A BROAD DEFINITION OF INTEROPERABILITY

Interoperability would seem to be a straightforward concept. Put simply, is a measure of the degree to which various organizations or individuals are able to operate together to achieve a common goal. From this top-level perspective, interoperability is a good thing, with overtones of standardization, integration, cooperation, and even synergy.

Interoperability specifics, however, are not well defined. They are often situation-dependent, come in various forms and degrees, and can occur at various levels—strategic, operational, and tactical as well as technological. They are also far more likely to be recognized when interoperability problems emerge and taken for granted when such problems do not.

Interoperability often comes at a price. These costs may be difficult to define and estimate insofar as they consist of military expenditures to enhance interoperability as well as the economic and political costs incurred. The issue, of course, is what sorts of interoperability are worth what sorts of costs.

Because of these various levels and multiple dimensions, we examine interoperability from the broadest available definition:

> The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the

services so exchanged to enable them to operate effectively to-
gether.[1]

This broad definition of interoperability encompasses several areas
that narrower definitions may not, including (1) the ability of forces
from different nations to work effectively together given the nature of
the forces and the combined military organizational structure (the
traditional narrow sense); (2) the effectiveness of the combined
military organizational structure (e.g., how well can the C2 structure
allocate combined assets to achieve military goals); and (3) the
degree of similarity of technical capabilities of the forces from
different nations, reflecting their fungibility in supporting coalition
military goals (e.g., do they have similar precision strike capabili-
ties?).

Thus, this broad definition lets us look at interoperability in all its
dimensions and offers the promise of revealing the most feasible and
prudent interoperability-enhancing options: those options that ad-
dress the most pressing problems while minimizing the costs to
NATO allies and to the United States.

In the remainder of this chapter, we elaborate on this definition by
examining interoperability in greater detail in the context of four
levels—strategic, operational, tactical, and technological (as depicted
in Figure 2.1 in the context of conducting an air campaign).

STRATEGIC PERSPECTIVES

At the strategic level, interoperability is an enabler for coalition
building. It facilitates meaningful contributions by coalition part-
ners. It supports whatever allied "buy-in" may be necessary for the
United States to use its forces effectively in regions of interest. As the
current formulation of the United States' national security strategy
states:

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[1]Host nation support such as communication networks, infrastructure, air bases, and
aircraft squadrons and special forces are examples of services, units, and forces. See
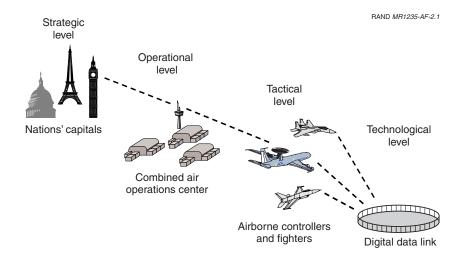Joint Staff (1999), p. 229.

Strategic
level

Operational
level

Tactical
level

Nations' capitals

Technological
level

Combined air
operations center

Airborne controllers
and fighters

Digital data link

Figure 2.1—Interoperability Examined at Four Levels

> We must always be prepared to act alone when that is our most ad-
> vantageous course. But many of our security objectives are best
> achieved—or can only be achieved—through our alliances and
> other formal security structures, or as a leader of an ad hoc coalition
> formed around a specific objective. Durable relationships with al-
> lies and friendly nations are vital to our security. A central thrust of
> our strategy is to strengthen and adapt the security relationships we
> have with key nations around the world and create new relation-
> ships and structures when necessary. Examples include NATO en-
> largement, the Partnership for Peace, the NATO-Russia Permanent
> Joint Council, the African Crisis Response Initiative, the regional se-
> curity dialogue in the ASEAN [Association of Southeast Asian
> Nations] Regional Forum and the hemispheric security initiatives
> adopted at the Summit of the Americas.[2]

At the highest level, interoperability issues center on harmonizing
the world views, strategies, doctrines, and force structures of the
United States and its allies (in this study, NATO members).
Interoperability at this level is an element of alliance/coalition will-

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[2]See The White House (1998), p. 2.

ingness to work together over the long term to achieve and maintain shared interests (e.g., adherence to the rule of international law, democracy, human rights, and open markets) against common threats. As such, interoperability provides a measure of deterrence to would-be troublemakers, and it helps motivate and shape defense research and development, acquisition, strategy, doctrine, tactics, training, and combined exercises.

Alliance and coalition interoperability is one means of achieving both effective and efficient military capabilities: a rationalized approach to interoperability can reduce alliance-wide military expenditures, increase the flexibility or fungible character of selected forces, or define military niches that will be provided by national members so that redundancy can be avoided. Further, substantial participation in coalitions can increase burden sharing by spreading both the costs and risks that are incurred.

The top-level DoD vision for future warfighting concepts, *Joint Vision 2010* (JV 2010), describes the importance of interoperability in multinational operations as follows:

> It is not enough to be joint, when conducting future operations. We must find the most effective methods for integrating and improving interoperability with allied and coalition partners. Although our Armed Forces will maintain decisive unilateral strength, we expect to work in concert with allied and coalition forces in nearly all of our future operations, and increasingly, our procedures, programs, and planning must recognize this reality.[3]

But the price of interoperability at the national level can be high, and equity can be difficult to achieve. National pride, the importance of each country's military-industrial base, and other economic considerations are part of the picture. Political costs and military risks might result from specific interoperability initiatives, which may lead to decisions not to sell or transfer the most advanced systems and technologies to allies. Risks of proliferation of shared technologies and systems to third parties also enter in: the United States (or its allies) might someday have to fight against its (or their) own systems or

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[3]See Chairman of the Joint Chiefs of Staff (1996), p. 9.

may find that they have been exploited by hostile states to produce effective countermeasures.

In pursuing interoperability initiatives to support JV 2010 interoperability guidance, one fact is apparent: there are limits on the extent to which any nation is willing to trust another. These limits constrain openness and system interdependencies (e.g., in intelligence, navigation, and communications), which in turn affect interoperability. For example, common or interoperable information systems and databases are vulnerable to disruption, corruption, and theft of data by an expanded number of insiders—a difficult challenge of the information age.

These interoperability problems may be exacerbated if one nation (e.g., the United States) takes actions that are not acceptable to NATO. If for example, the United States wants to defend interests in Southwest Asia (SWA) while NATO strenuously objects, the NATO nations may deny use of their airfields and airspace. This would result in an inability to deploy some combat air forces, a greater expenditure of tanker assets, and possibly the inability to use civilian nonrefuelable airlift.

When there is U.S. and NATO cooperation, overall effectiveness may still take a back seat to national pride, in which case wartime interoperability may become less about maximizing efficiency—in making the whole even better than the sum of its parts—and more about minimizing the burden of politically expedient coalitions. Further, because the United States is largely able to go it alone if necessary, NATO allies may view interoperability efforts as a one-way street, with interoperability compromises and costs unfairly forced on them.[4] Their response might be to accept less well-integrated interoperability levels with the expectation that the United States will ultimately absorb the costs of coalition interoperability shortfalls and inefficiencies.

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[4]Paradoxically, a U.S. ability to "go it alone" by acting unilaterally may be a requirement for leading a coalition effort insofar as the threat of unilateral action may spur coalition joining by those who hope to influence the objectives and nature of the military action; see Gebhard (1994), p. 39.

OPERATIONAL AND TACTICAL PERSPECTIVES

Interoperability at the operational and tactical levels is where strategic/political interoperability (discussed above) and technological interoperability (discussed below) come together to help the NATO allies shape the environment, manage crises, and win wars. This is the real-world realm of the warfighter. Interoperability's purpose and focus is to satisfy the political leadership's strategic objectives, within the given constraints and with the maximum possible efficiency and economy of force.

The benefits of interoperability at the operational and tactical levels generally derive from the fungibility or interchangeability of force elements and units. Planning for and conducting NATO-led operations or operations by ad hoc "coalitions of the willing" in out-of-area MTWs or military operations other than war (MOOTWs) involves a process of force "rationalization," i.e., assessing how best to accomplish the mission with the resources available from the coalition members.

The result can vary from a tightly integrated operation (e.g., mixed coalition strike packages) to a coordinated partitioning of the mission or battlespace into separate country-specific chunks. Integration can be achieved through a variety of means, including "interoperable" command centers with standardized communications and computerized data networks, intelligence, surveillance, and reconnaissance (ISR) systems, and force elements, or through ad hoc techniques, procedures, and linkages that include extensive use of liaison officers.

Interoperability-associated costs at the operational and tactical levels tend to result from inefficiencies caused by a number of possible factors outside the immediate control of the warfighters, such as the strategic objectives, strategy and doctrine, role, and systems capabilities of the dominant (whether in the lead or not) coalition partner (for the indefinite future, the United States) and those of the other coalition partners. Coalition operations such as tactical assessments, decisionmaking, planning, force execution, and evaluation are less efficient than U.S. unilateral operations simply because of the number and diversity of the participants. However, unilateral operation may be more costly. Coordination, consensus building, and una-

nimity lead to delays with potentially costly effects on the operational tempo ("shock and awe") that is the hallmark of U.S. military supremacy. Coalition-related reductions in operational tempo can result in longer conflicts, with resultant increases in material and human costs and possible loss of resolve at the political level.

From the perspective of the dominant partner, these inefficiencies and costs may be exacerbated by the need to divert scarce U.S. military resources to support the partners (e.g., airlift) and to wait for the partners to catch up on mission assignments that could have been more effectively accomplished by U.S. forces. However, these inefficiencies may be necessary to gain political support, access to infrastructure, and use of the airspace of nondominant partners in coalition operations.

Finally, the number and diversity of participants in a coalition increases the chance of military errors, e.g., fratricide or unacceptable collateral damage. These errors must again be hedged against with inherent efficiency penalties.

TECHNOLOGICAL PERSPECTIVE

This perspective takes our analysis of interoperability into the mechanics of system technical capabilities and interfaces between organizations and systems. It focuses on communications and computers but also involves the technical capabilities of systems and the resulting mission compatibility or incompatibility between the systems (hardware and software) and data of coalition partners.

At the technological level, the benefits of interoperability come primarily from their impacts at the operational and tactical levels in terms of enhancing fungibility and flexibility. (Technology areas include secure voice and data communications, combat identification, and PGWs.)

At the technological interface level, according to the National Institute of Standards and Technology (NIST), the Institute of Electrical and Electronic Engineers (IEEE), the Army Science Board, and the DoD, interoperability is

> The capability of systems to communicate with one another and to exchange and use information including content, format, and semantics.[5]

> (1) The ability of two or more systems or components to exchange data and use information;[6] (2) The ability of two or more systems to exchange information and to mutually use the information that are exchanged.[7,8]

> The condition achieved among communications-electronic systems or items of communications-electronics equipment when information can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases.[9]

Recognizing the need for systems to work together adequately in a realistic operational context, many organizations have developed definitions designed to facilitate future investments in systems and to harmonize existing programs. But discussions of such technology-based interoperability initiatives can quickly lose their focus on strategic and operational objectives and become arguments about more tractable tactical and programmatic issues. This phenomenon is not surprising given that technologists have difficulty fully comprehending operational stresses and realities and that operators have difficulty fully understanding the inherent complexity and rigidity of much of today's technology.

In theory, perfectly interoperable systems and data would support the strategic, operational, and tactical interfaces between organizations in ways that are consonant with preexisting agreements on organizations, strategic objectives, and operational concepts. Of course, such perfectly interoperable systems are unlikely to be achieved in practice, and as a result, critical interoperability shortfalls must be identified. Before technological systems are built, two perspectives must therefore be discussed: First, what contribution

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[5]See National Institute of Standards and Technology (1996).

[6]See IEEE STD 610.12.

[7]These two definitions are quoted in Department of the Army (1997).

[8]See Army Science Board (1995).

[9]See Joint Staff (1999), p. 229.

are such systems expected to make to the organization's strategic objectives? And second, what operational concepts will they enable in future military operations?

Interoperability also derives from the technical capabilities and design of standalone coalition systems. In a coalition with mixed capabilities, interoperability in the sense of seamlessly integrated operations may not be possible. In that case, different technology levels may require that the mission and battlespace be partitioned according to coalition member capabilities, and such assignments may lead to lower warfighting effectiveness and increased costs and risks. Less technologically capable U.S. partners may see such assignments as "second order" or even demeaning relative to U.S. roles and missions.

SUMMARY

Simply stated, interoperability supports U.S. national security and U.S. national military strategies. It can enable coalition building with coalition partners. It can sustain coalitions by reducing the costs of participation and increasing burden sharing. And it offers an opportunity to enhance future coalition operations. This final benefit confers additional advantages beyond the specific coalition operation. For example, effective allied forces will be better able to carry the continued burden of peace operations while U.S. forces can be redeployed to a major crisis or to an MTW. Furthermore, effective and efficient coalitions will improve the prospects that coalition partners will join future coalitions.

However, the complexity of interoperability and its multiple dimensions make it difficult to understand the nature of the benefits, costs, and tradeoffs that the United States and NATO allies will face in future efforts to improve the interoperability of coalition forces. In fact, much of the value of interoperability is intangible and not easily measured or quantified.