim-
iting only certain types of nuclear weapons delivery systems (such as
ballistic missiles) rather than as a means for limiting the total num-
ber of deliverable nuclear weapons. This is the situation for the cur-
rent START treaty. It may be more difficult for one or both sides to
accept with START II because the number of allowed nuclear
weapons will be smaller and the number of deployed long-range con-
tventional weapons might be larger. Alternatively, the United States
might consider restrictive limits on conventional as well as nuclear
weapons, or possibly favor limits on the nuclear warheads or fission-
able materials in addition to restrictions on nuclear delivery vehicles and weapons loadings.

Emerging technologies could similarly affect a CFE II treaty. Either the United States or the Soviet Union might determine that new systems like precision-guided munitions and deep-strike systems provide a significant capability for large-scale offensive operations. If so, the opportunities to restrict these new systems may be few. It should be possible to limit or ban deep-strike ballistic missile delivery systems, but ceilings on similar capable aircraft and cruise missiles may be difficult. It is also not likely that effective restrictions can be constructed for the key components of such systems that distinguish them from less capable variants: the surveillance and target acquisition sensors, the computation and communications systems capable of providing real-time targeting data, and the weapons with highly capable terminal guidance. Because of these emerging technologies, the United States may find it advantageous to move the focus of a CFE II away from ceilings on particular systems and move toward other forms of arms control, such as confidence-building measures and limits on military manpower.
2. QUALITATIVE ARMS CONTROL ABANDONED

Before delving into the question of how emerging technology systems could affect START and CFE, it is useful to review why previous treaties devoted greater effort to the control of new technologies, and why the current treaties do not. The traditional debate in the United States over the extent arms control should regulate the development of new military technologies can be usefully characterized by two opposing schools of thought. The first school argues that development and deployment of new military technologies tend to increase tensions and can destabilize the military balance, and that arms control can discourage such advances. This school draws from a long tradition, going back at least as far as the Hague Convention of 1897, which has tried to use international agreements to hold in check the increasing destructiveness of warfare spawned by scientific and technical progress [Tuchman, 1966].

A typical statement of this restricting technology school is found in the welcoming speech given by George Rathjens to a conference entitled “Impact of New Technologies on the Arms Race” in 1970 [Feld et al., 1970]. Rathjens argues that the technologies of Multiple Independently targetable Reentry Vehicles (MIRVs) and Antiballistic Missile Defense (ABM), which the United States was then in the process of developing, should not be deployed. He rests his argument on two grounds. First, MIRV and ABM are destabilizing in a crisis because each confers an advantage to launching first. The former system can threaten to destroy the opponent’s retaliatory capability, whereas the latter can threaten to render a ragged response ineffective. Second, MIRV and ABM contribute to an action/reaction cycle, in which the deployment of the system by one side leads to a countervailing deployment by the other that renders the first’s new capability inoperative. The result is increased spending on armaments with no corresponding increase in security.¹ Rathjens concludes that arms control efforts ought to focus on preventing the deployment of the then new ABM and MIRV technologies (including, if possible, improvements in accuracy and reliability of the latter). He argues that such limitations are more important than limits on the number of existing weapons. Similar, if sometimes less cogent,

¹This is the classic argument which Secretary of Defense Robert McNamara made against ABM in 1967 [McNamara, 1967].
arguments are often made against the development of other nuclear weapons systems.

The second school of thought argues that qualitative advances in military systems tend to favor the United States (and sometimes both superpowers) and thus such advances should not be enmeshed in treaty constraints. Writing in 1985, Kevin Lewis argues that by the early 1970s the strategic nuclear balance became vastly more stable than it had been in 1960, in large part because of the advent of new military technologies [Lewis, 1985]. In 1960, he argues, the Soviets' ability to strike the United States with nuclear weapons was limited to a few vulnerable and unreliable ICBMs, a few missiles aboard submarines that would have trouble operating within range of the U.S. coasts, and a bomber force that would have to face a significant North American air defense. Ten years later, large numbers of ballistic missile submarines, space- and ground-based early warning systems, and silo-based ICBMs on both sides produced a situation that many national security experts would have regarded as far more stable. Pointing to the decades' long competition between the Soviet Union's air defenses and the U.S. strategic bomber force, Lewis suggests some cases in which a technological arms competition can benefit the United States by inducing the Soviets to make heroic efforts to respond to less expensive U.S. actions. Many advocates of this school have also argued that the market economy of the United States is far more efficient at producing new technology systems than was the centrally planned economy of the Soviet Union, and thus saw new technologies as an important edge for the United States in its competition with the Soviets.

Treaties to control strategic offensive nuclear weapons have not emphasized constraints on new technology systems. The 1972 SALT I interim agreement on offensive arms placed a freeze on the number of deployed land- and submarine-based ballistic missiles, but had no restrictions on qualitative force improvements. The United States had proposed controls on ICBM throwweights and mobile ICBMs along with a ban on ICBM modernization [Newhouse, 1973]. However, the Soviet delegation had apparently been instructed to avoid proposals with qualitative limits [Carnesale and Hass, 1987]. Most notably, there were no limits on the development or deployment of MIRV technology, which when coupled with accuracy improvements became the most significant strategic force improvement of the time.

The SALT II treaty similarly had only few restrictions on qualitative force improvements. The most serious attempt to include such qualitative limits was contained in the "Comprehensive Option" pro-
posed to the Soviets by the incoming Carter Administration in March 1977. To help slow the increasing hard target kill capability of Soviet missiles, this option called for a ceiling on the number of ballistic missile flight tests allowed annually, with bans on the modernization of existing ballistic missiles and on the deployment of new types of ballistic missiles [Labrie, 1979]. The Soviets balked at accepting major revisions to the framework President Ford and General Secretary Brezhnev had agreed to in 1974 and to accepting these major restrictions on their own force improvements. In the end, SALT II allowed each side to test and deploy one new type of light ICBM, although it banned testing and deployment of new types of heavy ICBMs, and limited the number of warheads that could be tested on existing missiles. It had no significant restrictions on the newest strategic system, the long-range cruise missile.

The main success of the effort to control new weapons technology has been in the 1972 SALT I treaty, which restricts the development and deployment of antiballistic missile systems. After a decade of development work on ABM systems, the U.S. government became convinced in the late 1960s that deploying such a system to counter Soviet missiles would merely encourage the Soviets to increase the size of their missile forces and build a large ABM system of their own. The United States was able to convince the Soviets to sign a treaty built around the view that extensive defenses against nuclear weapon-carrying ballistic missiles are undesirable. At the time of the signing of the ABM treaty, the ABM systems under development consisted of large phased-array radars and ground-based interceptors. To limit the deployment of such systems, the treaty set a ceiling on the number of allowed interceptors and restricted their deployment to two sites, later reduced to one in the 1974 Treaty Protocol. Although the treaty allowed modernization of existing systems, it also made attempts to prevent the development of at least some new types of ABMs. It forbade testing of non-ABM missile systems, such as air defenses, in an ABM mode and forbade the development, testing, or deployment of ABM systems or components that were sea-based, air-based, or mobile land-based. In Agreed Statement D of the treaty, the United States and the Soviet Union also pledged to discuss how limitations might be applied to ABM systems based on “other physical principles” than the interceptors and radars restricted under specific numerical limits in the treaty. The extent to which the treaty prohibited the testing of systems based on other physical principles was hotly debated in the 1980s.

There are varying interpretations of why the Soviets, who tended to place more importance on defenses than the Americans, accepted a
treaty based on a largely American theory of nuclear stability. Some argue that the Soviets were merely interested in slowing the U.S. ABM program, which was then more technically advanced than the Soviets'. Others, such as MccGwire, argue that the ABM treaty was consistent with a then prevailing Soviet military strategy of accepting the mutual vulnerability of the United States and the Soviet Union to nuclear attack while trying to decouple U.S. strategic nuclear weapons from the defense of Western Europe against Soviet conventional forces [MccGwire, 1987]. The ABM treaty did allow the Soviet Union to build an ABM defense around Moscow, which helped both to satisfy the visceral Soviet interest in defenses and the more concrete need to provide some measure of defense against the smaller nuclear powers that ring the Soviet Union.

More generally, the reasons why negotiations to limit ABM technology development succeeded while those for MIRVs and cruise missiles failed are captured in a simple model put forward in Higgins et al. (1981). After surveying the history of negotiations on MIRV, ABM, cruise missiles, conventional arms in Europe, and chemical weapons, the authors suggested that three conditions can hinder successful negotiations on emerging technologies. These conditions are:

- **Application Diversity.** If the technology in question has multiple applications, the attractiveness of restricting some missions can be outweighed by the desire to retain others.

- **Technological Momentum.** Technologies that are progressing smoothly and rapidly toward a deployable system are more difficult to slow or stop with arms control than those technologies without strong bureaucratic advocates that do not appear to offer workable systems.

- **Technological Asymmetry.** If one side has a clear advantage in a particular area, it would not want its advantage removed by the treaty. Similarly, the side that is behind is unlikely to agree to restrictions that would institutionalize its disadvantage.

According to this framework, the MIRV was not limited because by the time the negotiations started in 1970, all three of these conditions were in force. There was technological asymmetry since the U.S. program was far ahead of the Soviets'. There was technological momentum, since the U.S. MIRV program had successfully overcome the hurdles of developing suitable guidance systems, small warheads, small propulsion systems, and reentry technology. Finally, there was application diversity, since the MIRV was useful not only for overcom-
ing defenses and providing a counterforce threat, but also for providing an economical means of covering targets.² Likewise, the cruise missile was not limited in SALT II because the U.S. program was far more advanced than the Soviets', because the U.S. program had considerable technological momentum by the late 1970s, and because the cruise missile is a weapon with a multitude of applications, not only as a strategic nuclear weapon, but as a theater nuclear weapon, long-range conventional power projection weapon, and anti-ship weapon as well [Gottemoeller, 1987].

Conversely, the absence of the three Higgins conditions allowed limits on new ABM systems to be successfully negotiated. There were few other applications for the then existing ABM technology, so that there was no application diversity. Both sides seemed to accept McNamarra's fundamental argument that defensive systems could always be overwhelmed by the offensive, and thus there was little technological momentum. Finally, while the U.S. ABM technology was somewhat superior to the Soviets', there was a rough overall symmetry since the Soviets at the time had a small deployed system and the United States did not.

Despite the mixed record of success, during the 1970s the U.S. government actively pursued limits on emerging technology systems. During the 1980s, this interest largely disappeared as the United States pursued aggressive modernization programs in its nuclear and conventional forces and launched the Strategic Defense Initiative (SDI). The Soviets, who had often rejected emerging technology limits during the 1970s because they did not want to be in a position of permanent inferiority, began in the 1980s to insist on such limitations as a means of slowing the advance of U.S. weapons technology. But by the end of the 1980s, the Soviets had dropped all their important demands, leaving START and CFE with no important limits on emerging technology systems.

The most important emerging technology issue in START raised and subsequently dropped by the Soviets was the linkage of offensive limitations to restraints on new ballistic missile defense technologies. In proposing the Strategic Defense Initiative, then President Reagan made the classic arguments of the unconstrained technology school. First, he argued, the successful development of new technologies.

²It is interesting to note in this context that the cost per deliverable warhead is one of the few costs of military capabilities that has decreased in recent decades [Lewis, 1990]. In particular, the per warhead costs of the ballistic missile submarine fleet are kept manageable only by MIRV deployments.
would be beneficial to both the United States and the Soviet Union (President Reagan offered to give to the Soviets the new defensive technologies once they were successfully developed) because it offered to put the survival of each country under its own control, rather than relying on threats of retaliation to deter nuclear attack. Second, the new defense technologies were a net advantage to the United States in its competition with the Soviets because the SDI technology stressed U.S. strengths and Soviet weaknesses and the United States could gain leverage over the Soviets by pursuing these systems. The Soviets argued that such defenses would be destabilizing, that far from being defensive weapons, they would have a counterforce capability. They also clearly feared that the U.S. defensive system might work, and overturn their hard-won nuclear parity with the United States. Even if the United States were unable to deploy a workable defense, the Soviets feared that the technologies SDI would develop along the way—directed energy weapons, precision terminal guidance, and complex battle management systems—would have significant spin-offs in U.S. antisatellite weaponry and U.S. conventional forces. Soviet insistence that any reductions in offensive forces be linked to U.S. restrictions on SDI were a major obstacle to an agreement. However, the Soviets agreed at the Jackson Hole Ministerial in early 1990 that START could proceed without any limitations on the new ABM technologies outside those already in the ABM treaty.

The issue of emerging technology restrictions was much shorter lived in the CFE talks than in START. At the beginning of the negotiations in 1987, Soviet spokesmen proposed that asymmetric reductions in the quantity of Soviet conventional forces be balanced by limits on qualitative improvements in United States forces and those of its allies. The United States was not interested in such restrictions, and the idea quickly disappeared from the public records of the negotiations. The Soviets were more interested in reducing force levels in Europe than in limiting U.S. emerging technologies.

In one major treaty in the 1980s, the INF treaty, the United States did agree to limits on emerging technology systems. The decision record, however, suggests that it was not reflective of a well-developed policy on the part of the U.S. government. The primary goal of the INF treaty was to limit the European-based intermediate and shorter range nuclear-armed, ground-launched ballistic and cruise missiles
the Soviet Union had deployed, and the United States was deploying. For a variety of reasons, the negotiators agreed to a mutual worldwide ban on these missiles. The treaty also banned, in addition to intermediate and shorter range nuclear ground-launched missiles, those missiles armed with conventional explosives or any futuristic or exotic types of weaponry, such as laser kill devices, microwave pulses, or kinetic-energy kill. All of these systems, including the conventional missiles, were emerging technologies when the treaty was signed.

The United States agreed to a ban on conventionally armed missiles late in the negotiations, in September 1987, at the insistence of the Soviets [Nunn, 1988]. The basis of the U.S. government position, as explained by State Department counselor Max Kampelman in an April 1988 letter to Senator Claiborne Pell, chairman of the Senate Foreign Relations Committee, was that (i) the United States did not have any specific plans or military requirements for conventionally armed systems in the INF treaty-limited ranges, (ii) the United States preserved its right to deploy conventionally armed Air-Launched Cruise Missiles (ALCMs) and Sea-Launched Cruise Missiles (SLCMs), since the INF treaty covered only ground-launched systems, (iii) such a ban was to the U.S. advantage since the Soviets could have deployed such systems in greater numbers than NATO, and (iv) no effective plan for verifying the difference between conventional and nuclear armed systems had been developed [U.S. Senate, 1988]. The last three points have a great deal of validity, although the third probably overstates the military usefulness the Soviets could glean from their relatively inaccurate conventional missiles, unless they were armed with chemical weapons. The first point was disingenuous, since at that time the United States had at least one system, the ground-launched Tacit Rainbow, in full-scale engineering development, which would have been banned by the treaty.

The ban on futuristic and exotic systems does not seem to have been seriously discussed among high-level U.S. officials until the Senate raised the issue during the ratification hearings. At least one high-

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3The treaty defines intermediate range as 1000 km to 5500 km and shorter range as 500 km to 1000 km.

4In response to queries by then Senator Dan Quayle, former Secretary of Defense Caspar Weinberger and former Arms Control and Disarmament Agency (ACDA) Director Kenneth Adelman wrote letters dated April 13, 1988, to Senator Quayle. Weinberger wrote, “In response to your question as to what consideration was given to ‘futuristic’ weaponry beyond existing nuclear, chemical, and high explosive munitions, prior to signing the INF treaty, I can simply state that there was no understanding of any kind that I knew about that the treaty covered anything related to these so-called
level official claimed that had he known about the issue, he would have opposed including “futuristic” systems in the treaty limitations. However, in the absence of specific language to the contrary, it was difficult to argue that the term “weapon” did not include future systems. Thus, the U.S. and Soviet governments subsequently agreed in an exchange of letters that the treaty language banned any ground-launched missile of INF range that carried weapons based on “current or future technologies” and that a weapon was “any warhead, mechanism or device, which, when directed against any target, is designed to damage or destroy it” [Note, 1988].

Thus, except for its decision on the INF treaty, the U.S. government opposed restrictions on emerging technology systems during the 1980s, specifically in its landmark treaties, START and CFE. The United States perceived itself to be far ahead in virtually all of these technologies [Kassel, 1989]. For their part, the Soviets acceded to substantial and asymmetric cuts in their own forces without insisting that those cuts be linked to restrictions on U.S. emerging military technologies. This is perhaps not surprising in light of the other dramatic actions that the Soviet Union has made over the last few years to normalize relations with the West and reduce its burden of military spending.

In addition to this primary reason, two others suggest themselves. First, since the mid-1980s the Soviet military has been interested in emphasizing quality over quantity in its forces [FitzGerald, 1989]. Soviet policymakers may have felt that the Soviet military would have been more willing to accept deep cuts in its forces if its modernization options were not also restricted. Indeed, one of the arguments Gorbachev has used to justify perestroika to the Soviet military is that a modernized Soviet industry will be better able to provide modern weapons systems to the Soviet armed forces. Second, the Soviets may have reasoned that a significant reduction in tensions would be effective in restricting U.S. emerging technologies by reducing the incentive to pay for them. In this, the Soviets may have calculated correctly.

futuristic weapons,” Adelman wrote, “I can not recall the issue of futuristic INF weapons ever arising during my tenure as ACDA Director.”

5Caspar Weinberger’s letter to Senator Quayle: “Indeed, had there been any such suggestion that ‘futuristic’ weapons were banned, I would have opposed it in the strongest possible terms, because it would have had an obvious adverse effect on SDI.”
3. THE BALANCE IS ROBUST: EMERGING TECHNOLOGIES AND START

New technologies have shaped the evolution of the strategic nuclear balance since the beginning of the nuclear age. The development of fission and fusion weapons were clearly seminal events, and the introduction of ballistic missiles, submarine-launched ballistic missiles, and multiple warhead missiles also had significant impact. The coming decade, however, is likely to be a period where emerging technologies will not foster great changes. Nuclear weapons are now sufficiently accurate that they can destroy virtually any target whose location is known. But for the foreseeable future new technology is not likely to deny the ability of submarines and mobile missiles to remain hidden. The ability of bombers and their associated tankers to escape destruction at their bases is more delicate and could be threatened by the deployment of low-observable sea-launched cruise missiles or possibly short-time-of-flight submarine-launched ballistic missiles. However, there are responses available to counter these threats, although they are likely to be quite expensive. Ballistic missile defenses are not likely over the next decade to reach a stage where they can defeat an unrestrained offensive capability.

We will thus argue in this section that the lack of restrictions on emerging technology systems will not be a major problem for START. Ballistic missile defenses are an exception since under certain circumstances a large deployment by either side could pressure the other to revoke its compliance with the offensive force limitations. Otherwise, there do not seem to be any new systems feasible during the 15-year life of the treaty that if deployed by one side would force the other to withdraw from the treaty. The treaty does not, however, do all it could to prevent the deployment of new systems that would require a treaty-compliant response by the other side. Our conclusion for START II is not so sanguine. If a START II came into effect within 10 to 15 years, it could be more easily undermined by emerging technologies. Technical capabilities may have improved by then, and at lower force levels potential threats to system survivability will become more serious. Another difficulty for a START II treaty may be the breakout potential posed by long-range, nonnuclear standoff weapons. If large numbers of such systems are deployed, START II may not be able to control the total number of strategic nuclear weapons either side could deploy during crisis or war.
We will begin this discussion by examining the goals of the START treaty, since it is in the context of these goals that we will understand the impact of emerging technology systems. The explicit purpose of START is to increase stability with lower and equal levels of strategic nuclear forces on both sides. Stability is a key goal because increasing it will reduce the chances of nuclear war. The most likely way a nuclear war could start is if in the midst of a severe crisis either the Soviet Union or United States perceived that an attack by the other was virtually certain, and judged that attacking second was discernably worse than attacking first. The leadership of one superpower might see such an advantage if it perceived an opportunity to destroy so many of its adversary's weapons that only a few would remain for a retaliatory strike, or if the leadership perceived its own weapons so vulnerable that it feared the adversary's first strike would take away the leadership's own ability to retaliate.

The key to preventing such a situation is to ensure that there are sufficient survivable forces on both sides for a devastating retaliatory blow. In such a situation both sides can afford to strike second, and thus neither need strike first. As described by Thomas Schelling, among the first to articulate these ideas, "the enemy's invulnerability to our own first strike could be to our advantage if it relieved him of a principal concern that might motivate him to strike first. If he has to worry about the exposure of his strategic forces to an attack by us, we have to worry about it too" [Schelling, 1960]. When sufficient survivable forces exist on both sides, we say there is a situation of first-strike stability.

First-strike stability is not, however, the only criterion for strategic nuclear forces. The United States deploys these weapons to fulfill a number of national security objectives. The most important of these objectives have been recently stated as [Carlucci, 1989]:

- Deter attack against the territory of the United States.
- Deter attack against friendly and allied nations, that is, provide extended deterrence.
- Should deterrence fail, limit damage to the extent possible.
- Should deterrence fail, deny Soviet war aims.
- Enhance arms race stability, that is, discourage action/reaction cycles.
- Minimize Soviet influence and coercion short of war.

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1The wording used here is from Kent [Kent and Thaler, 1989].
Some of these objectives are in tension. To deter a nuclear attack on the United States by the Soviet Union it is important to have first-strike stability. However, to deter an attack on U.S. allies with strategic nuclear weapons, particularly a nonnuclear attack, it is important that the strategic balance have an element of instability. Otherwise, the U.S. threat to use these weapons in circumstances other than a direct attack on the United States may not be credible and thus may not deter. The United States has interpreted the extended deterrence objective as requiring its nuclear forces to be capable of conducting limited strikes against Soviet military targets and as having some capability to limit damage to the United States. The ability to limit damage in case deterrence fails directly contradicts first-strike stability, since it implies that the United States be able to significantly degrade the Soviets' retaliatory capability against the United States. The greater the U.S. ability to do this, the more the Soviets will fear the effects of a U.S. first strike. To meet the limiting damage objective, the United States would have to have the capability to destroy Soviet strategic forces either before they are launched or when they are penetrating to their targets. The objective of denying Soviet war aims requires the United States to have the ability to destroy Soviet power projection forces. The requisite U.S. force can be consistent with first-strike stability, since it need not be able to target Soviet strategic nuclear forces. This objective has tended to increase the minimum number of weapons required for deterrence, since there are a large number of Soviet military targets that have been and may continue to be considered important power projection forces by the United States.

The force implications of the last two objectives—maintaining arms race stability and minimizing Soviet influence—are not as rigorously described as those for first-strike stability. Nonetheless, arms race stability is consistent with first-strike stability, but less so with extended deterrence and the ability to limit damage. Minimizing Soviet influence seems to require that U.S. strategic capabilities be at least as robust as those of the Soviets.

In this study, we will focus on the criterion of first-strike stability to assess the impact of emerging technology systems. We chose this measure, first of all, because achieving such stability is the key to a primary U.S. objective—deterring nuclear attack on the United States. The objectives of extended deterrence and limiting damage will likely be less important in the years ahead. With the demise of the Warsaw Pact, the CFE force reductions, and the expected withdrawal of Soviet troops from Eastern Europe, the need for extended nuclear deterrence to deter a Soviet attack on Western Europe has
diminished. This in turn reduces the need for an offensive posture that can limit damage. Deterring a Soviet nuclear attack on the United States will, however, be of enduring importance.

We will also use the criterion of force parity to assess the impact of emerging technology systems. By parity we mean forces that are roughly equivalent in capabilities and in numbers of deliverable warheads. It is not clear that this criterion will remain important in the years to come. It is related to the objective of minimizing Soviet influence, which may become a superfluous role for nuclear weapons. However, a primary reason for constructing START constraints in this period of good relations is to protect against times when relations may worsen. During such times, parity in strategic nuclear forces may carry political importance.

The final criterion we will consider is arms race stability. If possible, a treaty should limit the deployment of systems which provide little net military advantage, but which require an often expensive response by the other side.

**START DOES NOT CONTROL EMERGING TECHNOLOGIES**

We first argue that START does not control important emerging technology systems. Table 1 lists the results of a survey of important capabilities relating to strategic nuclear forces that could be enabled by new technology systems in the next 10 to 15 years. We consider emerging technology systems to be those military systems, planned or proposed, that have a novel capability enabled by a new technology and that have not yet been deployed. This list is based on a survey of a number of sources, including the Air Force Science and Technology Development Planning Program, the Department of Defense Critical Technologies Plan, lists of currently funded technology programs, and Air Force 21. With the Soviets' withdrawal from active competition with the West, many of these programs will have their development slowed or canceled. We thus do not regard this list as a prediction of what will be developed, but rather as a survey of potential systems. In this vein, we have not reviewed estimates of Soviet programs in new military technologies. For our purposes, we will assume that the U.S. research program is inclusive of all the capabilities of strategic significance that might be deployed by either side in the next 10 to 15 years.

The fact that START does not prevent the development and deployment of any of these technologies is indicated in the right-hand column of Table 1, which indicates whether the treaty places quanti-
tative constraints on a particular set of systems or leaves them unlimited. START places ceilings on both the number of strategic delivery vehicles and on the total number of warheads carried by these vehicles. The ceilings do apply to certain emerging technology systems, such as the B-2 strategic bomber and the aircraft that carry the Advanced Cruise Missile (ACM). The ceilings do not, however, pre-

Table 1
Emerging Technologies for Strategic Forces

<table>
<thead>
<tr>
<th>Capability</th>
<th>System/Technology</th>
<th>START Constraint&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locate/strike Strategic Relocatable Targets (SRTa)</td>
<td>Multispectral, multimode sensors, multisource data processing, automatic target recognition</td>
<td>U</td>
</tr>
<tr>
<td>Enhanced aircraft penetration</td>
<td>B-2</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>SRAM II</td>
<td>U</td>
</tr>
<tr>
<td>Strike buried targets</td>
<td>Advanced Cruise Missile (ACM)</td>
<td>L</td>
</tr>
<tr>
<td>Survivable ICBMs</td>
<td>Earth-penetrating warhead</td>
<td>L</td>
</tr>
<tr>
<td>Long-range conventional strike</td>
<td>HAVE-NAP</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Long-Range Conventional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cruise Missile (LRCCM)</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Near-real-time targeting data</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>High-accuracy terminal guidance</td>
<td>U</td>
</tr>
<tr>
<td>Ballistic missile defense</td>
<td>SDI</td>
<td>ABM treaty limitations</td>
</tr>
<tr>
<td>Air defense</td>
<td>Space-based radar</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Advanced over-the-horizon (OTH)</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Long-range hypersonic munition</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Advanced radar platform</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Advanced airborne surveillance radar</td>
<td>U</td>
</tr>
<tr>
<td>Antisubmarine warfare</td>
<td>Improved acoustic processing</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Non-acoustic detection</td>
<td>U</td>
</tr>
</tbody>
</table>

<sup>a</sup>U = unlimited by START; L = quantitative START limitations.
vent these systems from being deployed in militarily significant numbers. This is particularly true since the new systems count against the treaty ceilings the same as do the older ones, such as the B-52. Replacing the older systems with the newer ones on a one-for-one basis would result in a more capable force. The START negotiations made no effort to further restrict important systems such as for ballistic missile defenses,\(^2\) or constrain near-real-time space surveillance, sensors to detect and target strategic relocatable targets, or technologies for detecting and tracking ballistic missile submarines. The treaty does not place any modernization restrictions on strategic aircraft or cruise missiles. The emerging technology systems it does ban, such as multiple warhead cruise missiles, have little military utility compared to those that are not restricted. At the time of this writing, START negotiators are debating the limits the treaty will have on the testing and modernization of heavy ICBMs. Such limits would be intended primarily to restrict improved accuracy and increased throwweight in these missiles. Although such limitations are important, the capabilities they would affect, such as the threat against U.S. land-based ICBMs, are already highly mature.

**EMERGING TECHNOLOGY SYSTEMS THAT DEGRADE STABILITY**

Which of these unrestricted emerging technology systems could, if deployed, reduce first-strike stability in deployed forces under a START treaty? A number of the systems shown in Table 1 would have little effect on first-strike stability, or would act to increase it. Such systems include improved ballistic missile tactical warning and assessment and mobility for land-based missiles. The systems that could potentially degrade first-strike stability are shown in Table 2. We show for each system our estimate of its technical feasibility. We also show for each system what responses could counter a deployment by the other side. These potential responses indicate the nature of the action/reaction cycle that could result from the initial deployment and how serious the new system would be for the treaty regime. For instance, the deployment of ballistic missile defenses could provoke the other side to proliferate its offenses beyond the treaty ceilings, whereas the deployment of low-observable cruise missiles on submarines to threaten enemy bomber bases could require the deployment of an improved early warning system, which is allowed under

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\(^2\) The ABM treaty constrains the deployment of such systems.
Table 2
Strategic Technologies Affecting Stability

<table>
<thead>
<tr>
<th>Capability</th>
<th>Countering Response</th>
<th>Possible Arms Control Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Important if deployed</td>
<td>Ballistic missile defense</td>
<td>Proliferation, penetration aids, suppression</td>
</tr>
<tr>
<td>Short-warning attack:</td>
<td>Warning systems, antisubmarine warfare (ASW)</td>
<td>Submarine keepout zones</td>
</tr>
<tr>
<td>low-observable—SLCM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionable feasibility but</td>
<td>Improved air defense</td>
<td>Stealth, suppression</td>
</tr>
<tr>
<td>important if successful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detecting mobile missiles</td>
<td>Decoys, camouflage</td>
<td>Platform ceilings</td>
</tr>
<tr>
<td>Detecting SSBNs</td>
<td>Alter operations, increase SLBM range</td>
<td>Bastions, keep-out zones</td>
</tr>
<tr>
<td>Little impact</td>
<td>Increasing hard target kill capability</td>
<td>Mobility, defenses</td>
</tr>
</tbody>
</table>

the treaty. Finally, we indicate what arms control constraints might be successful in restricting development of the new capability. We will first explain the judgments that led to the entries in Table 2, and then discuss the implications.

As we have seen, the most critical factor determining first-strike stability is the number of invulnerable weapons posed by each side. Figure 1 shows the number of U.S. and Soviet weapons in a notional START constrained force structure that can be attacked (targetable) and cannot be attacked (untargetable) by the other side. We show these force structures for the case of day-to-day readiness, which is the most stressing case for survivability. At the time of this writing (summer 1990), the strategic force modernization programs in the United States and the Soviet Union are in a great deal of flux, so that any estimates of future forces are particularly uncertain. We have assumed here that both the Soviet and American strategic forces undergo only limited modernization between now and the time the two sides build down to the treaty constrained levels. The motivation for postulating such minimally modernized forces is that this provides a
Fig. 1—Number of warheads under START day-to-day alert
more stressing case for the effects of emerging technology systems. We assume that the treaty is ratified in 1991 and the build down is complete in 1998.

In the forces shown here, the United States deploys 17 Trident boats each carrying 24 D-5 missiles, no mobile land-based missiles, 1635 warheads on submarine-based missiles, 95 B-1Bs and 15 B-2s as penetrating bombers, and 99 B-52H as standoff bombers. The Soviets deploy 344 SS-25 and 112 SS-24 mobile missiles, 154 SS-18 missiles, 1896 warheads on submarine-launched missiles, 50 Blackjack as penetrating bombers, and 131 Bear H as standoff bombers. With these forces, the United States has 2800 untargetable weapons on day-to-day alert, on submarines and bombers. The Soviets have only 900 untargetable weapons on submarines and mobile missiles.\(^3\) If the forces are fully generated, both the United States and the Soviet Union have over 5000 untargetable weapons. The U.S. weapons are carried primarily by submarines and bombers, whereas the Soviet weapons are divided almost equally among bombers, submarine missiles, and mobile missiles.

To assess whether a particular set of Soviet and American force structures is first-strike stable, it is necessary to know how many untargetable weapons are necessary for deterrence on either side. Clearly this is an uncertain business, since the answer to the question of what is necessary ultimately depends on understanding how particular individuals make their decisions under very stressful conditions. This thought process can not be known by others (and perhaps not even by the individuals themselves) with great clarity. Nonetheless, it is important to present thinking that leads to a particular set of numbers, even if they are not the numbers we ultimately choose to believe.

As part of an exercise in quantifying the degree of first-strike stability, Kent and Thaler (1989) argue that a stable balance requires both sides to have enough untargetable weapons to attack most of the important targets in the enemy country. If, for instance, the United States did not have enough untargetable weapons to destroy a large percentage of the targets the Soviets find important, the Soviets, if they believed an attack were imminent, might perceive it worthwhile to strike first to limit the number of weapons the United States could deliver. Kent and Thaler suggest that the United States would reach

\(^3\)We have assumed alert rates of 60 percent and 30 percent for U.S. submarines and bombers, respectively, and 30 percent, 0 percent, and 25 percent for Soviet submarines, bombers, and mobile ICBMs, respectively [Kent and Thaler, 1989].
a level of diminishing marginal returns in damage against the Soviet Union with approximately 2000 survivable weapons and that the Soviet Union would reach a level of diminishing marginal returns in damage against the United States with about 1000 survivable weapons. The reason, in Kent and Thaler's analysis, that the Soviet Union needs fewer weapons than the United States to reach diminishing damage returns is that Soviet value targets are more numerous, more dispersed, and more hardened than those of the United States; that Soviet bomber defenses are more effective than those of the United States; and that the average Soviet weapon is larger than the average American weapon. The overall weapons numbers are also much lower than the current U.S. requirements for strategic forces because they do not include counterforce targets. The figure of 2000 U.S. weapons, however, does include most large military targets and industrial targets in the Soviet Union. Comparing these numbers to those in Fig. 1 gives the none too surprising conclusion that even the day-to-day force posture is first-strike stable. Most other analyses of similar or less formality come to the same conclusion.

We can now return to the emerging technology systems listed in Table 2 to examine their impact on first-strike stability under START. We have divided these systems into three groups: those that would have an important and deleterious impact if they were deployed by the United States or Soviet Union; those systems that would have an impact if they were successfully deployed, but that are not likely to be technically feasible in the next 15 years; and finally those systems that are not likely to have a significant impact on the strategic balance under START. The first category includes ballistic missile defenses, as well as low-observable cruise missiles deployed for short-warning attacks. The second category includes improved air defenses, systems for detecting mobile missiles, and systems for effective detection and tracking of ballistic missile submarines. The last category contains increased hard target kill capability.

**Ballistic Missile Defenses**

Strategic ballistic missile defenses have been the subject of intense debate since President Reagan proposed the Strategic Defense Initiative in 1983 [See Quinlivan et al. 1990 for a recent discussion]. In brief summary, a number of ballistic missile defense technologies developed during the 1980s could enable the deployment of strategic defenses that would likely be effective against offensive forces much smaller than those currently deployed by the United States and the Soviet Union. Such limited strategic defenses could be useful for
these countries as protection against unauthorized or accidental attacks from a small fraction of the other's arsenal, as protection against attack from third states armed with a small number of ballistic missiles, or as protection against cheating or breakout from a future treaty limiting offensive nuclear arms to levels far below those of START. The Bush Administration is interested in gaining Soviet agreement to modify the ABM treaty to expand the scale of permitted strategic defenses. If the Soviets are willing, it could be possible to deploy limited defenses in such a manner as to have no adverse implications for START.

On the other hand, a large-scale deployment of strategic defenses by either the United States or the Soviet Union, implemented in violation of the ABM treaty without a prior agreement to do so, could put pressure on the other to withdraw from START, though such a consequence is by no means certain. It is not clear whether it will be technically feasible to deploy strategic defenses in the next ten to fifteen years which would be able to defeat a large offensive force. Nonetheless, a strategic defense potentially effective against a large offense could degrade each side's perception of the effectiveness of their retaliatory capabilities—particularly for the Soviets who, as Fig. 1 makes clear, rely more heavily on ballistic missiles. A large strategic defense deployment by one side could put pressure on the other to respond by increasing the capabilities of their offense. The primary responses available are penetration aids, defense suppression capability, and proliferation of offensive forces. The last of these would entail an abrogation of the START treaty. Since 1990, the Soviet government no longer states that a full-scale strategic defense deployment by the United States would affect Soviet compliance with START. The Soviets, however, continue to insist on U.S. compliance with the ABM treaty and to oppose a full-scale U.S. strategic defense deployment. It is thus unclear how the Soviets might respond to such a U.S. deployment implemented outside the bounds of the ABM treaty or without a renegotiated agreement on strategic defenses. In the United States, administration policy would welcome a Soviet strategic defense deployment carried out under cooperative terms with the United States. However, there are conceivable circumstances in which a large Soviet deployment of strategic defenses, without a prior agreement with the United States, could be a contentious issue.
Short-Warning Attack

Adequate warning time is an important element in first-strike stability. It allows the bombers to get away from their bases and gives national leaders time to receive information about a potential attack, decide on their responses, and communicate with their forces. Currently, the minimum warning time is set by the flight time of submarine-launched ballistic missiles, which is about 20 minutes for Soviet missiles launched against U.S. bomber bases from submarines operating in the North Atlantic or North Pacific and as short as 15 minutes for submarines operating off the U.S. coasts. Low-observable cruise missiles, launched from submarines off the U.S. coasts, could eliminate warning time if they were able to arrive undetected.

The United States is particularly threatened by low-observable SLCMs because many important installations are along its long coasts, but the Soviet Union is not immune. Launched from positions near the U.S. coast, SLCMs can take over an hour to reach their targets, but because they are difficult to detect, they may arrive with no warning. A few tens of these missiles could be targeted against alert bomber and tanker bases and command and control nodes. A large follow-on attack of ballistic missiles against the victim’s ICBMs would be timed to begin with the detonation of cruise missiles at their targets. The idea behind such an attack would be to destroy the alert bombers and paralyze the victim’s ability to launch ICBMs on warning of the ballistic missile attack. Currently, the Soviet SS-N-21 is technically capable of such attacks against U.S. bases, although there are numerous operational difficulties involved [Postel, 1988/89]. The U.S. early warning system, with the addition of over-the-horizon backscatter (OTH-B) radars, has acquired a marginal capability to detect these systems. This capability is probably sufficient to reduce the utility of the leading edge attack. Neither side, however, currently has warning systems that could give reliable warning of an attack from low-observable SLCMs. As reported in the open literature, no such missile is under development. However, the technology is feasible. The United States has at least one low-observable air-launched cruise missile, the ACM, in development. The Soviets lag in the development of stealth technology, but have sufficient scientific and technical capabilities in this area to build systems that would cause the current generation of U.S. warning systems a great deal of trouble [Delaney, 1990].

To defeat the short-warning low-observable cruise missile threat, it is necessary to either detect and identify a small number of the incoming cruise missiles or use antisubmarine warfare to keep threatening
submarines away from their launch positions. To reliably detect low-
observable cruise missiles, it is necessary to deploy a denser array
than currently exists of modern ground-based radars with superior
subclutter visibility or deploy new types of warning radars or other
sensors [Delaney, 1990]. To reliably identify the cruise missile as a
hostile vehicle (and distinguish it from civilian air traffic), it is gen-
erally thought necessary to direct a manned intercept aircraft to es-
tablish visual contact with the missile. The options for new detection
systems include radars placed in aerostats or airships, a next-genera-
tion airborne early warning and control system aircraft (AWACS), or
a substantial upgrade of the OTH-B radars currently deployed by the
United States. To intercept a low-observable cruise missile, manned
interceptor aircraft will require reliable data from detection radars,
as well as improved on-board look-down radars and infrared detection
systems. Using such components, it should be technically feasible,
though quite expensive, to deploy a warning system against low-ob-
servable cruise missiles that would significantly reduce a potential
attacker's confidence that all his missiles could reach their targets
undetected. None of these systems is limited by START, so the de-
ployment of low-observable submarine-launched cruise missiles need
not undermine first-strike stability under the treaty. In practice,
however, the deployment of these missiles would be a concern, since
they would be an impetus for an expensive countering defensive de-
ployment by the other side. If such a response was not forthcoming,
the missile would represent a destabilizing weapon.

Improved Air Defenses

First-strike stability under START would be degraded if the Soviets'
extensive air defenses were able to neutralize the U.S. bomber force.
As shown in Fig. 1, the United States relies heavily on the weapons
carried by its bombers in both its generated and day-to-day forces,
while deploying virtually no strategic air defense. The Soviets rely
less heavily on their bombers. The struggle between U.S. bombers
and Soviet air defenses has been one of the most active areas of tech-
nological competition over the last 40 years. Not surprisingly, there
has been little competition between Soviet bombers and U.S. strategic

\footnote{It is interesting to note, however, that some potential ground-based and
aerostat/airship radars, designed to detect low-observable cruise missiles, may have
power-aperture products in excess of those allowed by the ABM treaty. The authors
would like to thank James Bonomo and Joel Kvitky for bringing this point to their
attention.}
air defenses since the U.S. abandoned its interest in strategic air defense after the development of the ballistic missile.

Could emerging technology systems give Soviet air defense the capability to defeat American bombers? The most recent generation of defensive systems—ground-based microwave surveillance radars with doppler processing, look-down/shoot-down fighters such as the Su-27 and MiG-29, airborne radar platforms such as the Mainstay, and powerful SAMs like the SA-10—are designed to detect and attack low-flying bombers and cruise missiles. These systems pose a serious threat to the current U.S. B-52 and B-1B bombers and ALCMs. If the Soviets continue deploying their most modern air defenses consistent with current trends, these U.S. vehicles will have difficulty penetrating Soviet air space by the end of the decade. These vehicles would penetrate more easily, however, if the Soviet defenses were suppressed by U.S. ballistic missiles.

In response to the improvement in Soviet air defenses, the United States is beginning to deploy a new generation of low-observable vehicles. The B-2 bomber and the ACM should be able to defeat the most modern Soviet defenses by denying them the ability to reliably detect and track penetrating air vehicles. The same types of emerging technology systems discussed above in the context of providing early warning—infrared sensors, low-frequency radars, airborne radars in balloons or airships—could improve Soviet capabilities against these vehicles. It is not likely, however, that they could deny the ability of these new systems to penetrate.\(^5\)

Thus, improvements in air defenses are not a threat to first-strike stability under START since the United States possesses the technical means to defeat Soviet defenses. Unlike the case for ballistic missile defenses, the necessary systems can be deployed under the treaty ceilings. Improvements in Soviet air defenses could, however, place an arms race burden on the United States because such deployments would call for increased deployments of U.S. low-observable vehicles.

**Attacking Mobile Missiles**

The United States has made a significant investment in researching technology to detect mobile missiles from airborne platforms. If the

\(^5\)These systems can deny the short-warning cruise missile attack but not penetration by bombers and cruise missiles because the latter mission is more stressing. To provide warning, it is necessary only to provide positive identification of a small number of the attacking missiles. To deny penetration, the defense must intercept a significant fraction of the incoming bombers and cruise missiles.
United States were able to develop the capability to detect strategic relocatable targets (SRTs) to the point where the Soviets became concerned about the survivability of their mobile missiles, first-strike stability under the START treaty would be threatened. A U.S. ability to attack Soviet mobile missiles would leave the postulated day-to-day Soviet START force with only 550 submarine-launched missiles as its untargetable force. The United States, on the other hand, would not be affected by Soviet capabilities in this area unless it deployed mobile missiles of its own. Even then, some mobile missile concepts are not vulnerable to improved airborne or space-based sensors.

Detection of mobile missiles requires high-resolution sensors such as synthetic aperture radar, imaging infrared, or imaging microwave radars, and sophisticated data processing in order to distinguish mobile missiles from clutter and false targets. One of the possible missions of the B-2 is to hold Soviet mobile missiles at risk using such sensors. However, the requisite systems are not likely to be developed over the next decade. A fundamental problem is that it is too easy to counter these sensors with camouflage and decoys. In addition, the time needed to effectively search the potential deployment areas for the mobile missiles could exceed the endurance capabilities of an aircraft the size and weight of the B-2. The Soviets will be able to counter U.S. deployment of forces for mobile missile detection with countermeasures such as improved decoys and camouflage, increasing the alert rates of their missiles, and improving their terminal air defenses.

**Detecting Ballistic Missile Submarines**

The ability to track and destroy ballistic missile submarines would have a profound impact on first-strike stability. As is clear from Fig. 1, such a development would not on its own have a greater impact than would effective ballistic missile defenses, effective air defenses, or systems that make alert bombers vulnerable on the ground. Nonetheless, the Soviets and particularly the United States rely on their ballistic missile submarines as their untargetable and enduring forces of last resort. Any system that makes these submarines vulnerable would be a profound blow to stability.

Based on information available in the open literature, however, such developments are not likely over the next 15 years [Stefanick, 1987]. Although acoustic detection is likely to improve as data processing capabilities allow weaker signals to be pulled from the background ocean noise, there is not likely to be a revolutionary improvement in capabilities, particularly with the concurrent trend in submarine qui-
eting. The slower a submarine travels, the harder it is to detect acoustically. Thus, the increasing range of submarine-launched ballistic missiles also contributes to submarine survivability by allowing them to travel more slowly to and within their patrol areas, and to operate in larger ocean areas or, if desired, more protected waters. Work on nonacoustic means of detecting submarines, such as magnetic disturbances, ocean penetrating lasers, or wake detection, is generally highly classified. However, the open literature suggests significant breakthroughs in these areas are not likely.

The United States and the Soviet Union could respond to any emerging threats to their ballistic missile submarine forces by continuing activities that are already under way, such as increasing quieting, altering operations, shifting operations under the ice caps or to bastions, and deploying longer-range missiles that would expand their areas of operations. None of these responses is constrained by START.

Improved Hard Target Kill

Since their introduction in the early 1960s, the accuracy of ballistic missiles has been steadily increasing from miss distances of a few miles to a few hundred meters. This increase in accuracy, combined with the introduction of MIRVs, has caused concern about the survivability of land-based ballistic missiles since the 1970s. Future developments could increase these accuracies to a few tens of meters in the next decade or so [Iklé and Wohlstetter, 1988]. In addition to the increase in accuracy of land-based missiles, the accuracy of submarine-launched ballistic missiles is increasing as well. The United States recently sent to sea the first of its Trident submarines armed with D-5 missiles. This missile has an accurate hard target kill capability against Soviet silos.

Although increasing missile accuracy has been a major issue in the past, it is not likely to further increase its salience as a potential problem under START because accuracy has reached a level of diminishing returns. Under START, the number of prompt, hard target killers in the Soviet and U.S. forces are sufficiently large to cover the silo-based missiles in each other's forces using two warheads per target. Further increases in accuracy are not likely to change either side's assessment of the survivability of their silo-based ICBMs. An attacker's confidence is now more limited by the reliability of his missiles and the possible presence of systematic errors in the force than it is by the accuracy of the missiles. For an attacker to confidently target silos with only one warhead per target would require in-
creases not only in accuracy but increases in missile reliability as well. Alternatively, a system that allowed the attacker to determine which missiles had successfully completed some portion of their flight, such as a successful launch, and quickly launch new missiles to replace those that failed, could reduce the necessary number of attacking warheads to nearly one per target. Even if a unitary warhead-to-target ratio were achieved, the strategic impact would still not be decisive, since both sides are already learning to live without reliance on survivable silo-based missiles. Thus, further increases in missile accuracy are not likely to significantly degrade first-strike stability under START, and neither side will be compelled to respond to technical advances by the other. If either side does wish to respond, the treaty allows appropriate responses, such as missile mobility (although the United States has in the past found it politically difficult to deploy such systems).

In summary, the emerging technology systems that could pose the most serious threat to first-strike stability under the present START treaty are ballistic missile defenses and low-observable cruise missiles deployed for short-warning attacks. The cruise missile threat can be substantially reduced within the START constraints. Thus, first-strike stability under START seems robust to the effects of emerging technology systems, unless one or both sides deploy ballistic missile defenses in violation of the ABM treaty. START will not, however, prevent arms race instability caused by the deployment of low-observable cruise missiles.

EMERGING TECHNOLOGY SYSTEMS THAT DEGRADE PARITY

START’s task of maintaining parity in the overall numbers of strategic nuclear weapons is not as critical as maintaining first-strike stability, but it is a more demanding criteria to satisfy. The stability of the force structures under START is sufficiently robust as to be insensitive to foreseeable emerging technology systems except ballistic missile defenses over the next 15 years. However, emerging technologies will provide opportunities to circumvent or break out of the treaty limits. We will consider a particular problem here—the breakout potential posed by nonnuclear strategic weapons, primarily conventional cruise missiles. By breakout we mean deploying forces in excess of the treaty ceilings a short time (days to months) after overtly violating one or more of the treaty provisions. The new systems are not the only source of a breakout potential, since nondeployed mobile ballistic missiles can be launched from their depots and
many ICBMs and SLBMs can be uploaded with more reentry vehicles than they are credited by the treaty. Although these breakout paths will be larger numerically than those presented by long-range conventional weapons, it is important to consider the latter systems, not only for completeness, but because they may pose some unique difficulties if strategic nuclear arms control is carried below the START ceilings in START II.

**Long-Range Conventional Weapons**

The United States has a strong interest in developing and deploying highly accurate, long-range conventional weapons. These systems would allow the United States to obtain the benefits of what is generally thought of as strategic air power without using nuclear weapons. Long-range conventional weapons, sometimes termed non-nuclear strategic weapons, have been advocated for attacks against economic targets and even as counterforce weapons against nuclear systems [Builder, 1983]. Others have seen them as deep interdiction weapons for theater battlefields, used against airfields, air defenses, command and control centers, transportation nodes, and space ports [Hosmer and Kent, 1987]. These weapons are envisioned not only, and often not even primarily, for use against the Soviet Union. They could play an important role in wars against other enemies in other theaters.

Nonnuclear strategic missions can in principle be performed without emerging technology systems. The first strategic weapons were the bombers used in World War II to attack German and Japanese cities and industrial targets. More recently, conventionally armed B-52 bombers were used as strategic weapons during the Vietnam War. However, with the wide proliferation of very capable modern air defenses, and the smaller force structures imposed on the United States by budgetary constraints, an effective capability for long-range conventional attacks will require new technologies. New systems are needed to penetrate these defenses. In addition, the high precision offered by emerging terminal guidance systems supported by a global surveillance network for targeting offers the possibility of destroying key targets with far fewer platforms, fewer U.S. casualties, and a much smaller expenditure of ordnance.

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6The House Armed Services Committee has estimated that these two breakout paths could conceivably lead to 9000 breakout warheads on the Soviet side [House Armed Services Committee, 1988].
There are three potential types of long-range conventional weapons—intercontinental range ballistic missiles, intermediate range cruise missiles both air- and sea-launched, and long-range penetrating manned aircraft with short-range missiles or gravity bombs. Of these, only cruise missiles and penetrating bombers are currently deployed or under development in the United States. Each of these delivery systems would require for its successful use a surveillance and communications systems capable of providing the targeting and other data to the weapons in a timely manner.

Currently, the U.S. Navy deploys a first-generation long-range conventional cruise missile, the armed Tomahawk Land Attack cruise missile (TLAM-C), on its ships and submarines. This missile is a variant of the nuclear Tomahawk and uses a digital terrain matching system for its terminal guidance. The Navy plans to deploy several thousand of these systems. In addition, the B-2 bomber could potentially be armed with smart bombs for use as a penetrating conventional weapons platform. Although the Soviets have developed a number of nuclear long-range cruise missiles, they have not revealed any conventional variants [Gottemoeller, 1987]. It is not clear whether this is due to lack of interest or a lack of capability in the necessary guidance technology.

The fundamental problem with these systems from an arms control standpoint is that they and the platforms that carry them can be converted to strategic nuclear use. Restricting either the weapons or platforms as if they were nuclear limits the size and thus the effectiveness of the conventional force that can be deployed. If these weapons are not included in the treaty as if they were nuclear, they present a breakout potential because the uncounted conventional systems can be converted to nuclear armaments. It has always been true that many land-based and sea-based aircraft, as well as many missile systems, could be conventionally or nuclear armed; emerging technology systems exacerbate the arms control problems for several reasons. The more potent capabilities of long-range conventional weapons make them more troublesome as nuclear weapons. For instance, the latent nuclear capability in a B-52 bomber armed with conventional cruise missiles is a more serious threat to the Soviets than a B-52 capable only of dropping nuclear gravity bombs. In addition, the capability for long-range strike is proliferating over many platforms since the launchers for long-range weapons are becoming increasingly multipurpose. The U.S. Navy, for example, is currently deploying a common launcher, the vertical launch system (VLS), for use on its cruisers, destroyers, and frigates. This launcher is designed to carry much of the Navy's primary ordnance, such as the Standard missile,
the Harpoon, and the Tomahawk. Thus, ships able to carry the first
two weapons will also be able to carry the third.

It is true that the intrusive inspection provisions now possible in
arms control treaties can greatly ease the problem of distinguishing a
nuclear and conventional force. Inspections can be very useful in de-
termining that at any particular time a particular force is nonnuclear.
For instance, conventional bombers could be isolated on bases without
nuclear weapons, a fact that inspectors could likely verify. Nuclear
weapons could be banned from naval vessels, which could be verified
by short-notice inspections in ports. An observer with proper equip-
ment, such as a radiation detector, who is given access to the exterior
of an individual cruise missile can easily determine whether that
missile is at that time conventionally or nuclear armed.

Given sufficient time, however, a long-range conventional weapon can
be converted into a nuclear one. There is little a treaty regime can do
to prevent this. For instance, the design of the Tomahawk missile
makes it impossible to convert a conventional variant to a nuclear one
on board a ship, except, perhaps, on an aircraft carrier. The missile is
environmentally sealed in its cannister at its maintenance facility.
Although it is built in sections, the missile cannot be reassembled
without careful realignment and numerous electrical connections. In
addition, U.S. ships lack the heavy equipment necessary to lift a
weapon as heavy as the Tomahawk. It is probably possible for a
treaty regime to constrain the design of new conventional cruise mis-
siles so that they would be at least as hard to convert as a Tomahawk.
The missile could be made of a single welded body so that it could not
be opened without being cut apart, or the warhead bay could be
partitioned by structural members that would allow chemical high
explosives but not a nuclear warhead. However, it is not likely that a
treaty could specify design constraints that would prevent the missile
from being converted to a nuclear weapon given a few days or weeks
in a proper maintenance facility well stocked with the necessary
components, such as additional warhead bays. This is not to argue
that all conventional cruise missiles could be converted to nuclear,
only that it would be virtually impossible for an inspector to gather
the information that could prove such a conversion could not be done
[Lempert, 1989].

More important, the platforms that carry or that are themselves long-
rage conventional weapons can easily become nuclear weapon
carriers given enough time. The time it takes to convert the force
could be as short as a day for a bomber force or several weeks for a
fleet of naval vessels. The former represents the time it takes to
move the conventional bombers to a base with nuclear storage and load them with nuclear weapons. The latter represents the time it takes for ships to return from their stations at sea to a naval base, reload, and return to their stations. A treaty can successfully separate the standing nuclear force from the standing force of nonnuclear strategic weapons, but it cannot prevent the latter from being converted into the former in a few days or weeks.

As an example of why conversion is so hard to prevent, consider a heavy bomber designed to carry long-range conventional weapons. The avionics that a heavy bomber would need to launch a high-precision conventional weapon, whether it is a short-range laser-guided bomb or a long-range cruise missile, is at least as complex, if not more so, than that needed to launch a similar nuclear weapon, owing to the greater accuracy requirements of the conventional system. Permissive action links or any other special nuclear-related systems could be imbedded in the existing avionics so that no reasonable inspection could determine whether it was present.

In principle, conversions could be prevented by making the physical launchers for conventional and nuclear weapons incompatible so that nuclear weapons could not be loaded on a conventional bomber. This idea fails on three grounds. First, conventional cruise missiles can be converted to nuclear ones given enough time. Second, nuclear cruise missiles compatible with the conventional launchers could be stockpiled. Third, the launchers on the bombers could be replaced. The situation for naval ships and submarines is similar. It would be impossible to convince an inspector that a vessel capable of launching a conventional cruise missile was not capable of launching a nuclear one.

Let us examine how START grapples with these issues. The treaty proper places no limits on sea-launched cruise missiles, but the United States has agreed to exchange legally nonbinding declarations with the Soviet Union that neither will deploy more than 880 nuclear SLCMs. There are no restrictions on conventional SLCMs nor on the number of SLCMs that can be carried by either side’s fleet. The treaty counts bombers carrying nuclear cruise missiles against the nuclear delivery vehicle and warhead ceilings. It does define a class of nonnuclear long-range cruise missiles, which must be distinguishable from nuclear cruise missiles. The conventional systems can be deployed on a limited number of conventional bombers based at non-nuclear bases.

The reason that this arrangement seems acceptable to the United States despite the breakout potential inherent in the conventional
cruise missiles is that the number of conventional cruise missiles involved is not large compared with the numbers of nuclear weapons allowed by the treaty, and that the largest breakout potential is on the U.S. side. Figure 2 shows the breakout potential posed by nonnuclear strategic weapons under the same START-constrained force structure used for Fig. 1. The figure compares this breakout potential with the number of actual weapons that can legally be deployed under START. We have assumed that in addition to the nuclear forces, the United States has deployed 55 conventional B-52 bombers armed with conventional cruise missiles, that the B-2 force is used as a dual-capable force, and is thus counted under the nuclear ceilings and does not present a breakout potential. We have also assumed the U.S. Navy deploys conventional cruise missiles on its vessels according to its present plans. We assume that the Soviets, in addition to their nuclear forces, deploy 55 conventional Bear bombers armed with conventional cruise missiles and that the Soviet attack submarine fleet carries approximately 1000 conventional cruise missiles. The assumptions for the U.S. conventional forces are consistent with planned deployments. The Soviets, it should be recalled, have revealed no such interest in these systems.

As is apparent from Fig. 2, the breakout potential inherent in the conventional air-launched cruise missile force is small. The breakout potential inherent in the nuclear SLCMs is considerably larger. In both cases, however, the breakout potential is preponderantly on the U.S. side because the Soviets do not have as many of the necessary platforms as does the United States. That START allows these conventional systems is entirely consistent with the general Soviet willingness to accept potential U.S. advantages in return for rapid agreement on the treaty. The United States has a strong interest in long-range conventional weapons and finds itself at an advantage in these systems. The Soviets, in the overall interest of obtaining an agreement, and perhaps perceiving that the United States would find it politically difficult to procure the systems it would need to take advantage of any breakout potential, have not insisted on formal restrictions on these systems. The conventional weapons do, however, have the potential to be a source of future friction if the United States deploys large numbers of them and the Soviet Union begins to object, or if the Soviets begin to deploy large numbers of systems of their own.
Fig. 2—START breakout potential posed by long-range conventional weapons
Space Launch Vehicles

In contrast to conventional cruise missiles, space launch vehicles are not likely to pose a breakout threat to START. They are nonetheless worth mentioning since questions about them have been raised. Space launch vehicles have traditionally been closely related to intercontinental ballistic missiles. The Soviet launch of Sputnik was a shock largely because it demonstrated the Soviets' ability to make intercontinental ballistic missiles. All three of the expendable launch vehicles used by the United States today—the Delta, Atlas, and Titan—are based on the designs of ballistic missiles produced in the late 1950s and early 1960s. The Soviet Union's SL-4 and Proton boosters are similarly based on ICBM designs of the 1960s. Despite their heritage, these systems do not pose a military threat, since they are few in number, take a long time to prepare for launch, and are launched from vulnerable above-ground facilities. Accordingly, it has never been any problem to specifically exclude these systems from arms control agreements, as was done in SALT II and will be done in START.

A number of new types of space launch vehicles are now under development. In the commercial sector, increasing interest in launching small payloads and strong international competition to reduce launch costs is leading to the development of small, flexible, solid-rocket space boosters. In the military sector, the need for survivable access to space is calling for similar systems. Initially there was concern that some of these systems might be enmeshed in the START limitations. An example of such a system is the Pegasus, a 40,000-lb rocket, launched from a B-52 bomber, capable of taking 900 lbs into low earth orbit. This system was developed by a private company, Orbital Sciences Corporation, under contract with the Defense Advanced Research Projects Agency. Pegasus provides an inexpensive launch system, which is part of its commercial appeal, but unlike older boosters, this solid rocket system is considerably more flexible, speedily launched, and survivable.

Additionally, since the START reductions will make ICBM boosters and production capability available, there is interest in using such vehicles in space launch systems. In the United States, the Taurus would be a mobile launch vehicle for the military, which would use the first stage from an MX missile. The Soviets, in a joint venture with a Houston-based company, have proposed producing a space launch vehicle at the same plant which produced SS-20 first stages. The new space launch vehicle would use SS-20 parts that are not re-
quired to be destroyed by the INF treaty and would be produced with the same tooling as the SS-20 [Broad, 1989].

The arms control impact of these space launch vehicles appears to be marginal. First, it is difficult to convert a space launch vehicle to an ICBM. Bans on testing launch vehicles as ICBMs can provide a useful barrier to such conversions. Second, launch rates, although increasing, are still small compared with the number of ballistic missiles in each side's arsenals under START. The United States should average about 20 to 25 military launches per year in the 1990s [Euroconsult, 1988], whereas the Soviet Union has in the past averaged about 100 annual launches. This is small compared with the total number of nondeployed mobile missiles allowed in START, which is on the order of several hundred. If it does become desirable to prevent the accumulation of large space launch vehicle stockpiles because they are seen as a breakout threat, a treaty could require that the production rate of such vehicles match their launch rate, averaged over several years.

**IMPLICATIONS FOR A START II TREATY**

The effects of emerging technologies on START II are likely to be greater than those on START I. Several systems that did not threaten stability under the former treaty may do so under the latter. In addition, increased deployment of long-range, conventionally armed standoff weapons could undermine the ability of START II to meaningfully limit the number of nuclear weapons deliverable by either side.

The underlying goals of a START II treaty are likely to be the same as those for START I: to increase stability at lower and equal levels of strategic nuclear forces. First-strike stability in START II could be enhanced by particular measures such as severe limits or bans on multiple warhead missiles. However, all other factors being equal, reducing force levels below those of START I would not necessarily increase stability. The impetus for continuing with reductions past those in START I is some combination of the following interests (not all equally good): to reduce long-term operations costs for strategic forces, to increase domestic political support for the treaty-constrained nuclear forces, to induce nonnuclear countries to adhere to nonproliferation controls, to reduce the chance of accidental war, and perhaps to provide a waystation on a path to a defense dominant world. The structure of any START II treaty is far from clear. For the purposes of this discussion, we will assume that it would come into effect around the end of the century, and set a ceiling of 4000
strategic nuclear warheads. The treaty might have a ban on multiple warhead ICBMs and have no special discounting rate for bomber warheads. The points important for the following discussion, however, are that START II as currently envisioned will likely have ceilings significantly lower than START I's, and will require more extensive provisions to control the size of the breakout potential.

The same emerging technologies that could pose problems to first-strike stability in START I could pose problems for stability under START II. In addition, the systems that did not seem technically feasible during the lifetime of START I—effective detection of ballistic missile submarines or of mobile missiles by airborne platforms, and effective air defenses against low-observable vehicles—might become so during the lifetime of START II. These potential threats would be more significant for the latter treaty because of the smaller number of weapons allowed. It is important to note that unlike the case for ICBMs, the threat to submarines and bombers does not substantially diminish with the number of opposing nuclear forces, since at their bases these platforms present a small number of targets. Away from their bases, the threats to these platforms are in general not strategic nuclear weapons.

For these reasons, START II negotiators may become more interested than their START I counterparts in using arms control to limit emerging technology threats to the first-strike stability under their treaty. They will find that only some of the new problematic systems are amenable to such limitations.

Ballistic missile defenses and perhaps air defense systems are new systems suitable for verifiable arms control limits. There has been a long debate over the ways in which the testing and deployment of new types of ballistic missile defenses could be restricted. The conclusion is that systems based on space-based kinetic kill weapons and directed energy weapons of all types can be defined and limits on their deployments verified. Probably the most difficult capability to limit and verify would be the addition of a ballistic missile defense capability into a highly netted air defense with long-range surface-to-air missiles.

It may also be possible to limit some air defense systems in a START II treaty. The numbers of interceptors, the number of ground-based radars and airborne radar platforms, the number of surface-to-air missile launchers, and the permitted locations of some of these systems could be subject to treaty limits. There would be significant problems, however, with verifying the number of mobile systems and devising a balance between the allowed ceilings for the United States
and the Soviet Union, since the latter will desire the capability to defend itself not only against U.S. strategic aircraft and cruise missiles, but against the air forces of a large number of its neighbors. In addition, it would be difficult to limit the quality of air defenses. Although limits on the power aperture product of radars are certainly possible, the performance of modern air defenses, particularly against low-observable aircraft or in a jamming environment, depends at least as critically on hard-to-restrict properties such as ability to detect targets in clutter, the amount of data processing, and the system's ability to fuse and transmit data among its many components.

Other emerging technology systems do not appear to be good candidates for arms control restrictions on new systems. If they represent problems, they will have to be countered by other means. Low-observable sea-launched cruise missiles need be deployed only in small numbers, a few tens of missiles, to present a short-warning attack threat. A treaty could ban the deployment of such missiles on submarines, but at best this would protect only against attacks occurring while the treaty was in force. After a few weeks of crisis during which the inspection regime broke down, the low-observable cruise missile threat could be on station [Lempert, 1989]. Thus, a cruise missile ban might be a confidence-building measure during a crisis, since by adhering to the inspection regime both sides could demonstrate to the other that they were not preparing a short-warning cruise missile attack. But the treaty could not prevent the capability for such an attack from being quickly deployed.

It would also be difficult, for two reasons, to limit aircraft-based sensors designed to detect mobile nuclear missiles. First, such sensors would be useful for a number of other missions. Second, the capabilities that made the system effective—resolution and data processing—would be difficult to define in a treaty and to verify.

As for advances in the ability to detect ballistic missile submarines, it is difficult to speculate on what emerging technology restrictions might or might not be appropriate without references to specific systems. Arms control measures such as keepout zones and submarine bastions could enhance the survivability of ballistic missile submarines against many types of threats.

The need to limit certain emerging technology systems to protect first-strike stability could complicate START II negotiations. The inability to limit other new systems that might lead to arms race pressures could diminish the comprehensiveness of the protection provided by the treaty. In addition, the increased deployment of long-range conventional weapons could threaten START II because of the
breakout potential they provide. This would be especially true if such a treaty took serious steps to limit the breakout potential from the ballistic missile forces by restricting the number of nondeployed mobile missiles and accrediting ballistic missiles with as many reentry vehicles as they could actually carry. The extent of the problem depends on how large a force of conventional standoff weapons the United States (or the Soviet Union) deploys. If there are platforms capable of carrying several thousand such weapons, which is easily possible on several tens of ships and submarines or some one hundred cruise missile-carrying aircraft, then the breakout potential could be a significant fraction of the nuclear warheads allowed by the treaty. Whether these systems pose a significant problem in START II depends on two factors that are difficult to predict at this point. Will the Soviets continue to accept a largely asymmetric U.S. breakout potential from these weapons, and will the Soviets themselves decide to deploy a significant long-range conventional capability?

If the answer to either of these questions is yes, then it may become necessary to grapple with this breakout potential in START II. This could prove difficult to do. In general, there are three not entirely satisfactory options.

In the first option, the treaty could count all bombers and launchers on naval vessels capable of carrying long-range conventional weapons as dual-capable nuclear platforms under the nuclear delivery vehicle ceilings of a treaty. Such restrictions would prove more constraining on the Navy than the Air Force, since the ability of bombers to be rapidly resupplied makes it possible for a small number of platforms to deliver a large amount of ordnance. The force would, however, be sensitive to attrition, and thus this option would constrain long-range conventional weapons capabilities. It is possible that the Soviets would be particularly interested in this option because it would allow them to restrict the U.S. ability to launch conventional attacks.

The second option would entail developing a treaty regime that limited the number of nuclear warheads and the amount of fissionable weapons-grade material the United States and the Soviet Union could possess and produce. Traditionally, arms control treaties have concentrated on restricting nuclear delivery vehicles rather than nuclear warheads because it has been much easier to verify limits on the former. However, this may be less true in the future. Clandestine production and storage facilities for cruise missiles may in fact be less easy to detect than facilities for the production of nuclear materials and weapons, although reliable detection of either will be difficult [Lempert, 1989]. If a treaty restricting nuclear warheads and mate-
trials were successful, it would clearly remove the breakout potential inherent in long-range conventional weapons and other delivery systems. A primary problem with instituting such a treaty regime is that there would be no way to accurately know the amount of material and weapons which had been stockpiled before the treaty went into effect. This difficulty seriously reduces the attractiveness of this option as a means of reducing the breakout potential in strategic nuclear arms treaties.

Finally, both sides could accept START II as a treaty that controls standing nuclear forces and does not limit the total number of weapons that could be deployed quickly should the treaty regime be violated. As such, START II would be more a treaty of specific measures to enhance stability, such as restrictions on multiple warhead ballistic missiles, than a means of restricting the numbers of strategic nuclear weapons deliverable by either side. This is to some extent true of START I, but in START II it would be more explicit, since the controlled weapons would be a smaller fraction of the possibly deployed total. Such an emphasis in START II may not be unreasonable, since there is little military benefit in a pure reduction in the number of deliverable weapons, and the restriction of standing forces may be sufficient for arms control to play its political role.
4. A SECOND REVOLUTION? EMERGING TECHNOLOGIES AND CFE

Two revolutions are affecting conventional military forces in Europe. Both will influence the effect of emerging technologies on the CFE treaty and the U.S. approach to limiting new technologies in any follow-on treaty. The most important revolution is the political metamorphosis of the continent—the abandonment of Soviet control over Eastern Europe, the revolutions toppling communist governments, the unification of Germany, and the pending withdrawal of Soviet troops. These events are fundamentally changing the size and posture of future military forces in Europe.

The second revolution is a technological one. Starting in the late 1970s, the United States and its NATO allies began to develop and deploy new conventional systems meant to compensate for the West's numerical inferiority against the Soviet Union by dramatically increasing the quality of Western weapons systems. The new systems are based heavily on the new technologies of information processing, although other technologies, such as that of new materials, are important as well. Many examples of the first generation of new systems are already deployed. Precision-guided munitions such as laser-guided bombs or wire-guided antitank missiles are examples of high-probability-of-kill systems intended to increase the efficiency with which smaller forces can destroy large numbers of enemy targets. The F-117 stealth fighter represents the first generation of low-observable aircraft, designed to counter the increased potency of modern air defenses. These new systems seemed to have proved their potential in the Persian Gulf war.

The next generation of systems will build on these and other technologies. The U.S. Advanced Tactical Fighter will incorporate low-observable technologies in a higher performance aircraft than the F-117, and the Have Slick missile [Fulghum, 1990] will incorporate them into airborne standoff weapons. The broad class of non-line-of-sight weapon systems, mostly developed as part of the U.S. follow-on forces attack (FOFA) concept, emphasize attacking the enemy before he has a chance to establish contact with friendly forces. These systems could greatly enhance the capability to make attacks from a few kilometers deep against nearby tanks and other vehicles or make attacks hundreds of kilometers deep into enemy territory against airfields, command and control facilities, air defense systems, bridges,
and moving military vehicles. In addition, many of these FOFA systems will carry individually guided submunitions so that a single weapon can make many kills. Further in the future, directed energy weapons, primarily lasers but also microwave weapons, may be employed to disable enemy sensors [Rawles, 1989]. Electromagnetic rail guns might provide more power than do current projectiles and a higher rate of fire. Some commentators envision robot tanks that would operate in advance of manned vehicles.\(^1\) If even some of these sytems turn out to have a substantial fraction of the capabilities ascribed to them, they will have a profound effect on the conventional battlefield.

How might these new technologies affect CFE? The treaty's objectives are to establish a stable balance of conventional forces in Europe and to eliminate the capability to conduct large-scale offensive operations. The withdrawal of Soviet troops from Germany, scheduled to be completed by 1995, and the effective dissolution of the Warsaw Pact as a military force, will go far in satisfying these objectives. The new tenor of Soviet foreign policy puts the chances of war in Europe at their lowest level in the postwar period. In these circumstances, the main military purpose of CFE is as an insurance policy to lock in the benefits of an improving military balance in case Soviet relations with the West sour. CFE ought to inhibit competitive rearment and deny the Soviets the ability to augment legally their ability to conduct large-scale offensive operations by deploying new technology systems.

**CFE DOES NOT CONTROL EMERGING TECHNOLOGY SYSTEMS**

We first return to our earlier claim that CFE leaves these new technology systems virtually unrestricted. CFE has national ceilings and aggregate ceilings for NATO and Warsaw Pact members on military manpower and on five categories of weapons—main battle tanks, artillery pieces, armored troop carriers, combat aircraft, and combat helicopters. The treaty governs forces in the Atlantic to the Urals region and divides the overall region into four concentric areas centered on Germany, each with its own subceilings on manpower and the five categories of weapons. System replacement and modernization are explicitly allowed. The definitions of these weapons' categories are based on quantitative measures of the systems'

\(^1\)See Darilek et al. [1988] for reviews of emerging technology sytems for land warfare.
dimensions and weight, highly qualitative descriptions of their military role, and on lists of existing weapons in that category. For instance, artillery is defined to be:

Large calibre systems capable of engaging ground targets by delivering primarily indirect fire, namely guns and howitzers, artillery pieces combining the characteristics of guns and howitzers, mortars, and multiple launch rocket systems. Such artillery systems provide the essential indirect fire support to combined arms formations. In addition, any future large calibre direct fire system which has a secondary effective indirect fire capability will be counted against the artillery ceilings. Large calibre artillery systems are considered to be artillery systems with a calibre of 100 mm or above.

Combat aircraft are defined as:

fixed or swing-wing aircraft, permanently land-based, of a type initially constructed or later converted to drop bombs, deliver air-to-air or air-to-surface missiles, fire guns/cannons, or employ any other weapons of destruction.

Such treaty limitations do not restrict the ability of the United States and its allies to deploy virtually any of the new technology systems they are developing. We will demonstrate this for the FOFA systems, but it is true for others as well. Table 3 shows example non-line-of-sight weapons systems. By no means an exhaustive list, the table does represent the types of systems that could operate at different ranges of interest. Each system consists of surveillance sensors to de-

<table>
<thead>
<tr>
<th>Objective</th>
<th>Surveillance</th>
<th>Platform</th>
<th>Target Acquisition</th>
<th>Weapon</th>
<th>Sub-Munition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving regiments (0–20 km)</td>
<td>UAVs</td>
<td>Truck or helicopter</td>
<td>NLOS</td>
<td>NLOS</td>
<td>—</td>
</tr>
<tr>
<td>Moving columns (20–150 km)</td>
<td>JSTARS, TRS, UAVs</td>
<td>F-16</td>
<td>LANTIRN + GACC</td>
<td>SFW or MSOW</td>
<td>Skeet</td>
</tr>
<tr>
<td>Moving columns (20–150 km)</td>
<td>JSTARS, TRS, UAVs</td>
<td>MLRS</td>
<td>JSTARS or UAV + AFATDS</td>
<td>ATACMS</td>
<td>Skeet</td>
</tr>
<tr>
<td>Units on roads (&gt; 150 km)</td>
<td>F-15E</td>
<td>LANTIRN + GACC</td>
<td>AGM-130</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Units on roads (&gt; 150 km)</td>
<td>B-52</td>
<td>B-52</td>
<td>LRCCM</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

NOTE: See Glossary for definitions.
tect targets and a well-integrated communications net to process the data and transmit them to the weapons platform, which is either an aircraft or a ground-based missile launcher. The target acquisition system is carried by the aircraft, if it is using line-of-sight weapons, or by the weapon itself. The terminal guidance is carried by the weapon, if it carries a unitary warhead, or by submunitions released by the weapon. The systems shown here are in varying stages of development. Some, like LANTRIN, have already been deployed. Others, like LRCCM, are still in the concept formulation stage. The performance of the overall systems is still uncertain. In particular, many deep-strike and non-line-of-site weapons may be vulnerable to countermeasures such as jamming or decoys. A brief description of some of these systems, given below, will make clear the extent to which they depend on new microelectronics technologies and the extent to which the critical components of these systems are not restricted by CFE.

The shortest range system shown in Table 3 is the NLOS, which can be used at the company level to attack enemy forces within 0 to 20 km of friendly troops.\textsuperscript{2} NLOS is a small rocket-boosted glider that can be carried on a truck or by helicopter. It carries a television camera in its nose and transmits its image to a human operator via a fiber optic cable that spools off the tail of the missile in flight. The missile glides above an area in which targets have been reported while the human operator performs the target acquisition function by examining the images sent back by the missile. When the operator chooses a target, the missile is locked on, and flies itself into it for the kill.

At ranges of 20 to 150 km, the division and corps level commanders would have aircraft and missile artillery available to strike enemy forces moving to the front. JSTARS surveillance aircraft operating behind the front would scan a broad, deep coverage area with a moving target indicator (MTI) motion-sensitive radar to detect and indicate moving vehicles. Alternatively, unmanned air vehicles (UAVs) could fly into the target areas to provide targeting data. A communications net would transmit the data in real time to controllers, attack aircraft, and missile batteries for situation assessment, attack planning, and target updates in support of interdiction attacks. Data on enemy air defense operations would also be gathered by AWACS and tactical reconnaissance system (TRS) airborne sensors and transmitted to penetrating aircraft. Penetrating aircraft such as the F-16

\textsuperscript{2}The NLOS program has recently been canceled due to cost overruns. It is likely, however, that another weapon with similar capabilities will be deployed over the next 10 to 15 years.
could overfly targets releasing dispensers of antiarmor submunitions like Skeet. At night or in bad weather the LANTRIN infrared navigation and targeting system would allow target acquisition. Alternatively, the aircraft could use standoff weapons such as MSOW to deliver the submunitions to the target area. Another means of delivery would be Army Tactical Missile System (ATACMS) missiles fired from a Multiple Launch Rocket System (MLRS) launcher that could similarly deliver submunitions into the target area. The submunitions themselves use infrared sensors or millimeter-wave radar to acquire and home in on enemy vehicles.

Deep attacks against targets 150 km or more behind the front would be carried out by long-range penetrating interdiction aircraft such as F-15Es or F-111s, or by cruise missiles launched from heavy bombers. While aircraft could attack all types of targets, near-term cruise missiles would be restricted to attacking fixed targets.

The only elements of these extensive systems affected by CFE are the platforms that carry the weapons. The MLRS launchers, interdiction aircraft, and helicopters count under the artillery, combat aircraft, and combat helicopter ceilings, respectively. The surveillance sensors, the communications networks, and the weapons and submunitions are all uncontrolled. Although the platform ceilings do in principle restrict the number of weapons that can be delivered, these new systems are intended to be force multipliers, so that the treaty allows a tremendous growth in overall capabilities if the older systems are replaced by the new. For instance, both a 155-mm towed artillery piece and an MLRS launcher vehicle count as a single artillery piece against the aggregate ceiling of 33,000 artillery pieces allowed to all parties in the Atlantic to the Urals region. The MLRS vehicle, however, can carry 12 MLRS missiles or two of the larger ATACMS missiles each with several dozen terminally guided submunitions.

In addition to CFE, the treaties affecting European nuclear forces could also affect conventional forces on the continent. As discussed previously, the INF treaty bans ground-launched conventional weapons with ranges between 500 and 5500 km. This does not put a crippling constraint on deep strike capabilities to such extreme ranges, since cruise missiles that would otherwise be ground-launched can be carried by aircraft or naval vessels. The INF treaty does make it harder, however, to develop conventional deep-strike ballistic missiles, since such systems are easily launched only from the ground.
The Short-Range Nuclear Forces (SNF) treaty is also not likely to restrict these emerging technology systems. The status of this potential treaty, which is on the docket for negotiations, is far from clear. In May 1990, the United States cancelled its Follow-On to Lance short-range nuclear ballistic missile program, ended further modernization of nuclear artillery shells in Europe, and agreed to begin negotiations with the Soviet Union on a treaty limiting short-range nuclear forces in Europe once the CFE treaty had been signed [Bush, 1990]. The Soviets have since agreed to withdraw their forces from the former East German territories within five years and presumably will take their short-range nuclear forces with them. If the Soviet army remains in Poland, it will likely retain its nuclear weapons unless there is an agreement removing them. If the Soviet army withdraws further, there will be no Soviet nuclear weapons outside of Soviet territory. It is not yet clear what American nuclear forces the German government will allow. It is very likely that all ground-launched nuclear missiles and nuclear artillery shells will be removed, leaving at most air-launched nuclear weapons [Bajusz and Shaw, 1990].

If an SNF treaty were approached in the same style as INF, with the objective of limiting a nuclear capability by eliminating the vehicles that deliver them, the treaty would capture a significant number of emerging technology systems. Table 4 makes this point by plotting a number of unmanned air vehicles, including ballistic missiles, cruise and other air-breathing missiles, and rocket-assisted gliders, as a function of their range and lethality. Lethality is divided into six categories ranging from reconnaissance, which is considered the least lethal, to nuclear delivery, which is considered the most lethal. If the SNF treaty, like INF, applied to all weapon delivery vehicles, it would capture all the ground-launched non-line-of-sight weapons. It would also capture many unmanned reconnaissance drones, since several of these systems also have antiradar and antiarmor variants. On the other hand, if the SNF treaty limited nuclear delivery systems, it would suffer the same breakout problems long-range conventional standoff weapons posed for START. An inspection regime could determine that a given ballistic missile or cruise missile was not carrying a nuclear weapon at the time of the inspection. However, the inspector could not determine that the missile could not be converted to nuclear use once a crisis had begun.

An SNF treaty faces a more difficult problem with convertible weapons than does START. Although there are more intercontinental nuclear delivery systems than conventional, the number of short-range conventional weapons dwarfs the number of short-range nuclear delivery systems. Not only emerging technology systems but
### Table 4

Range and Lethality of Unmanned Air Vehicles

<table>
<thead>
<tr>
<th>Ranges</th>
<th>Unmanned Vehicle</th>
<th>Nuclear Delivery</th>
<th>Conventional Delivery</th>
<th>Anti-Armor</th>
<th>Anti-Radiation</th>
<th>Electronic Warfare</th>
<th>Reconnaissance</th>
<th>Launcher</th>
</tr>
</thead>
<tbody>
<tr>
<td>INF</td>
<td>TLAM</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Sea, ground, air</td>
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<tr>
<td></td>
<td>MR-UAV</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>Ground, air</td>
</tr>
<tr>
<td></td>
<td>Tacit Rainbow</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Air</td>
</tr>
<tr>
<td>SNF</td>
<td>Tacit Rainbow</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
<td>Ground (MLRS)</td>
</tr>
<tr>
<td></td>
<td>E.175</td>
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<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td>Ground</td>
</tr>
<tr>
<td></td>
<td>Brevel^a</td>
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<td></td>
<td>Ground</td>
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<tr>
<td></td>
<td>SR-UAV</td>
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<td></td>
<td></td>
<td></td>
<td>Ground</td>
</tr>
<tr>
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<td>NLOS</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Ground</td>
</tr>
</tbody>
</table>

Nuclear/conventional division | Weapon/nonweapon division (INF)

^aFrench/German system.
^bGerman system.
most ground-attack aircraft and most artillery pieces can potentially deliver nuclear weapons. An SNF treaty will not limit these systems sufficiently to remove their latent nuclear delivery capability. But perhaps most damning to an SNF treaty's ability to meaningfully limit a breakout is the fact that the threat of interest is no longer the short-warning attack. When NATO was most concerned with deterring an attack with 10 days or less warning, a treaty regime that could guarantee that certain platforms were not nuclear-armed on inspection day might usefully restrict the short-range nuclear forces with which an enemy could begin a war. However, when any fighting would likely be preceded by months of mobilization, the treaty regime would do little to prevent the enemy from reconstituting a theater nuclear force. This would not be true if the inspection protocols were observed during the mobilization, but as this would involve inspectors gaining access to the conventional forces being readied for battle, it is likely the inspections would be curtailed once serious mobilization had begun.

There are two conclusions from this discussion. First, an SNF treaty is not likely to follow the lead of the INF treaty and limit conventional delivery systems because there are too many potentially nuclear-capable systems in the ranges of interest. Second, an SNF treaty, if it is negotiated, would necessarily focus on the nuclear warheads themselves and not the vehicles that deliver them. It could do this in two ways. The treaty could confine itself to controlling only the disposition of forces in peacetime. For instance, all nuclear artillery shells and ground-launched nuclear missiles could be banned from the Atlantic to the Urals region with the understanding that few physical constraints prevented them from being reintroduced in a crisis. The treaty could also require that all short-range nuclear weapons currently in Europe be destroyed, which would have the effect of reducing the existing stockpiles.

**EMERGING TECHNOLOGIES AND OFFENSIVE OPERATIONS**

Having established that there are likely to be no important treaty constraints on emerging technology systems for conventional forces in Europe, we ask whether the Soviets could use the unrestricted new systems to undermine the central goal of the CFE treaty by legally augmenting their capability to wage an offensive war against the West. During the 1970s and 1980s, Soviet modernization of their conventional arsenal did significantly increase the capabilities of their conventional armies in Europe. Many of their weapons systems, such as the T-72 and MiG-29, are roughly equivalent to their Western
counterparts, and in some areas, such as reactive tank armor, the Soviets surpassed Western capabilities. The impetus behind many of the new U.S. emerging technologies was to counter the capabilities the Soviets gained by these improvements in their forces. If the Soviets continue these incremental modernizations in the absence of a Western response, the military balance will swing toward them, even under the constraints of CFE.

Our concern here, however, is with the more revolutionary capabilities offered by emerging technology systems, which may alter our ideas of an acceptable military balance even if they are deployed in equal numbers by both sides. We will concentrate our discussion on the FOFA systems, because of the particularly significant effect they may have on our notions of conventional stability. The NATO nations developed these systems to aid their defense against successive echelons of Soviet attackers. Yet it is far from clear whether these new systems might not give significant new capabilities to a potential aggressor. Answering this question is made even more difficult by a number of important uncertainties, including the rapidly evolving security situation in Europe and the capabilities these systems will actually have when if they are deployed. We will outline some of the important issues involved to point the way toward a more complete answer.

The military context in which the capabilities of these new FOFA systems must be evaluated is only beginning to become clear. It is probable that the Soviets will have lost their former allies' divisions and vital infrastructure such as munitions stores, airfields with shelters, command bunkers, and buried communications lines. It is possible that the Soviet armies may be separated from the West by a neutral Poland. This would be a key development in presenting any future military threat to Western Europe since such a buffer would force Soviet troops to violate an international frontier 600 km before they could engage Western forces and would put the rear areas of each side's army out of reach to all but long-range aircraft and missiles.\(^3\)

Even after the overall military context becomes clear, it will be necessary to understand the extent to which non-line-of-sight and deep-strike weapons contribute to offensive operations. Though much has been written on this subject, there is as yet little consensus. One of the reasons is that there is less agreement on the proper measures of stability for conventional forces than there is for assessing the stability of strategic nuclear forces. In contrast to the latter case, where our only experience is analytic, the outcome of conventional wars is known to depend a great deal on luck and skill in addition to the ca-

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\(^3\)The authors would like to thank Fred Frostig and Paul Davis for discussions on the significance a buffer zone in Poland would present.
pabilities of the opposing forces. Nonetheless, there is a growing analytic literature on conventional stability. A key element of this literature is whether a given balance of forces allows one or both sides to conduct large-scale offensive operations. A stable balance of conventional forces is generally thought of as a situation in which both sides are reasonably confident they could defeat an attack by the other, but are unsure if they themselves could succeed if they were the aggressor. We will consider the offense to be the side that initiates a conflict and tries to seize territory, and the defense to be originally sovereign over the territory to be seized.

In modern warfare, offensive operations are considered to require the ability to mass firepower to shatter defensive positions, as well as highly mobile forces to seize and hold ground. Thus, CFE limits tanks, artillery, armored personal carriers, combat helicopters, and aircraft in order to control offensive capabilities. Ideally, a stable conventional balance would have both sides deploying forces capable only of defense and not attack. Unfortunately, a strong defense requires the ability to counterattack, so that most weapons can play offensive or defensive roles depending on the context of their deployment and use.

Soviet commentators have argued that by expanding the range at which combat takes place, non-line-of-sight weapons will further blur the distinction between offense and defense capabilities [FitzGerald, 1989]. Today it is the offense which can choose the time and place of attack. By breaking through the defensive line, the offense can achieve decisive objectives in the enemy rear. Non-line-of-sight weapons may also allow the defense to seize the initiative by attacking the offense's lead forces or rear areas, even before the offensive has begun.

Deep-strike weapons could also change the character of the forces on the battlefield. Soviet commentators have argued that such weapons could approach the destructiveness of tactical nuclear weapons against exposed forces. Massing forces for attack would no longer be possible if massed forces would merely become high-density targets. However, massing forces may no longer be necessary, since dispersed attacking forces can concentrate fire on weak points in the defense. Prepared defensive fortifications might become more important, as these might give protection from the non-line-of-sight weapons. The new systems could contribute to a deemphasis of heavy armored forces and an emphasis on highly mobile, light, flexible forces.

To examine the extent to which these changes (if they occur) would ultimately contribute to offensive operations, it is useful to consider separately short- and long-range non-line-of-sight systems. Shorter range weapons, those capable of attacks less than several tens of kilometers deep, would seem to favor the defense because advancing
forces would be more vulnerable than the defenders while advancing on the latter's positions. However, if one side had systems substantially more capable than the others, it could have an advantage on the offensive as well.

It is unclear whether the net effect of deep-strike systems favors the offense or defense. There are several reasons to argue that they would favor the defense. First, the attacker must move to make contact with the defender while the defender can remain hidden. Because these weapons are most deadly against vehicles moving in the open, they could effectively interdict the attacker's advance. Second, if defensive fortifications are indeed useful in countering deep-strike weapons, the defender could make better use of such facilities. These two arguments would be especially strong if NATO and Soviet forces were separated by a neutral Poland. Crossing that divide could expose the attacking forces to extensive interdiction fire. Finally, a major advantage of the offense has always been that the attacker could chose the time and place the action would commence, hoping to catch the defensive forces misdeployed. The deep-strike weapons allow a dispersed defense to rapidly concentrate fire against the attackers without needing to physically redeploy.

There are also arguments that these weapons could favor the offense. First, the defender relies on reserve forces to counter the main thrusts of the enemy attack. The attacker could use deep-strike weapons to interdict such defensive reinforcements. This argument is contradictory to the idea expressed above that the deep-strike weapons reduce the need for the defender to concentrate forces. Which effect predominates is a question that requires detailed analysis and that may well depend on the particular scenario and forces involved.

The second argument that deep-strike weapons may favor the offense is that they offer the possibility of decisive opening strikes against the enemy rear. The impact of a surprise attack against unprepared and undispersed defensive forces could be significant. In addition, a surprise attack against the victim's own deep-strike forces could reduce their ability to respond in kind, and an attack against the victim's air or tactical missile defenses could cripple their ability to repel future attacks. Thus these weapons could introduce a first-strike instability into the conventional balance. Moreover, the possibility that one side might come to believe that they had found critical weaknesses in the enemy's organization or deployments that could be exploited by deep strikes could increase their confidence that they could conduct a successful attack even if the forces were otherwise well-balanced.

This last point also suggests that both long- and short-range non-line-of-sight weapons could be arms race unstable. Opposing armies armed with such weapons systems would find that the battle over in-
formation is a key component of warfare. In a war where it is possible to kill those forces that can be detected, even if they are hundreds of kilometers away, the side that can collect accurate data on the positions of the enemy forces and deny that data to the other side will have a powerful advantage. In addition, the effectiveness of individual munitions depends strongly on the countermeasures employed. The advantage in this informational warfare will be difficult to assess, since it will depend on the capabilities of sensors and data processing equipment rather than on force features that are more observable, such as tactics and new types of weapons systems. Such uncertainty might decrease the confidence of a potential attacker, but also promote a competition between nations wary of each other’s capabilities.\(^4\)

It is thus possible that the CFE treaty has left unrestricted a class of emerging technology systems that, if deployed, could rebuild the offensive capabilities the treaty is meant to deny. In addition, the treaty has probably left open an avenue for a significant arms race competition. These flaws are probably not critical for the present. The Soviets are far behind the United States and its allies in their ability to develop such weapons. The treaty's most useful function is to require the Soviets to destroy many of the weapons they will withdraw from Eastern Europe instead of placing them into storage. (This benefit was reduced, however, when the Soviets moved great quantities of equipment out of the treaty area before the treaty was signed.) This is a more important accomplishment than limiting the deployment of systems the Soviet have not yet developed. Nonetheless, the CFE treaty's lack of restrictions on emerging technology systems may significantly reduce the treaty's value as a barrier to Soviet rearmament if relations with the West sour.

**IMPLICATIONS FOR CFE II**

If the United States, Soviet Union, and other European nations begin negotiations on a follow-on treaty to CFE—a CFE II—what should be the U.S. position on restricting emerging technology systems? How should the United States respond if the Soviets renew their interest in limiting Western modernization? The full answer to these questions involves careful balancing of diverse national security interests and is beyond the scope of this report. Our point is that even if the United States decides that it is in its interest to try to restrict some or all of these emerging technology systems in a future CFE II, it will prove difficult to do. The character of the systems places them by and

\(^4\)It is interesting to note that if both sides deployed non-line-of-sight weapons, the stability of balance could be perceived as unknowable. Years could go by with industrial countries armed with non-line-of-sight weapons and no actual combat experience that would shed light on how two such armies might fare against each other in combat.
large outside the reach of the quantitative limits and bans on particular types of hardware that are the standard tools of traditional arms control.

Let us start by looking at the deep-strike systems developed under FOFA. A key determinant of the U.S. position on whether such systems should be restricted is if they aid offensive operations. If a consensus develops that they do, the United States would have a strong interest in discouraging the Soviets from large deployment of such weapons. However, deep-strike weapons can be delivered by ballistic missiles, aircraft, or cruise missiles, and it would be exceedingly difficult to meaningfully restrict the deep-strike capability of cruise missiles and aircraft without compromising other important military capabilities. Limitations on the number of cruise missile launchers or the range of potential cruise missiles would be plagued by the simplicity of the launchers for the smaller, lighter missiles and by the close relation between weapons-carrying cruise missiles and unmanned and unarmed reconnaissance platforms (see Table 4). For aircraft, it would be difficult to usefully restrict their range, but it might be possible to limit the number of ground attack platforms. However, the multirole nature of many modern aircraft would complicate such an approach, as would the need for ground-attack aircraft in many roles outside of Europe. It would also be difficult to limit the ability of ground attack aircraft to carry the sensors, avionics, and weapons needed for deep-strike missions.

Ballistic missiles are deep-strike platforms that might be restricted. The range of ballistic missiles can be determined by outside observers, and ballistic missiles do not have a diversity of missions. It is possible that all ballistic missiles over some minimum range could be banned from European armies, with the possible exception of the French ICBMs. If a neutral Poland does separate the Soviets and the West, the INF bans will be sufficient since it would prevent forces based on either side of Poland from striking into one another's rear areas with ballistic missiles. Because ballistic missiles have short flight times and do not today face extensive defenses, it may be sufficient under some circumstances to limit only those systems and not the air-breathing delivery vehicles.

It is also possible that either the Soviet Union or the United States might desire to restrict all non-line-of-sight systems, long and short range, in a CFE II. The Soviets might insist on such an agreement as a means to prevent the West from developing capabilities the Soviets could not or did not wish to match. In such a situation, the United States would have to decide if a Soviet willingness to make conces-
sions in other areas, such as reductions in their ground forces outside of Europe, would be sufficient reason for the United States to con-
strain non-line-of-sight weapons that would also be useful against other adversaries.

Alternatively, the Soviets might develop a capability to compete with the United States in deploying such weapons, and the United States might wish to limit them to inhibit a competitive arms buildup. In ei-
ther case, it is likely that any limits on non-line-of-sight weapons would be difficult to define and to verify. The heart of these sys-
tems—the sensors, the communications nets, and the capability for data fusion and processing—are all externally immeasurable capabilities. The delivery mechanisms are rockets, artillery pieces, aircraft, and unmanned air vehicles. These systems are ubiquitous and too vital to military operations to ban. However, allowing any such systems allows non-line-of-sight systems since it does not appear possible for treaty limitations to differentiate between externally similar weapons on the basis of their ability to acquire and destroy targets.

Given the difficulties in restricting these emerging technology sys-
tems, the United States and Soviet Union may agree that any CFE II continue limiting tanks, artillery, and other current conventional forces without placing restrictions on emerging technology systems. We suspect, however, that given the potential impact of the newer weapons, such a course would not be a viable option. Thus, the United States may find that the emerging technology systems force it to change the emphasis of its arms control efforts for conventional forces. Fortunately, at the same time that the emerging weapons systems are becoming harder to restrict, the new Soviet openness has made other types of arms control, such as confidence-building mea-
sures and limitations on military exercises and other military activi-
ties, more effective and easier to achieve. Already the numbers and scope of such agreements have increased. Depending on the evolution of the Soviet domestic political system, aggregate limits on military manpower or military spending may also become more feasible. Such measures could provide the longer term insurance that the current CFE does not provide by inhibiting competitive arms buildups and providing barriers to the Soviets developing a significant offensive ca-
pability. The United States may find it more advantageous to pursue arms control along these directions than to try to define and limit a new generation of difficult-to-restrict weapons systems.
5. CONCLUSIONS

Should the United States be concerned that the START and CFE treaties do not restrict emerging technology systems? It should not. The main military purpose of the START treaty is to institutionalize a strategic nuclear balance with increased stability at lower force levels and to place barriers against the Soviets undermining this balance if they renew an aggressive posture toward the West. With two exceptions, there are no emerging technology systems likely to pose a threat to these goals over the 15-year life of the treaty. The exceptions are new types of ballistic missile defenses deployed in violation of the ABM treaty and long-range, conventionally armed standoff weapons such as conventional cruise missiles. Both are systems the United States worked hard to keep free of restrictions during the START negotiations. The deployment of ballistic missile defenses by one side, in the absence of an agreement to do so, would put pressure on the other to end its compliance with START. The difficulty posed by conventional cruise missiles is that they can be converted into nuclear systems. However, this problem does not appear to be serious because only the United States currently deploys such systems and their numbers are small compared to the number of nuclear weapons allowed by START.

Over time, emerging technology systems could upset the balance of conventional forces in Europe mandated by the CFE treaty. It is possible that emerging non-line-of-sight and deep-strike weapons technologies will enable the United States or the Soviet Union to significantly augment their offensive capabilities without violating the treaty limits. It is not yet known whether these weapons will provide such an opportunity. However, the large U.S. lead in these systems and CFE's usefulness in helping to manage the military component of the political changes now sweeping Europe make the treaty's long-term vulnerability to technological change of secondary importance.

If the United States chooses to pursue strategic nuclear and conventional arms control with the Soviet Union beyond START and CFE toward START II and CFE II treaties, emerging technology systems will probably become more important to the negotiations. START and CFE were able to omit restrictions on new systems because the Soviets were more interested in reaching agreements than in using arms control limitations to curb the advance of U.S. military technologies. It is probable that the Soviets would not be as accommodating on this
point in the future. In addition, the United States may find it important to restrict some new systems that may threaten to undermine the goals of the treaty regimes. However, many key emerging technology systems are not amenable to arms control limitations. In addition, the United States may be reluctant to accept restrictions on these systems, even for Soviet concessions in other areas, because the United States will see its new military technologies as increasingly important outside the context of U.S.–Soviet competition. Thus, the development of these new systems may force future U.S.–Soviet arms control treaties in new directions.

A START II treaty would most likely restrict strategic forces to lower levels than START I, which will make high survivability in the remaining forces even more important. However, emerging technology systems that did not seem feasible in the time horizon of START I—such as effective detection of ballistic missile submarines, detection of mobile missiles from airborne platforms, and effective air defense against low-observable vehicles—may pose significant threats to these forces during the lifetime of START II. The United States may thus be interested in restricting the development and deployment of such systems. Ballistic missile defenses and air defenses are the areas in which such limitations would be most feasible.

Additionally, the increased deployment of long-range, conventionally armed, standoff weapons could undermine the ability of a START II to meaningfully limit the number of nuclear weapons deliverable by either side. Because it is not possible to prevent the platforms that carry these weapons from being nuclear capable nor prevent the conversion of the conventional weapons to nuclear ones over a few days' to weeks' time, nuclear arms control treaties may become less able to restrict those forces that either side might actually take into a crisis or war. The United States and Soviet Union may accept this shortcoming, and view START II as a vehicle for limiting only certain types of nuclear weapon delivery systems (such as ballistic missiles) rather than as a means for limiting the total number of deliverable nuclear weapons. Otherwise, the United States will have to accept limits on conventional as well as nuclear weapons, or possibly adopt negotiated limits on nuclear warheads and fissionable materials themselves, in addition to ceilings on nuclear delivery vehicles.

A number of emerging technology systems, among the most important of which are non-line-of-sight and deep-strike weapons, may become key weapons on the future conventional battlefield. If a consensus develops that some of these systems provide a capability for offensive operations, or if the Soviets continue to lag behind the United States
in such systems, one or both sides may insist on their being included in a CFE II treaty. There are, however, few opportunities to limit such systems. Limits or bans on ballistic missiles are possible, but severe restrictions on ground-attack aircraft and cruise missiles do not seem feasible. In addition, the externally immeasurable qualities that distinguish most of the new systems from less capable forces, such as the quality of their sensors, their data processing, and the communications net supporting them, are not as accessible to arms control. Thus, the United States may find it more advantageous to pursue arms control initiatives that focus on confidence-building measures and aggregate limits on manpower than on those that focus on ceilings on specific systems.
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