This chapter discusses institutional and legal issues that can affect how GPS signals and signal augmentations are provided, including alternatives for managing and funding these services. It first identifies the basic institutional capabilities necessary for managing, operating, and funding GPS and uses them to define criteria for assessing management and funding options. It then assesses a range of institutional arrangements for GPS that address possible funding and cost-recovery mechanisms. It also addresses recurring themes—often presented as criteria for preferring one set of options to others—in GPS policy debates, and attempts to inform the debate with relevant legal and historical background. This chapter provides a framework for thinking about the advantages and disadvantages of the various institutional options and clarifies terms in the policy debate.

Here, we assume that the domestic benefits of making GPS available for non-military uses exceed the risks of misuses of GPS and the cost of countermeasures against the misuse of, or interference with, GPS signals by terrorists, smugglers, or hostile military forces. These countermeasures could conceivably include converting the GPS system to one with greater control over usage or access. Today, the only barrier to the use of the GPS Standard Positioning Service is the retail-taxed price of GPS receivers. Although it might seem that the marginal cost of delivering GPS to any new user in its broadcast range is zero (like any radio broadcast), the expanding use of GPS can create additional costs and risks in the need to protect GPS signals that are not reflected in current equipment prices. A larger percentage of the benefits that are derived from GPS might need to be devoted to ensuring the continued reliability of GPS-dependent systems, whether through taxes, fees, or private investments.

GPS MANAGEMENT, OPERATION, AND FUNDING OPTIONS

As policymakers evaluate the implications of increasing civil, commercial, and military uses of GPS, institutional questions on its future can be reduced to two
key questions: (1) Who should manage and operate GPS? and (2) How should GPS be funded? Different “visions” for the institutional future of GPS can be summarized as:

- GPS continues as a U.S. military system
- GPS becomes jointly or exclusively governed by one or more U.S. civilian agencies
- GPS is privatized and managed by a U.S. entity
- GPS is privatized and internationally managed
- GPS is augmented by civil/private/foreign elements (space-based or ground-based)
- GPS is gradually displaced by private space systems or other technologies.

These visions are not all mutually exclusive. A GPS that continues to be a U.S. military system may be augmented by elements from foreign countries or international consortia, such as INMARSAT. Similarly, a GPS under the control of a private U.S. entity may be part of a broader international venture in related space-based communication services. There can be hybrids of privatization and international management whereby governments enforce fee payments to a private international entity. In any event, ensuring continued benefits from GPS will require competent and stable operations and protection of interests of the United States (as the country likely to be most dependent on GPS).

Each of the institutional visions has different funding options associated with them. In the status quo case of GPS continuing as a U.S. military system, the Department of Defense pays for the space and control segments, as well as the military user equipment. All other users buy their own ground equipment. Civil U.S. government agencies are responsible for paying for any GPS augmentations that they might require, as is being done by the FAA and the U.S. Coast Guard. If U.S. civil agencies were to become more responsible for GPS, then they may be asked to share in the cost of maintaining the basic system.

If GPS is to be funded in some way other than with U.S. tax dollars, then private and international (perhaps foreign government) sources of payment are needed. Private sources could include special taxes on GPS receivers or fees for the use of GPS signals, assuming payment could be enforced. Being able to charge for equipment and/or services is central to any proposal to privatize GPS. Whether GPS is under government or private control, it may be displaced by private systems such as space-based communications that could offer competing services. Like a privatized GPS, such systems would need the ability to charge, exclude users, lower costs, or offer better services to compete effectively with it.
NECESSARY CONDITIONS FOR GPS

Theoretically, there are several possible options for organizing the management, operation, and funding of GPS, although these options usually assume the existence of other institutions and mechanisms. Necessary institutional conditions for the operation of the GPS include:

1. The continued cooperation of the International Telecommunication Union in allocating an exclusive worldwide “easement” to a frequency range or ranges;

2. The continued cooperation of the United Kingdom and the Republic of the Marshall Islands for easements to the territory on which three of the five ground stations that communicate with the satellites have been established, as well as the cooperation of the United States for access to the two ground stations on U.S. territory (or substitute control stations must be established);

3. A group of skilled engineers and technicians who know how to manage satellite operations;

4. A source of funding for the maintenance of the system;¹ and

5. A highly reliable organization disciplined to follow operational procedures, especially emergency procedures.

In aggregate, these conditions are sufficient for the continued operation of GPS. Given the proof of the technical feasibility of satellite-based navigation, as demonstrated by GPS, one might argue that the only really necessary and sufficient condition for its continued operation is a source of funds—whether from public or private sources. Not surprisingly, funding is a central institutional issue.

Debates over whether a public or private organization should operate a particular system, whether garbage collection or telephone service, often focus on who can best reduce operating expenses. In the case of GPS, however, payment collection techniques and procedural discipline (conditions 4 and 5) are more important factors than operating-expense reduction for several reasons. Although we care about measurable results (e.g., GPS accuracy, availability, and reliability), which can be well-served by private, profit-seeking organizations, we also care very much about procedures to be followed during national secu-

¹Whether the United States should and can recover its capital investment in the GPS can be separated from the maintenance question.
irtty emergencies. Second, it is not clear whether it would ever be technologically cost-effective to collect from nongovernmental users for the provision of GPS signals in ways other than those available to a government (e.g., taxes). Third, given the need to service military as well as nonmilitary users, there does not appear to be much opportunity to drastically reduce the GPS operating budget, which goes primarily toward satellites and launch services. There may be ways of reducing military and civilian personnel costs for functions not directly related to the operation of GPS, and these can be explored independently in any case.

Although it might have been difficult for a private company to obtain the necessary easements (conditions 1 and 2) in the first place (that is, the military utility of the GPS, as originally conceived in the 1970s, might have been the reason the easements were granted), we can assume that a private company, a civilian agency, or an international governmental organization might be assigned the existing easements. We can also assume that any organization made responsible for the GPS can hire engineers who know how to fly satellites (and contract with others to design and build replacement satellites).

The question of who should provide the GPS, if not the DoD through the U.S. Air Force, thus seems to reduce to funding capabilities and procedural discipline: What payment-collection methods do potential GPS operators have? Who can be most trusted to follow procedures, both for evaluating user requirements and for emergencies? U.S. and international user groups are becoming very large now that commercial GPS receivers can be obtained for less than $300. As these groups come to depend on GPS, they seek assurance that it will be available and reliable. At the same time, changing the availability or reliability of the signal might be necessary to counteract an undesired use of the system, and the government seeks assurance that GPS operators will predictably execute emergency procedures.

ASSESSING INSTITUTIONAL OPTIONS

Table 5.1 ranks how well each institutional GPS option meets the necessary conditions for GPS operation. A minus (–) means that the option cannot

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3 U.S. Government, Joint DoD/DoT Task Force on GPS, *The Global Positioning System: Management and Operation of a Dual-Use System*, December 1993, p. 3. The operation of the ground-control stations might be quite efficient right now, and contracting to (or selling to) a profit-seeker might not reduce the $30 million per year price tag. The bulk of the $400 million per year cost of GPS already goes for privately produced goods such as satellites and rockets.
Table 5.1
Ability of Institutional Options to Meet GPS Conditions

<table>
<thead>
<tr>
<th>Institutional Option</th>
<th>Condition 1, Frequencies</th>
<th>Condition 2, Sites</th>
<th>Condition 3, Personnel</th>
<th>Condition 4, Funding</th>
<th>Condition 5, Discipline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Military</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2. U.S. civil</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
</tr>
</tbody>
</table>

NOTES: Options
1. Continue as a U.S. military system
2. Jointly or exclusively governed by U.S. civilian agencies
3. Privatized and managed by a U.S. entity
4. Privatized and internationally managed
5. Augmented by civil/private/foreign elements
6. Gradually displaced by private systems or other technologies

Conditions
1. Frequency allocations
2. Ground station sites
3. Skilled operators
4. Funding
5. Procedural disciplines, especially for security

meet—or is very unlikely to meet—an operating condition. A question mark (?) means that the option may be able to meet the condition, but that there is some uncertainty. A plus (+) means that the option already meets the operating condition or there is no major barrier to doing so.

As a military system, GPS today meets all of the necessary operating conditions. While it can be argued that there are areas of national interest that GPS does not support as well as it might, the system nonetheless meets the minimal conditions to operate successfully. GPS could also operate with the participation of U.S. civil government agencies, such as the Department of Transportation (DoT), but the key uncertainty is whether DoT would be able to provide adequate or stable funding as more congressional committees became involved.

Some form of international GPS is possible, but the uncertainties are much greater than for a U.S. system. Aside from obtaining frequencies and ground control sites, the key uncertainties are how the systems would be funded and what procedural disciplines would apply. An international system may be able to use the power of government to secure funding, whereas a private operator of the current GPS would have no way of enforcing payment. The alternatives would be to make some arrangement to use governmental power to collect taxes or to encrypt the signal so as to enforce payment. The latter is likely to be
so disruptive—especially given the large installed base of GPS equipment—as to be impractical.

Procedural disciplines in national or regional security emergencies are likely to constitute a major problem for any private or international GPS system. The 1992 Federal Radionavigation Plan declares that

civil users worldwide may rely upon the availability of GPS signals and services at specified accuracy levels. Only in the event of national emergency would the U.S. degrade the accuracy and availability of GPS-SPS signals. Any such degradation would be undertaken only at the direction of the President of the United States.4

U.S. military forces are increasingly reliant on GPS in ways that potential adversaries are not. It is unlikely that the United States would willingly give up that advantage to an international organization. If GPS were managed by a private entity under U.S. jurisdiction, it would be subject to national security regulations, as are commercial satellite communications and remote sensing.5

The following sections address more specific arguments and alternative assessments made in the course of the study.

**Collective and Individual Payments**

In a financial accounting sense, the GPS program is a distinct operation. The projected cost to maintain GPS over the next several years is about $400 million per year.6 What kind of organization is most likely to accrue enough payment to meet ongoing expenses?

The overall cost of DoD procurement may be as much as 18 percent higher than the cost of comparable commercial procurement.7 In looking at the GPS space and ground segments, however, there seems to be little opportunity for major cost savings.8 It does not seem likely that a different organization could significantly reduce direct costs—much of the budget already goes to contractors, rather than to government employees, for the production of GPS satellites and related support equipment. In addition, GPS satellite operations at the master

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4Joint DoD/DoT Task Force on GPS, op cit., p. 46.
5For example, commercial remote sensing systems licensed by the United States may have operations suspended in the event of threats to U.S. national security. 15 U.S.C. § 82 (5621–5625).
6Joint DoD/DoT Task Force on GPS, op. cit., p. 3.
8We did not look closely at GPS Joint Program Office activities such as the procurement of military user equipment.
control station are increasingly in the hands of skilled enlisted personnel, rather than officers, both of whom are already paid less than their private-sector counterparts. One might ask whether operating costs could be reduced if a commercial entity operated the system without DoD regulations. This step could conflict, however, with one of the other necessary conditions for GPS—the existence of procedural disciplines for national security and public safety.

GPS can be thought of as a super-lighthouse that delivers its signal like a broadcast radio or television station. But unlike radio and television, payment for these helpful beacons cannot come from the sale of advertising ("sender-users"), which leaves receiver-users as the only possible paying customers. In addition to general tax receipts, one might imagine excise taxes on receivers, indirect fees for GPS-specific trust funds, patent royalties, and direct usage-metering (e.g., encryption keys or prepaid cards similar to telephone cards).

The GPS program, like other defense activities, is financed through collective payment by U.S. taxpayers and provided by the public sector. If the system were sold or turned over to a private corporation, it would then be delivered by the private sector and could be funded by individual or collective payments. See Figure 5.1.

Government agencies (e.g., the Department of Defense), that need navigation aids could become customers of a commercial GPS, so part of the firm’s revenue would come from government funds, as shown by (a) in Figure 5.2.

This complication suggests that the representation of government-provided GPS should not be a single point. Indeed, most GPS expenses are payments for privately-supplied goods and services, such as satellites and launch services as represented by (b) in Figure 5.2.

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9According to definitions in the Code of Federal Regulations, the GPS seems partly a beacon and partly a buoy: Beacons are aids to navigation structures that are permanently fixed to the earth’s surface; buoys float. 33 C.F.R. § 62.23(b)–(c) (1990). Although GPS satellites are not geostationary, their positions in orbit are nevertheless precisely known, so that at each moment they transmit, they are indeed “fixed” relative to the earth’s surface. Thus they should be considered a kind of beacon.

10Unless, for example, an FM station that sublicense part of its subcarrier capacity to a DGPS supplier chooses to do so as a public service, much like time and temperature information is provided via toll-free telephone numbers. Advertising, of course, can also be considered to be an indirect user charge, paid for by the subset of listeners who become customers of the advertiser.

11Encryption keys might be good for a set or indefinite period of time, whereas a prepaid card would be good for a set amount of usage.

12Although in each case we might say that the system is being provided “to the public,” the word “public” is best used as an adjective to describe a government organization; it reduces confusion not to use “public” as a noun and instead to say “to private persons and commercial organizations.”
A civilian government program can be paid for by general funds, but it might also be funded through excise taxes that support a GPS trust fund. Airline ticket taxes and gasoline taxes are used to support trust funds for the maintenance of air transportation and highway infrastructures, respectively. In Figure 5.3, the horizontal axis of the diagram is modified to include this possibility, which is more focused than a general tax yet may not reach every individual GPS user, much as the government charges over-the-counter fees for passports, national park entrances, political risk insurance on overseas investment loans, and postal services.

As the experience of the U.S. Post Office suggests, however, when it is possible to charge individuals for services, the American economic system creates private alternatives to government provision of public goods and services.
Private Conditions to Operate GPS

Each of the possible means of funding GPS has its own associated collection costs. Although numerical estimates of collection costs have not been made (and seem difficult to make), it is usually asserted or implied that funding from the general treasury or from government trust funds is the most efficient approach. Let us assume that a private company invents a feasible method of collecting payments from GPS users that is cost-effective enough to overcome the costs of transition to a fee system and meet operating expenses, without interrupting the supply of the GPS signals. What other factors might influence the price that the private firm would bid for the GPS?

The firm would probably want governmental assurances (from the United States and as many others as possible) that unauthorized GLONASS receivers would be banned. In effect, the company would ask for a monopoly, since its collection method is moot if another supplier charges nothing for its signals. Could the private GPS supplier stay in business if the United States were its only market? It would likely be subjected to cost-of-service rate regulation, similar to a public utility, although there would be none of the usual issues of capacity problems or adequacy of service to remote customers for regulators to solve. If this reduction in profit potential makes a private company decline to bid for

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13 Although the United States has declared its intention to deliver GPS signals worldwide without direct user charges, this does not require the domestic payment to continue to be from general federal funds if a cost-effective way to charge users is found.

14 The “public utility”—a privately owned firm regulated by public agencies—has been the United States’ solution, beginning in the 19th century, to the problem of dealing with goods and services that complicate the functioning of competition because they seem so essential to all persons that delivery should be ensured for all who ask for them. Roger Sherman, The Regulation of Monopoly, Cambridge University Press, New York, 1989, p. 3.
GPS, a nationalized GPS is still possible, since GPS does not have the allocation and efficiency problems often associated with nationalized services. In any event, the viability of the private GPS operator would still depend on active use of governmental power, even with a feasible individual payment method.

**GPS as a Civil Function Within DoD**

It is sometime argued that since there are fewer military users than civil or commercial users, U.S. civil agencies should have a greater role in the policy, management, and funding of GPS. On the other hand, the DoD has demonstrated its stewardship of GPS to date and supports GPS for the benefits it provides to U.S. forces worldwide. At present, there is no clearly viable alternative home for GPS other than the U.S. Department of Defense. U.S. civil agencies may want to have a larger direct role in GPS management and operations, but they have limited budgets to sustain large financial contributions. Excise taxes may be increased or imposed, but the associated transaction costs and dis-benefits are unclear.

A hybrid option for continuing GPS operations within the federal government would be to create a civil function within the Department of Defense. Its purpose would be to maintain military involvement for the institutional conditions of funding and procedural discipline, but to allow a greater role for civil agencies in advocating the interests of civil, commercial, and international users. A well-known example of a civil DoD function is the U.S. Army Corps of Engineers, which uses civilian contractors under the direction of uniformed military personnel. GPS operations could be delegated to the Air Force and continue to be subject to the Federal Radionavigation Plan. Making GPS civilian, but leaving it within DoD (like the Corps), would significantly dilute the “military” nature of the activity, which could benefit international cooperation and attract greater civilian participation without jeopardizing the critical connection of GPS to military operations.

The flows of funds to and from a civil GPS function within the DoD (CF) are shown in Figure 5.4. The civil function could receive funding from general tax funds, from user community excise taxes, as well as from interagency transfers from user agencies such as NASA and the Department of the Interior. These agencies could in turn decide whether to institute charges of their own or pay from their appropriations. Thus funds from multiple sources could support Air Force operations and their contractors. The Air Force and other DoD elements could negotiate the level of support they would provide to the civil function or agree to mutual support with no transfer of funds. In principle, this structure could also allow for payments from foreign user agencies, such as civil aviation authorities.
In the civil function option, GPS funding would no longer come from DoD military appropriations and compete with more traditional weapon system procurements. Appropriations would become the responsibility of the Transportation Subcommittee of the Appropriations Committee, a subcommittee that can more easily receive input from nonmilitary government, industry, and other user groups.\(^\text{15}\) Nonmilitary user groups’ requirements for GPS design and operations could also be incorporated through appropriate agencies within the Departments of Transportation and Commerce. While this would lower the burden on DoD, it would also increase the voice of non-DoD agencies in setting GPS policy and priorities. Whether the new system of funding would be more stable than the current reliance on DoD is unknown.

How much should identifiable civilian, commercial, and private users pay for the GPS to reduce the collective-payment burden that up to now has been justified by the national-defense function of the GPS?\(^\text{16}\) Perhaps nothing at all. The GPS could continue to be funded through general funds. Compared with private expenditures on other commonly available goods and services, the GPS budget does not seem a large burden on the economy. Compared with the entire budgets of U.S. civil agencies involved with navigation, however, it does indeed seem large, and significant contributions would be a major burden on those agencies.\(^\text{17}\) See Table 5.2.

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\(^{15}\)The Army Corps of Engineers is similarly funded through a nonweapons Appropriations Committee, the Water and Energy Subcommittee (inland waterways); yet it too is managed by uniformed military personnel.

\(^{16}\)The intention of the United States not to impose direct user fees for GPS on the international aviation community is independent of the domestic funding burden.

\(^{17}\)Estimated budgets are from *Budget of the United States Government*, Fiscal Year 1995.
The alternative to having civil agencies pay for GPS out of their appropriations is to allow them to impose excise taxes. Revenues from excise taxes can be considerable, as shown in Table 5.3. Possible domestic excise-tax sources include transportation fuels, receiver equipment (it is too late to enforce U.S. government GPS patents, as discussed in Chapter Four), vehicle/vessel registration, passenger tickets, surveyor’s licenses, map publishers, exploration companies, and DGPS services. Some fees for navigation aids are also levied on foreign vessels.\(^\text{18}\)

### Table 5.2
**U.S. Expenses for Traditional Utilities and Major Civil Agencies**

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount (B)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal U.S. consumption of</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>$75</td>
<td>(1991)(^a)</td>
</tr>
<tr>
<td>Communications</td>
<td>$54</td>
<td>(1991)</td>
</tr>
<tr>
<td>Gas</td>
<td>$28</td>
<td>(1991)</td>
</tr>
<tr>
<td>Water/sewer</td>
<td>$28</td>
<td>(1991)</td>
</tr>
<tr>
<td><strong>Annual GPS maintenance</strong></td>
<td><strong>$0.4</strong></td>
<td>(1993)</td>
</tr>
<tr>
<td><strong>GPS receiver purchases</strong></td>
<td><strong>$0.9</strong></td>
<td>(1994)(^b)</td>
</tr>
<tr>
<td>Civil agency budgets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAA</td>
<td>$9</td>
<td>(1995 est.)</td>
</tr>
<tr>
<td>Corps of Engineers</td>
<td>$7</td>
<td>(1995 est.)</td>
</tr>
<tr>
<td>Coast Guard</td>
<td>$4</td>
<td>(1995 est.)</td>
</tr>
</tbody>
</table>


### Table 5.3
**Example Revenues from U.S. Excise Taxes, 1994**

<table>
<thead>
<tr>
<th>Source</th>
<th>$ Billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highway (trust fund)</td>
<td>16.7</td>
</tr>
<tr>
<td>Transportation fuels</td>
<td>9.4</td>
</tr>
<tr>
<td>Alcohol</td>
<td>7.5</td>
</tr>
<tr>
<td>Tobacco</td>
<td>5.7</td>
</tr>
<tr>
<td>Airport (trust fund)</td>
<td>5.2</td>
</tr>
<tr>
<td>Telephone</td>
<td>3.5</td>
</tr>
</tbody>
</table>

**SOURCE:** *Budget of the United States Government*, Fiscal Year 1996, Table 2.4.

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If the GPS does not fully displace other civil navigation systems, an increase of a few percent in the pertinent excise tax revenues would seem to be required to cover its costs (even if DoD appropriations continued to pay for part of the annual expense). Such increases can be expected to be resisted by the user communities asked to bear them. As discussed in Chapter Four, additional taxes and fees are a threat to the continued growth of GPS. A full assessment of the merits of such taxes would have to balance not only collection costs but the potential decline of general tax revenues from slower adoption of GPS-based applications in the economy.

The primary motivation for creating a civil function for GPS would be budgetary. One could argue that as long as GPS is included in the military portion of DoD’s budget, it is in jeopardy of losing the increasing competition for DoD dollars, dollars that will not be supplemented by civilian agencies because of GPS’s location in the budget (under OMB Function 050). By converting GPS into a DoD civilian program, the Congressional Appropriations Committee jurisdiction would also change, most likely to Transportation, which would open the possibility of using transportation-related trust funds. Once the funding of GPS was officially shared or transferred between DoD and civilian agencies, neither would be likely to think of it as “free,” which is how the civilian agencies now view it.

The major concern for GPS users is that the signal continue to be supplied in a stable, competent, and fair manner. Any movement of GPS toward more civil involvement could raise concerns that military support, particularly from the Air Force, would decline. While we acknowledge the budget constraints felt by the Air Force, a decline in support seems unlikely given both the military importance of GPS to national security and the popularity of GPS, compared to other military space activities, among conventional force commanders.

**DIFFERENTIAL GPS ISSUES**

Better GPS accuracy and reliability can be achieved by installing known, fixed-reference receivers that can send differential GPS (DGPS) corrections to remote or mobile GPS receivers. The relation of DGPS to GPS is similar to the original relation between community-access television (CATV) and broadcast television—it is an added-value service that improves the quality of the signal received directly from distant broadcast transmitters. Like CATV, persons who want DGPS data can be charged for it and others can be excluded by the DGPS supplier through encryption or activation by a prepaid card.

One of the reasons most countries have provided lighthouse services and other navigation aids out of general funds, or from ship tonnage fees and airport and excise taxes, is that private operators cannot overcome the problems of small
numbers of customers and free-ridership (non-excludability) without government assistance.\textsuperscript{19} DGPS is different because there are several ways to deliver (or exclude) DGPS signals. Private companies already collect for the provision of DGPS data around the world and the industry can support price and service-level competition. Although some refereeing might be needed for frequency assignments, neither cost-of-service rate-making nor nationalization is a necessary requirement.\textsuperscript{20}

The first use of DGPS receivers to be required by federal regulation are in Prince William Sound, Alaska.\textsuperscript{21} Other U.S. Coast Guard DGPS locations are being assessed.\textsuperscript{22} DGPS services can be delivered by either the government or private companies, but the government can charge user fees for the DGPS data it provides or restrict access to it to prevent preemption of private providers.\textsuperscript{23} OMB Circular A-25 provides guidance on the scope and types of government activities for which the government may assess user charges. One of its objectives is to “allow the private sector to compete with the government without disadvantage in supplying comparable services, resources, or goods where appropriate.”\textsuperscript{24} If a private company can charge for a service, then the government should not provide the same service for free. There are some important exceptions, however, such as providing the service for national security, foreign policy, or public safety reasons. Thus, the United States can provide a free service for its forces, as part of an international agreement, or as necessary for safety-of-life purposes such as air and sea navigation. The latter is a key reason for the installation in Prince William Sound, which has already suffered from the oil spill of the \textit{Exxon Valdez}.

Individual charges to persons needing DGPS signals can be used in conjunction with incremental increases in excise taxes to pay for the use of GPS. For example, the U.S. government might collect a value-added tax from private DGPS providers and users. The fundamental difference between DGPS and CATV involves sources of revenue. Broadcast television companies (the “networks”) were not allowed by the FCC to collect fees from CATV companies because


\textsuperscript{21}33 C.F.R. § 161.376(a)(5).

\textsuperscript{22}For example, see 60 F.R. 5453 (Atlantic Intercoastal Region)(January 27, 1995); 59 F.R. 59816 (Hawaii Region)(November 18, 1994).

\textsuperscript{23}The U.S. charges fees for other navigation-related services, even where there is no parallel private provision (e.g., light dues/tonnage dues, 14 C.F.R. 4.20–22; harbor maintenance, 14 C.F.R. §§ 24.24; navigation fees, 14 C.F.R. § 4.98; and aircraft arrival fees, 14 C.F.R. § 24.22, 111.96, 122.29).

\textsuperscript{24}Office of Management and Budget, Circular No. A-25, Revised, Transmittal Memorandum no. 1, ¶ 5.c, July 8, 1993.
CATV increased the reach of the sponsors’ advertising messages, which made the broadcast time more valuable. GPS is not funded by advertising and thus can be paid for only by “subscription” or taxes.

NAVIGATION USES OF DGPS

The U.S. government seems to have little interest in competing with private DGPS suppliers in commercial markets such as survey and mapping. The government does, however, have a strong interest in ensuring that reliable, effective navigation aids exist for public safety and commerce. As discussed in Chapter Four, it is the overlap between public and private interests in DGPS navigation that has stimulated conflicts over FAA and U.S. Coast Guard plans for DGPS services. Furthermore, the U.S. government places special burdens on private providers of navigation aids, as described below.

Water Navigation

The United States has a long history of supporting aids to navigation for both military and commercial reasons. Aids to water navigation have been provided by the federal government since 1789, for two basic reasons. First, by directing the states to cede their lighthouses and beacons to the United States and by putting the federal government in the business of constructing, operating, and financing a nationwide system of aids to navigation, Congress could assert a national authority and a national responsibility, and begin to bind the states to the idea of a common enterprise.

Lighthouses and beacons were brought under control of the Secretary of the Treasury, which suggests a second reason for Federal jurisdiction. Coastal lights were not only part of a nation’s internal identity, but also a part of a nation’s stance toward other nations. Ships in harbors were one of the few sources of collectible revenue for the young U.S. government. Other countries, of course, charged import duties, but Great Britain also charged light
dues.\textsuperscript{28} Thus it seems that the United States set up tonnage duties and, soon after, a "light money" duty, to reciprocate Great Britain’s practice.\textsuperscript{29}

Today, the U.S. Coast Guard is specifically empowered to

establish, maintain, and operate electronic aids to navigation systems required to serve the needs of the armed forces of the United States peculiar to warfare and primarily of military concern as determined by the Secretary of Defense or any department within the Department of Defense\textsuperscript{30}

or as required to

serve the needs of the maritime commerce of the United States.\textsuperscript{31}

In addition to empowering the Coast Guard, private DGPS providers are correspondingly limited by federal regulations. Commercial DGPS services are not authorized for use by the armed forces or for maritime commerce. The only kind of private electronic aids to water navigation that are authorized are "radar beacons and shore-based radar stations."\textsuperscript{32} This leaves open the possibility of a noncommercial maritime navigation market for private DGPS providers. GPS equipment is increasingly popular on recreation boats, and DGPS systems could find favor with current users of Loran-C radio beacons. One of the familiar barriers, however, is the fact that Loran-C is free of direct user charges.

Air Navigation

Provision of air navigation facilities and services is the duty of members of the International Civil Aviation Organization (ICAO) within the limited range set forth in Article 28(a) of the 1948 Chicago Convention. Each signatory undertakes, so far “as it may find practicable,” to provide in its territory radio services, meteorological services, and other air navigation facilities for international air navigation. In 1987, a commentator on the work of the Future Air Navigation Systems (FANS) committee of the ICAO asserted that nothing in the Chicago Convention "prevents the States from delegating their functions to a specific

\textsuperscript{28}Britain had consolidated ownership of lights in 1679 into the Trinity House, which began as an association of seafarers in 1514 to control pilots in harbors and to accumulate funds for old seamen, their widows, and orphans. Trinity House either exploited the exclusive licenses itself or leased the “patents” to individuals. Most holders employed local collectors provided by Trinity House who were paid commissions on the amount collected from ships that entered port.


\textsuperscript{30}14 U.S.C. § 81(3)(a).

\textsuperscript{31}14 U.S.C. § 81(3)(b).

\textsuperscript{32}33 C.F.R. § 66.01-1(d).
entity, public or private, within their jurisdictional limits.” This could be taken as allowing an international organization to provide navigation services based on GPS.

The U.S. Secretary of Transportation prescribes the regulations on standards for installing navigational aids for air commerce, including airport control towers. The Federal Aviation Administration is responsible for locating, constructing or installing, maintaining, and operating federal aids to air navigation. In contrast to the practice with maritime aids, many kinds of privately operated air navigation aids are permitted by the FAA. The FAA could also permit private DGPS companies to compete in air navigation markets under suitable regulation for signal accuracy, reliability, availability, and integrity.

Land Navigation

The Global Positioning System has, of course, stimulated the market for land-navigation DGPS services, and neither the Coast Guard nor the FAA seems to have jurisdiction over that user segment. Private providers of DGPS signals already serve the land-navigation user segment. As GPS technology develops, there may be interest in regulating the use of DGPS for land navigation—for example, for use on public highways, where public safety may be affected.

INTERNATIONAL CONTROL AND MANAGEMENT

By the middle of the 19th century, most nations were providing maritime and inland-waterway navigation aids, such as lighthouses, as a public service to their own merchant marine as well as foreign ships. These aids were paid for from general funds and without direct user fees. (Customs duties and tariffs were designed to achieve other purposes.) Most countries had recognized the provision of lighthouses and harbor markings as a mutual service, and had decided not to charge navigation-aid fees. Radionavigation aids, made possible

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3549 C.F.R. § 1.4(c)(4).
37See David E. Van Zandt, “The Lessons of the Lighthouse: ‘Government’ or ‘Private’ Provision of Goods,” 22 J. Legal Studies 1993, 47–72, at p. 70. England seems to have been a hold-out. In the late 19th century, Britain continued to refuse to eliminate the light dues. Even today, 46 U.S.C. 128 declares “a duty of 50 cents per ton, to be denominatd ‘light money’, shall be levied and collected on all vessels not of the United States. . . .” The Customs Service of the U.S. Department of Treasury ex-
by the development of radar during World War II, might not be as palpable or as romantic as lighthouses, but they are a traditional government responsibility. Since the formation of the ICAO in 1947, nations have been responsible, so far as each “may find practicable,” for providing air navigation systems in their territories. Radio-based aids for water navigation have been developed during the past 50 years.

By design, GPS signals extend beyond U.S. territory and can be received anywhere on the earth’s surface or in its atmosphere. The decision not to exclude use of a “civilian” signal outside the United States had been made by the time of a 1981 notice in the Federal Register, but the decision was more dramatically announced soon after an off-course Korean airliner (flight KAL 007) was shot down by the Soviet Union in 1983. President Reagan declared that GPS would be made available to international civilian aviation to help prevent such tragedies in the future. The general availability of the system, however, was not expected to occur until 1987 or 1988.

The declaration of GPS availability was repeated, and in some ways expanded, to ICAO by the FAA administrator, in 1991, 1992, and 1994, and by President Clinton in 1995. It was stated that the United States intends to deliver GPS signals on a continuous, worldwide basis, subject to the availability of funds (as required by U.S. law) while not charging direct user fees, for ten years, and will give six years notice if it is going to discontinue the service. Today, this policy might strike some as overly generous, but it probably would have proven expensive or impossible to collect direct user fees for a system that (a) was not asked for, (b) could displace national radionavigation systems, (c) was subject to U.S. national control, and (d) was already available without encryption to U.S. users. Short of creating some kind of signal “shadow” over a country (which would overlap neighboring areas), or changing the signal so that new re-

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38Chicago Convention 1944 Art. 28(a).

3946 F.R. 20724 (April 7, 1981): Notice by the Secretary of Defense re NAVSTAR GPS Navigation Satellite Systems Status: “Notice is hereby given that the Department of Defense’s NAVSTAR GPS program is now in the Full Scale Development phase. . . . the satellites may transmit both the precise (P) and coarse acquisition (C/A) signals which are intended only for military or other Federal agency testing purposes. Other possible users are cautioned that the system is developmental and that availability of the signals, or the accuracy possible, are subject to change without advanced warning. The latest DoD policy concerning NAVSTAR GPS is that when the system is declared operational, the highest possible level of C/A signal accuracy will be made available to the worldwide civil/commercial community within the limits of national security considerations. It is projected that this will be an accuracy of 200M Spherical Error Probable (SEP). This level of accuracy will be reviewed by DoD annually and the level modified to accommodate any changes commensurate with our national security posture. It is anticipated that this non-military accuracy may be increased as time passes. The DoD is also considering the possibility of charging users of the NAVSTAR GPS worldwide positioning/navigation system for the service provided.” [Emphasis added.]
receivers would have some kind of metering system, the United States did not have much leverage to induce payment. Yet it is precisely because these acts are thought possible, at the option of the system operator, that other countries are reluctant to rely on GPS for domestic civil aviation or maritime navigation.

The United States seeks international acceptance of GPS for many reasons, including enabling allied and U.S. forces to work more easily together and promoting economic growth through use of GPS applications and sales of U.S. equipment and services. Given that seeking payment is not a U.S. objective, U.S. economic interests could be pursued even if other systems, such as GLONASS, became the world standard. Assuming U.S. manufacturers are allowed to build GLONASS-capable receivers, the key condition enabling the United States to compete is whether the signal structures of the others systems are published. The fact that U.S. industry led in developing GPS equipment and applications means that it is in the economic interest of the United States to see GPS as a global standard now. However, the ability to compete depends on the availability of open, international standards that can be used by anyone.

The United States would like other countries to install DGPS reference receivers and correction-data transmitters at their airports and harbors because GPS signals alone do not give sufficient approach accuracy. Since the United States is planning to use DGPS for its domestic airports and harbors, it seeks international acceptance of GPS “to limit the amount of expensive equipment that U.S. ships and aircraft must carry and to prevent duplication of systems at U.S. airports and harbors.”


Although other nations might install DGPS systems with their own funds, the United States could consider other means of achieving widespread DGPS availability and standardization, including (a) installing both GPS and “GLONASS-capable” radionavigation receivers on U.S. aircraft and ships when they are refitted for DGPS, or (b) paying for DGPS equipment to be installed and operated at foreign airports and harbors (which would of course displace the expense of installing the GLONASS equipment on every U.S. aircraft and ship). 41 Given the wide availability of GPS equipment and the relative lack of comparable GLONASS equipment, a decision to use GLONASS would likely be a political rather than an economic or technical decision.

41 If there are multiple DGPS and D-GLONASS data formats possible, then (b) seems the better choice, to ensure that differential equipment sending the same format is installed everywhere. The (b) option would also eliminate the problem of having to install still other types of radionavigation equipment in aircraft for airports that use neither DGPS nor D-GLONASS. In each of these plans, the problem of what equipment gets installed on foreign craft that might travel to the United States could be overcome by allowing U.S. GPS receiver manufacturers to build and sell “GPS and GLONASS-ready” models (similar to television sets that are capable of making sense of feeds from NTSC, PAL, SECAM, HDTV, CATV, and VCR sources). This would seem to satisfy another ostensible objective of “international acceptance” of the GPS, which is to foster export sales by U.S. manufacturers of GPS receivers, who currently have a product-design lead and a strong market share.
Like all radio broadcasts, GPS can be seen as an intrusion into the sovereign territory of a nation. Aids to navigation are landmarks and inland-waterway marks, and thus represent claims to territory and jurisdiction. The resistance to quick acceptance of the GPS (or GLONASS) might be best explained by this disturbance of sovereign identity and power as states realize the commercial and military benefits of satellite-based navigation.

By making superfluous some existing aids to a nation’s navigation, GPS overlaps with the power of other sovereigns to provide aids to navigation within their territories and at their frontiers, and with the missions of some international civil governmental organizations (IGOs) and some long-established international nongovernmental organizations (INGOs); see Table 5.4. It seems likely that a civil agency or a private venture to build a GPS would have been blocked, or at least boycotted, by various interest groups. The national security purpose of the GPS and the commitment of the United States were vital to overcoming historical inertia. It is understandable, now that the GPS is operational and available for civilian purposes, that some of these groups would suggest that other nations should not become dependent on a system controlled by the United States, but instead should develop and operate a separate system, unless control of the GPS (and GLONASS) were somehow moved to an international organization. Potential homes include existing satellite operators (INMARSAT, INTELSAT, EUTELSAT), and others without current specific authority in their charters to operate navigation systems (IMO, ICAO, IALA, the European Space Agency).

Table 5.4
Sample International Civil Organizations Affected by GPS

<table>
<thead>
<tr>
<th>IGO (International governmental organization):</th>
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<tbody>
<tr>
<td>ICAO—International Civil Aviation Organization (171 UN members)</td>
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<tr>
<td>IMO—International Maritime Organization (137 UN members)</td>
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<tr>
<td>INMARSAT—International Maritime Satellite Organization</td>
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<tr>
<td>INTELSAT—International Satellite Organization</td>
</tr>
<tr>
<td>Eutelsat—European Telecommunications Satellite Organization</td>
</tr>
<tr>
<td>Eurocontrol—European Organization for the Safety of Air Navigation</td>
</tr>
<tr>
<td>Loran-C Operating Authority in six European states</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>INGO (International nongovernmental organization):</th>
</tr>
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<tbody>
<tr>
<td>IOC—Intergovernmental Oceanographic Commission</td>
</tr>
<tr>
<td>IATA—International Air Transport Association</td>
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<tr>
<td>IALA—International Association of Lighthouse Authorities</td>
</tr>
<tr>
<td>IAIN—International Association of Institutes of Navigation</td>
</tr>
<tr>
<td>IFCSMA—International Federation of Shipmasters’ Associations</td>
</tr>
<tr>
<td>ICS—International Chamber of Shipping</td>
</tr>
<tr>
<td>OCIMF—Oil Companies International Marine Forum</td>
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</tbody>
</table>

There are few advantages to be gained by the United States from selling or transferring GPS to an international organization and some distinct risks. In the
first place, economic benefits from the sale would depend on maintaining or increasing international use of GPS equipment and services. An international organization would be unlikely to be able to positively affect voluntary economic choices save indirectly through maintaining stable, high-quality GPS signals. Second, the United States would continue to be a major, if not primary, user of GPS and would probably continue to pay a large share of the operating budget. The United Nations could not afford to pay very much for GPS, unless it found a collection system to allow it to recover costs over several years with income from operations. Even if the UN could give a credit toward the annual U.S. assessment of about 25 percent of the total regular UN administration budget, the amount would be less than the annual GPS maintenance budget. Third, and perhaps most important, the United States could not have the same level of control over procedural disciplines for GPS in an international organization. Given the national security importance of GPS to the United States, this is likely to be a decisive factor in keeping GPS under U.S. jurisdiction.

If the United States wishes to gain economic benefits from GPS and protect its national security interests, then it should retain ownership and operational control. This does not preclude, however, an international effort to make individual agreements with major trading nations that address concerns of availability, reliability, emergency procedures, liability, and payment. Other nations do have legitimate technical, legal, and political concerns with relying on GPS—as would the United States if positions were reversed. No existing international organization can address the full range of international security and economic concerns found in GPS. Thus, direct discussions between the United States and its traditional friends and allies would be more effective than specialized, multilateral negotiations.

INFORMING THE POLICY DEBATE

Many kinds of justifications for preserving or changing the GPS governance and funding arrangements are advanced in public policy debates. The remainder of this chapter examines some of these themes in order to explore underlying assumptions and premises sometimes relied on by advocates. We argue that the criteria for deciding how GPS should be governed, managed, and funded can be reduced to two questions: (1) Who can be most trusted to follow particular procedures, both for evaluating user requirements and for emergencies? (2) What effective payment collection methods are available to potential GPS operators?

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GPS has been an occasional subject of speculation for potential “privatization,” transfer to a civil agency, or transfer to an international organization. In varying forms, there are at least four recurring reasons for this interest:

1. GPS is seen as a natural monopoly, a public good, or a utility.
2. GPS is seen as a dual-use technology and should therefore be managed jointly by civil and military authorities.
3. The United States needs to change the way it provides GPS in order to earn international “good will.”
4. Governance of GPS should naturally fall to the U.S. government because it performs a “government function,” or because the liability issues preclude private-sector control.

GPS as a “Natural Monopoly,” “Public Good,” or “Utility”

Proponents of keeping the U.S. government in control of GPS frequently assert that GPS is more efficiently run by the U.S. government because it is a “natural monopoly,” “public good,” or a “utility.” Yet these terms beg the question of how GPS should be managed. In fact, their use assumes that a particular model of management and funding is natural for GPS or has already been determined.

The delivery of some goods is labeled “a natural monopoly” not because of company behavior, but because of “natural” constraints on competition. These constraints are not necessarily legal ones, but rather the result of larger production plants or distribution networks being dramatically more efficient than smaller ones. These economies of scale then create competitive barriers to entry. Examples of natural monopolies include the delivery of natural gas, electricity, and water, all of which require physical connections to customer sites and which seem to be most efficiently supplied by one big (local) supplier. A satellite-based navigation aid would seem to qualify as a “natural monopoly” because it requires a large initial investment and it can be provided efficiently by a single system. Thus, we should simply consider the two traditional institutional solutions for a natural monopoly—nationalization or a private company regulated with cost-of-service ratemaking.43

One must be careful not to label something a natural monopoly too quickly, however, because “once a service is labeled a natural monopoly the urge takes hold to enshrine in law what reality seems to have ordained and to forbid com-

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43Cost-of-service ratemaking, of course, presupposes a payment-from-individuals collecting method.
petition in that market as wasteful and harmful to the public interest.”

It would be misleading to label the GPS a natural monopoly, both because competition is possible without redundancy and because the label presupposes that all nations have granted the GPS a franchise to operate in their countries.

To an economist, “single-firm efficiency” means that the average cost of providing the service declines indefinitely as output (or usage) grows, so that the larger firm is more efficient than the smaller one. In the case of a satellite broadcast, the marginal cost (leaving aside any effect on military utility) of serving additional users is zero. However, the economy of scale for the satellite system is not in the size of its plant, but in the range of its signal and its availability and reliability. A satellite navigation system does not have the easement problems that traditional natural monopolies have. Unlike gas and electric lines, and the waste that multiple pipe and wire pathways seem to create, radio spectrum and orbital space, although finite, are not yet so crowded as to foreclose other satellite-based navigation systems. It remains possible for there to be competition in terms of availability, reliability, and the accuracies achievable from different operators’ signals.

The United States may prefer to minimize the number of “GPS-like” systems for reasons unrelated to easements (such as frequency licenses) or economies of scale, but rather for national security and foreign policy objectives. Even if GPS is treated as a natural monopoly from one country’s perspective—that is, a second system seems superfluous—it is not necessarily a natural monopoly from another’s perspective. The United States cannot stop another country from putting up a GPS-like constellation of satellites. Although the redundancy might seem wasteful, there could be competitive—not just military—reasons for such an investment.

GPS is sometime referred to as a “public good,” with the implication that it should continue to be made available by government. The term “public good” is formally applied to things which are nonrivalrous and non-excludable in use. (National defense is the archetypal example of a public good.) Nonrivalrous means that one person’s benefit does not preempt another’s benefit. For example, if I benefit from GPS, that does not prevent you from benefiting from GPS. Non-excludable means that it is difficult to deny the benefit to particular persons. For example, if I am using GPS, I cannot prevent you from using GPS.

Although GPS is nonrivalrous, it need not be non-excludable, and thus GPS need not be a public good. Excludability is a function of the costs of fee-collection methods, and these costs can vary with time. The United States

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could have chosen to deny the GPS signal to all but military users, limited use to those with “registered” decrypting receivers, or imposed an excise tax. Even if we treat GPS as a public good, labeling it as such does not resolve the question of whether a private company should be paid by the U.S. government to operate it, or questions of international use, mutual benefits, and competition.

In contrast to “public good,” GPS is sometimes referred to as a “utility,” with the implication that it be made available by a private firm as are public utilities. The imagery may be understandable, but the analogy is not accurate when applied to GPS. In the United States, a public utility is a privately owned and operated business whose services are so essential to the general public as to justify the grant of special franchises for the use of public property or the right of eminent domain, in consideration of which the owners must serve all persons who apply, without discrimination . . . . To constitute a true public utility, the devotion to public use must be of such character that the public generally, or that part of it which has been served and which has accepted the service, has the legal right to demand that service shall be conducted, so long as it is continued, with reasonable efficiency under reasonable charges.45

Aside from the obvious fact that GPS is a DoD-owned and -operated system, there are other differences between GPS and a public utility. The most important one is the inability to collect payment for the Standard Positioning Service. Although it is possible to collect payment for access to the Precise Positioning Service, current U.S. policy clearly opposes making that service available to all person who apply. National security concerns are another barrier to allowing users to legally demand GPS service at specified terms and conditions.

If the United States were willing to allow legal recourse to users, say in the context of an international agreement, that would be a significant change in U.S. policy. To become a public utility, a method of enforcing payment would have to be imposed and national security concerns would have to be resolved. The same technology may serve both ends, leaving a policy judgment as to whether government management or private management best serves the public interest.

GPS as a Dual-Use Technology

Although GPS was not originally designed to meet commercial or private requirements, position and velocity information is useful to nonmilitary activities such as civil aviation, merchant marine shipping, city bus fleet monitoring, am-

bulance dispatch/routing, land surveying, farming, and navigating city streets by automobile. Some GPS applications might improve upon and thus displace other aids to navigation and their costs. Other applications were not feasible before GPS and are thus dependent on GPS continuing.

It can be confusing to call GPS a “dual-use technology” in the same sense as radar, jet propulsion, or night-vision devices, because it is not just the technology of satellite radionavigation signal-making that is sought by other groups, but access to the system. In this sense, the GPS is similar to the 42,795-mile Dwight D. Eisenhower System of Interstate and Defense Highways, a program whose original military function likewise helped overcome obstacles to obtaining easements and funding that a private company or even a civilian agency might not have overcome. The major commercial and private benefits of the interstate highways were not derived from new road-building technology that could be sold or exported; it was the direct use of the system itself.

Like the interstate highway system, GPS signals are shared by the military because of their commercial and private utility. The additional usage provides supporting justification the DoD might need to sustain funding for the system. These additional benefits also introduce additional costs. In the case of the highway system, sharing the system reduced the military utility of the system by reducing its availability. This reduction in military utility has not proved to be a problem because the military need for the interstate system has been small relative to its total capacity. In the case of the GPS, which is “nonrivalrous”—one user does not preclude any others—the sharing of the system reduces its military utility because the accuracy and reliability required for some commercial applications are equal to or greater than some military requirements, and therefore hostile uses of GPS cannot be reduced by simply denying access to military-level accuracy. In addition, if commercial and private users do not keep or install local, alternate navigation systems as backup to the safety-of-life uses of the GPS, then turning off the “civilian signal” will be a politically difficult option to exercise. Clearly, military users will need other means of countering potential hostile users of GPS than simply turning the system off.

The problem of commercial and private dependency, which hostile users can exploit, would exist even if the GPS was not shared and a similar, separate system were established for commercial uses. To block the access of hostile users to the GPS, while at the same time enabling one’s own military users, means blocking the access of commercial and private users. Thus there seem to be no

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domestic advantages, for national emergency purposes, in having a second, somewhat redundant, GPS, even if the price of the second system were affordable. The military must develop countermeasures whether it directly operates the GPS or not. These countermeasures can operate at the GPS reception site (e.g., jamming), act against the use of GPS (e.g., defenses against GPS-aided weapons), or be emergency institutional procedures. In the case of U.S. air navigation aids, emergency procedures were developed between the DoD and the Federal Aviation Administration to prevent their use by hostile aircraft during wartime.

It is unlikely that U.S. commercial and private users will agitate for the transfer of GPS operation and control from DoD to a civil agency, let alone a private corporation, if their accuracy, reliability, and availability requirements are being met. From a historical viewpoint, other civil works, especially those related to transportation and navigation, have long been provided by military or hybrid-military organizations. The Naval Observatory is the keeper of the nation’s time standard; the Army Corps of Engineers builds dams and bridges and maintains interior navigable waterways; the interstate highway system was originally conceived and funded as a troop and weapons transport network; the Coast Guard serves private boaters and commercial shipping, but becomes part of the Navy in military emergencies; and, as mentioned earlier, the country’s civil aviation navigation aids come under military control during defense emergencies (SCATANA).

In 1789, lighthouses could be as useful to naval vessels as they were to commercial vessels. Thus it could be argued that lighthouses were “necessary and proper” for providing and maintaining a (future) navy, or that, because navigation aids were important to commerce, they were “necessary and proper” to the regulation of commerce. Unfortunately, the legislative record does not make clear what authority the first Congress used for the Act that

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47This is in contrast to, for example, the Virginia state toll road that parallels the Washington-Dulles Airport access road, which serves both “emergency” (access to Dulles) and toll-collecting purposes.

48One of the first steps that Executive Departments take in deciding whether an activity should be performed under contract with commercial sources or in-house, using government facilities and personnel, is to apply the following two tests: (1) If activity is a governmental function, retain in-house; (2) if in-house performance is required for national defense, retain in-house. See the “Flow Chart, Implementation of OMB Circular No. A-76, Existing government activities and expansions,” August 1983, Supplement, OMB Circular No. A-76 (Revised), Performance of Commercial Activities, Part 1 (Policy implementation), Exhibit 1, p. 4–5.

49Plan for the security control of air traffic and air navigation aids (Short title: SCATANA), 32 C.F.R. § 245, 12 p.


brought lighthouses under the control of the Treasury. The construction and operation of lighthouses is not itself regulation of commerce, and the states, though prohibited from levying any of their own duties on imports or exports, or on tonnage, without the consent of Congress, could have nevertheless continued to operate their lighthouses and get paid for doing so by Congress. Congress has the power to “provide,” which is not necessarily to “supply,” for the general welfare of the United States and a state or private role is not precluded.

In short, there is no compelling historical or legal argument for preferring civil or military federal control of GPS as a navigation aid—or any preference for government or private providers. The choice is essentially one based on U.S. national interests and the availability (or inability) to charge for services provided.

International Good Will

It is sometimes argued that GPS should be transferred to a civil agency or an international organizations in order to generate international “good will.” While acknowledging that providing free GPS signals to users worldwide is already a major gift on the part of the United States, some say the fact that the system is controlled by one country and operated by its military is unwelcome. Thus, GPS should be placed under civilian control, preferably an international organization in which all users could share in decisions about GPS operation, management, and funding. What the United States would presumably gain is additional good will, enhanced international standing, and the satisfaction of seeing GPS more rapidly adopted as a global standard with concurrent economic benefits.

In the past, the United States has led the development of international technical systems such as the Internet, weather satellites, and INTELSAT. In the case of the Internet, which was initially developed as a military research program, there was no hardware system to transfer. Instead, there is a series of interface standards and protocols that allow anyone to use this global communications system. In the case of weather satellites, space-faring countries deploy weather satellites on their own and exchange data internationally through the World Meteorological Organization (WMO). Space and ground elements are paid for

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52See David P. Currie, The Constitution in Congress: Substantive Issues in the First Congress, 1789–1790, 1994. The fact that states, rather than private parties, had been operating the lighthouses, however, indicates that the provision of navigation aids is in part a function of available payment-collection methods.


by states, but the data (with some exceptions) are shared globally. In the case of INTELSAT, the United States led an effort to create an international organization that would own, operate, and manage a global communications system. The INTELSAT model is most often brought up as a desirable future institutional structure for GPS in terms of international funding and control.

Notwithstanding how previous examples of U.S. technical leadership have earned international good will, the case for securing good will through the transfer of GPS operations away from DoD is not compelling. First, while DoD may operate GPS, policy is set at a national level through the Federal Radionavigation Plan and the Office of the President. A country may say it does not trust GPS in the hands of the United States, but it is not accurate to blame that mistrust on the DoD alone. Second, GPS is well on its way to becoming a global standard as a result of the compelling productivity benefits from its use. It is not clear that this pace would quicken with changes in the institutional home of GPS.55 Third, the INTELSAT comparisons are inaccurate in that GPS does not have a feasible mechanisms for collecting payment in the way that two-way communications do. Conversely, GPS does not require “landing rights” in the areas it serves but broadcasts its signals uniformly and globally. Finally, international civil organizations by their nature cannot address the military risks associated with the potential misuse or denial of GPS to U.S. armed forces. Providing a greater role for U.S. civil agencies in GPS would not necessarily risk U.S. security interests, but the potential for earning goodwill would seem to be limited to those countries with a prejudice against the DoD but not the United States as a whole.

Government Functions and Liability

Aids to navigation in the United States have been provided by the federal government since 1789, first administered by the Treasury, later by the Department of Commerce, and since the 1960s by the Department of Transportation.56 This tradition is reflected in current federal statutes and regulations. Aids to navigation in the United States are provided by the Coast Guard, the Federal Aviation Administration, and the Army Corps of Engineers. The Department of Defense may also, of course, establish aids to navigation for its own use.

Private navigation aids can cross the boundaries between civil, commercial, and military interests, and their regulation is a bit more complex. The statutes

55 What could change is the pace of international acceptance by governments to catch up with international public acceptance of GPS.

and regulations could be changed to make an additional exception for private GPS operation, which serves users on land, water, or in the air.\footnote{GPS has created a market for land-navigators; neither the Coast Guard nor the FAA seems to have jurisdiction over that user segment.} At present, private aids to water navigation may be established and maintained only if the Coast Guard authorizes them.\footnote{33 C.F.R. § 66.01-1(a).} Operation of private electronic aids to water navigation will not be authorized at all, except for radar beacons and shore-based radar stations, which may be operated if authorized.\footnote{33 C.F.R. § 66.01-1(d).} The Federal Aviation Administration is responsible for locating, constructing or installing, maintaining, and operating federal aids to air navigation, wherever necessary.\footnote{49 C.F.R. § 1.4(c)(4); \textit{U.S. Government Manual}, 1993/4, p. 464: “Location, construction or installation, maintenance, operation, and quality assurance of Federal visual and electronic aids to air navigation.”} Many kinds of privately operated air navigation aids are permitted by the FAA, such as:

- VOR facilities
- Nondirectional radio beacon facilities
- True lights
- Simplified directional facility (SDF)
- Distance measuring equipment (DME)
- VHF marker beacons
- Interim Standard Microwave Landing System (ISMLS)
- Microwave Landing System (MLS).\footnote{C.F.R., Title 14—Aeronautics and Space, Chapter I—Federal Aviation Administration, Department Of Transportation, Subchapter J—Navigational Facilities, Part 171—Non-Federal Navigation Facilities.}

Some attempts at defining “government functions” have addressed the question of who should manage and operate GPS. The Office of Management and Budget Circular A-76 definition of governmental functions includes the “regulation of the use of space, oceans, navigable rivers and other natural resources.”\footnote{OMB Circular A-76, \textit{Performance of Commercial Activities}, August 4, 1983, ¶ 6e(1); see also OFPP Policy letter, 57 Federal Register No. 190, Wed 30 Sept 1992, p. 45096.} Whereas “regulation” is usually thought of as meaning “rule-making” and not “operation of an electronic system,” one could try to construe regulation to include the actual operation of a traffic management system. As an example, consider the Federal Reserve’s operation of an electronic transfer
system, through which all transfers of funds, including all personal checks, are executed. This raises the possibility that government operation of a satellite-based navigation system, for its own use as well as private use, could be construed as part of the act of governing.63

Likewise, questions of liability have sometimes been raised by opponents of privatization, claiming that the government has a special role in providing transportation safety systems. Yet the liability rule for the government maintenance of aids to navigation (at least for buoys), seems to be the same as what the rule would be for a private organization. Once an aid is established, the government has a duty to maintain it.64 The government neither invokes sovereign immunity nor offers private persons a higher standard of care than a private organization might agree upon.

An important consideration in assessing the magnitude of liability is whether notices of reliability and availability of a navigation aid were adequate.65 For GPS, the U.S. government is already delivering service-level information and operational notices, via the Federal Radionavigation Plan, Federal Register notices, FAA Notices to Airmen, USCG Notices to Mariners, and the Coast Guard’s GPS Information Center.66 A private company could deliver similar forms of notification about its services to insulate itself much as the U.S. government already does.

Liability is not a strong criterion for choosing between government and private providers of GPS, and liability considerations do not preempt the possibility of private provision. The liability argument against privatization is sometimes extended to say that while private companies may have the same exposure as governments, their ability to pay is less. Thus private companies cannot economically assume the large potential liabilities inherent in some safety-of-life

63The OMB also says that the Secretary of Defense can decide that the government performance of a commercial activity is required for national defense reasons, based on criteria that the Secretary shall furnish to the Office of Federal Procurement Policy, OMB, upon request. OMB Circular A-76, Performance of Commercial Activities, August 4, 1983, ¶ 8b(1). For the purposes of this chapter, we assume that DoD has not exercised this option.


65We did not find a case involving the Loran radionavigation system that also involved the reliability or availability of the Loran signals themselves. Tringali Bros. v. U.S., 630 F.2d 1089 (5th Cir.(La.), 1980) (buoy maintenance; the person did not use the Loran system on board); Greer v. U.S., 505 F.2d 90 (5th Cir.(Fla.), 1974) (buoy maintenance); U.S. v. Sandra & Dennis Fishing Corp., 372 F.2d 189 (1st Cir.(Mass.), 1967) (while USCG was towing a vessel, its Loran receiver stopped working; the error was in not using the other vessel’s Loran); Universe Tankships, Inc. v. U.S., 336 F.Supp. 282 (E.D.Pa., 1972) (buoy maintenance).

66See, for example, U.S. Coast Guard, “Announcement of Global Positioning System (GPS) Initial Operational Capability (IOC) and its impact on vessel carriage requirement regulations,” 59 Federal Register, 13757 (Mar 23, 1994).
applications. Whether a private organization would be willing to provide a GPS is a separate question, one that involves the aviation and marine insurance industries, and the existence of profits commensurate with the risks.67

INSTITUTIONAL AND LEGAL FINDINGS

- Current legal structures and historical precedents that may be applicable to GPS are more descriptive than prescriptive. There is no compelling historical or legal argument for preferring civil or military federal control of GPS as a navigation aid, or any preference for government or private providers. The choice is essentially one based on U.S. national interests and the ability (or inability) to charge for services provided.

- The two most important criteria for selecting among various institutional options for GPS are (1) the existence of procedural disciplines to deal with emergencies (e.g., wars and crises) and user requirements, and (2) the existence of an effective funding mechanism, whether taxes or fees.

- Although the terms are often used, GPS is not a natural monopoly or a utility. Its characterization as a public good arises more from the lack of an effective means of charging individual users—given the current state of technology—than any legal or policy decision.

- A private GPS system does not appear feasible because of the lack of an enforceable funding mechanism that can deny access to non-authorized users. An internationalized GPS does not appear desirable because of potential risks to U.S. security and the lack of compensating benefits.

- If the United States wishes to gain economic benefits from GPS and protect its national security interests, then it should retain ownership and operational control of the GPS.

- A civil function for GPS could be created within the Department of Defense to receive funds from user agencies. The major benefit of this step would be to shift the competition for GPS funding outside of the Armed Services Appropriations Committees. U.S. civil agencies could play a larger direct role in GPS management and operations, but they have limited budgets to sustain significant financial contributions to GPS. Excise taxes may be increased or imposed, but the associated transaction costs and disbenefits are unclear.

67 The U.S. government has acted as an insurer in market niches that the commercial insurance industry does not serve. For example, the FAA Act of 1958 allowed the Secretary of Transportation, with approval from the President, to provide insurance and reinsurance for aircraft used to carry out the foreign policy of the United States. See Rod D. Margo, *Aviation Insurance*, Butterworths, Boston, MA, 1989.
There does not appear to be any international organization that can address the full range of international security and economic concerns found in GPS. Thus, direct discussions between the United States and its traditional friends and allies would likely be more effective than specialized, multilateral negotiations.