

**Privatization and Commercialization of the Internet  
Infrastructure:**

Rethinking Market Intervention into Government and Government  
Intervention into the Market\*

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INTRODUCTION

While some, if not many, people imagine that the Internet is and should continue to be the product of pure, free market competition, this view ignores reality.<sup>1</sup> The U.S. government funded much of the early

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<sup>1</sup> See e.g., Steve Bickerstaff, *Shackles on the Giant: How the Federal Government Created Microsoft, Personal Computers, and the Internet*, 78 TEX. L. REV. 1 (1999) (arguing persuasively that the federal government played a significant role in the

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investment in the Internet and continues to be a major player in its evolution. Government and industry have both shifted the size and direction of their investments in the Internet over time as the potential applications of the rapidly evolving computing and networking technologies became apparent. Public investment in the “early” days (1960-1985) was based primarily on three objectives: (1) to establish a secure, reliable communications and control system for national defense purposes, (2) to facilitate cooperative research among government agencies and among academic institutions, and (3) to advance the computing and networking technologies themselves. Nevertheless, the emergence of unanticipated, yet extremely attractive, applications “forced” a shift from public funding and public management of its research results towards commercialization and privatization.

This article analyzes the following general question: *Will the full range of end-users be adequately supplied with the Internet in the long term to satisfy their particular end-uses if the Internet infrastructure remains privatized and commercialized?* In other words, if the Internet infrastructure is a necessary input for producing various public and private goods (*i.e.*, in facilitating different end-uses),<sup>2</sup> will procurement and commercial markets adequately supply society with Internet infrastructure? Of course, such a general question cannot be answered in this article, but analyzing the question itself sheds light on fundamental misconceptions regarding our society’s exaltation of market-based provision of goods and services in general, and of the Internet, in particular. In order even to approach the question, we need to understand what the Internet is and how it is “produced,” who the end-users are, how

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development of, *inter alia*, the Internet); JANET ABBATE, *INVENTING THE INTERNET* 3 (1999) (discussing the evolution of the Internet).

<sup>2</sup> See *infra* Part II. During the 1960s, 1970s and 1980s, the primary end-uses served by networks and their interconnection were the production of public goods: government agency missions, research and education. See, *e.g.*, COMPUTER SCIENCE & COMMUNICATIONS BOARD (“CSCB”), *REALIZING THE INFORMATION FUTURE: THE INTERNET AND BEYOND* 241 (1999). See NATIONAL RESEARCH COUNCIL (“NRC”), *FUNDING A REVOLUTION: GOVERNMENT SUPPORT FOR COMPUTING RESEARCH* ch.7 (1999); KAREN D. FRAZER, *NSFNET: A PARTNERSHIP FOR HIGH-SPEED NETWORKING*, FINAL REPORT 1987-1995, at 16, 18 (1996). Using the Internet as an input for private goods production emerged in the late 1980s and 1990s, driving the government towards privatization and commercialization. See each of the sources *supra* and Part I *infra*.

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they utilize the Internet, and how to best define “adequate.” This article develops a framework for understanding these preliminary questions, and, accordingly, is only the beginning of what should be a substantial theoretical and empirical (re)evaluation of the respective roles of government and the market in supplying society with the Internet.<sup>3</sup> As Joseph Stiglitz, Peter Orszag and Jonathan Orszag recently highlighted in their study, *The Role of Government in a Digital Age*, there is a growing “need for re-thinking the role of government by policy-makers, the press, the business community, and academics.”<sup>4</sup> In tandem with that analysis, the role of markets must be reevaluated as well.

Part I provides a brief, descriptive account of the evolution of the Internet. It focuses on the establishment, management, and eventual privatization, commercialization, and decommissioning of NSFNET, the precursor of today’s Internet. Although initially developed to achieve noncommercial research-oriented objectives, under the management of the National Science Foundation (“NSF”)<sup>5</sup> the network was gradually transitioned to accommodate commercial interests. Importantly, the roles of government, industry and academia shifted in line with changes in the expected applications of the emerging technologies. Thus, as the technologies evolved, so did the expected applications and objectives behind continued development efforts, and, not surprisingly, so did the roles of government and industry. Furthermore, the transitions were prompted by, among other things, the recurring need to upgrade the Internet infrastructure in the face of growing congestion.

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<sup>3</sup> It is well established that such a reevaluation is required broadly due to the evolution of the Internet, information technology, the “new economy,” the “digital age,” etc. See, e.g., JOSEPH E. STIGLITZ ET AL., *THE ROLE OF GOVERNMENT IN A DIGITAL AGE* 9 (2000); Shane Greenstein, *The Evolving Structure of Commercial Internet Markets*, in UNDERSTANDING THE DIGITAL ECONOMY 151, 177 (Erik Brynjolfsson and Brian Kahin eds., 2000). See also John Haltiwanger and Ron S. Jarmin, *Measuring the Digital Economy*, in UNDERSTANDING THE DIGITAL ECONOMY, *supra* at 13; Hal Varian, *Market Structure in the Network Age*, in UNDERSTANDING THE DIGITAL ECONOMY, *supra* at 137, 145.

<sup>4</sup> STIGLITZ ET AL., *supra* note 3, at 9.

<sup>5</sup> The NSF is an independent federal agency with a mission to promote the progress of science; advance the national health, prosperity, and welfare; and secure the national defense. See 42 U.S.C. § 1861 et seq. (1994). See also 42 U.S.C. § 1885 (1994) (granting the NSF additional authority); 20 U.S.C. §§ 3911-3922 (1994) (same).

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Part II provides an economic model of the Internet infrastructure, focusing on both its intrinsic and extrinsic nature. Intrinsically, Internet infrastructure is a “sometimes rivalrous,” nonexcludable good. Often, it acts as a public good and is nonrivalrously consumed by end-users, but during peak usage times it acts as a common pool resource that is rivalrously consumed. In addition, the Internet infrastructure has been built upon an end-to-end architecture, which essentially means that the infrastructure does not discriminate (or differentiate) among data packets it carries. This design principle promotes the interconnection of networks (rather than fencing) and focuses application development and innovation on the demands of end-users. Extrinsically, the Internet infrastructure acts as an input in the production of a wide range of goods – private, public, and all steps in between. Both the intrinsic and extrinsic nature of the Internet infrastructure should guide an assessment of how society should rely on the market, the government, or both to provide it with the Internet.

Part III then applies the model developed in Part II to assess both the past and the future of the Internet, focusing primarily on the Internet’s interconnection infrastructure. In looking at the past, as described in Part I, Part III.A evaluates the justifications for shifting from government ownership and control to private ownership and control.<sup>6</sup> Was privatization and commercialization of the NSFNET justified? Then, by looking at the potential congestion and public goods problems on the Internet in the future, Part III.B considers whether a shift back to some degree of government provision will likely be justified: Will the market effectively supply Internet infrastructure to the public? This Part is a preliminary theoretical assessment of market and government

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<sup>6</sup> For the purposes of this article, assume that “government provision” and “market provision” are the extremes of a continuum measuring the degree of government investment, oversight, management and control over a productive activity. Direct government provision involves complete oversight, management and control while market provision involves minimal (although necessarily some) oversight. Government procurement, direct subsidy and tax incentives are examples of intermediate points where government exercises varying degrees of oversight, management and control through institutional mechanisms. I will generally compare the extremes; however, in the end, some mix of institutional mechanisms will be needed to fully satisfy social demand for the Internet.

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provision of Internet infrastructure that sheds light on what we mean by “adequate.” As explained below, “adequate” provision does not simply equate with “efficient” operation of the market because social demand for Internet infrastructure will be underrepresented by market demand over the long run. Moreover, if the underlying design (or architecture) of the Internet infrastructure is driven solely by commercial concerns (even in the theoretically ideal market scenario) the Internet commons likely will disappear in future upgrades of the infrastructure.

Part IV takes a more focused look at an Internet-dependent application where individuals are the end-users creating important public goods – the public domain for information. This example illustrates a particularly important dynamic: namely, the Internet increases and enhances the opportunities for individuals to contribute meaningfully to the production of public goods. However, in order for individuals to produce these public goods, they must purchase an essential input - the Internet, whether access, interconnection, posting capacity, bandwidth, etc. - from commercial firms. On one hand, individuals may have difficulty assessing social demand for the public goods they produce. On the other hand, even if they could assess this downstream social demand, they may lack the incentives to pay market rates upstream for the necessary Internet inputs. While this dynamic is well known with respect to public goods as a general matter, the synergistic role of the Internet and individuals in the production of public goods is a topic deserving of future study.

Finally, Part V concludes with some observations. Given the tremendous expectations society has for the Internet, privatization, commercialization and deregulation should be tempered by a more careful consideration of social welfare. There is no doubt that market actors have contributed immensely to the evolution of the Internet in terms of investment, products, services, and infrastructure. Furthermore, the government’s light-handed approach to regulation has given producers and consumers substantial freedom to innovate and to self-regulate with respect to many issues affecting the Internet community in ways that have produced substantial social benefits. This article does not challenge either of these general observations. Nor does it directly advocate increased government regulation. The basic and rather straightforward point is that, even if the market were to perform perfectly

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in terms of allocating resources and satisfying consumer demand, it would nonetheless undersupply society with Internet interconnection infrastructure over the long-run, because market demand for the Internet is but some fraction of social demand.<sup>7</sup>

### I. BACKGROUND

Perhaps the most defining characteristic of the Internet is the *interconnection* of multitudinous, *different* networks, serving *different* sets of end-users with *different* end-uses.<sup>8</sup> During the course of both public and private research, many different communication networks were created. Government agencies built networks to serve mission-oriented ends; private entities built networks to serve their needs. Some networks spanned large distances; others were localized. Some networks connected thousands of users; others connected less than ten users. The various networks utilized (and tested) different technologies and communications protocols, different communication infrastructures and media, and different management structures. While standardization of communication protocols has occurred, many of these differences still persist.<sup>9</sup> Yet still, the Internet has become a limitless horizon of seamlessly networked computers (or people), because the various networks interconnect with each other. Thus, while much of the discussion will encompass other aspects of the Internet, this article focuses primarily on the interconnection infrastructure that transforms multitudinous, *different* networks into seamless web of interconnected networks.

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<sup>7</sup> While the interesting and important debate over governance of the Internet is a related issue, it is beyond the scope of this article. On the governance issue, see LAWRENCE LESSIG, *CODE: AND OTHER LAWS OF CYBERSPACE* (1999); David Post, *What Larry Doesn't Get: Code, Law, and Liberty in Cyberspace*, 52 *STAN. L. REV.* 1439 (2000); David R. Johnson & David Post, *The New Civic Virtue of the Net: A Complex Systems Model for the Governance of Cyberspace*, in *THE EMERGING INTERNET* (C. Firestone ed. 1998).

<sup>8</sup> See MICHAEL KENDE, *THE DIGITAL HANDSHAKE: CONNECTING INTERNET BACKBONES* (Federal Communications Commission OPP Working Paper No. 32, 2000); ABBATE, *supra* note 1, at 3 (discussing the "role of users in determining the features and ultimate success of a technology," focusing on ARPANET).

<sup>9</sup> See CSCB, *supra* note 2, at 243-251; see generally *id.* App. A.

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The government played a crucial role in facilitating the interconnection of independent, *different* networks with the creation of the NSFNET Backbone during the 1980s and later during the 1990s with the creation of Network Access Points. Importantly, the government's early efforts were focused on interconnections between government and academic networks and decidedly not on interconnections with private networks, unless for research or educational purposes.<sup>10</sup> In 1990, commercial entities began to jointly create and manage interconnects, primarily to circumvent the limitations on commercial traffic for the NSFNET Backbone.<sup>11</sup> As commercial interests in the Internet began to blossom in the late 1980s and early 1990s, the government began a gradual transition towards privatization and commercialization of the NSFNET Backbone. This process reflected a shift in the underlying objectives for government involvement in the development of the Internet. As Chinoy & Salo note:

During the 1990s, the evolution of the U.S. portion of the Internet has, to a very large extent, been driven by two related policies: commercialization and privatization. Under commercialization, the mission of the Internet was broadened from its initial focus on supporting research, education, and defense to include commercial (as well as nearly any imaginable) activity. At the same time, privatization shifted responsibility for the design, implementation, operation, and funding of the Internet from the Federal government to the private sector.<sup>12</sup>

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<sup>10</sup> See e.g., Dan L. Burk, *Patents in Cyberspace: Territoriality and Infringement on Global Computer Networks*, 68 TUL. L. REV. 1, 15 (1993).

<sup>11</sup> See Bilal Chinoy & Tim Salo, *Internet Exchanges: Policy Driven Evolution* (visited Apr. 23, 2000) <<http://www.ksg.harvard.edu/iip/cai/chinsal.html>>; Burk, *supra* note 10, at 15. Today, networks are interconnected at Network Access Points, Federal Internet Exchanges, Commercial Internet Exchanges, and some private exchange points. See Chinoy & Salo, *supra*; NSF, *Connections to the Internet*, Program Announcement 98-102 at 2 (1998).

<sup>12</sup> Chinoy & Salo, *supra* note 11.

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The result of the commercialization and privatization process is that “[v]ery little of the current Internet is owned, operated, or even controlled by governmental bodies. The Internet indirectly receives government support through federally funded academic facilities that provide some network-related services. Increasingly, however, the provision of Internet communication services, regardless of use, is being handled by commercial firms on a profit-making basis.”<sup>13</sup>

The remainder of this Part takes a closer look at the joint evolution of the Internet and the roles of government, industry and academia in creating and managing the Internet’s interconnection infrastructure.<sup>14</sup> This is a helpful starting point for analyzing the question posed at the beginning of this article. The purpose here is to gain insight into (1) the shifting objectives behind government creation and management of the interconnection infrastructure and (2) the shifting mechanisms employed for “providing” interconnection infrastructure, from direct government provision to cooperative arrangements between government and industry and, finally, after privatization, to market provision. As shown below, the relationship between government and industry shifted over time as the technologies, the risk-reward payoffs, and the political climate changed. In addition to shifting expectations, the recurring need for expensive infrastructure upgrades in response to congestion problems created a demand for investment dollars that tested

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<sup>13</sup> Robert E. Kahn, *The Role of Government in the Evolution of the Internet*, in REVOLUTION IN THE U.S. INFORMATION INFRASTRUCTURE 13, 13 (1995).

<sup>14</sup> For a more detailed history of the Internet, see ABBATE, *supra* note 1; NRC, *supra* note 2, ch.7; Kahn, *supra* note 13, at 14-20; Barry M. Leiner et al., *A Brief History of the Internet* (visited Apr. 23, 2000) <<http://info.isoc.org/internet/history/brief.html>>; Vinton Cerf, *Marshall Symposium: Keynote Address* (visited Apr. 23, 2000) <<http://www.si.umich.edu/marshall/docs/p106.htm>>; Vinton Cerf, *Cerf’s Up: Internet History* (visited Apr. 23, 2000) <[http://www.wcom.com/about\\_the\\_company/cerfs\\_up/internet\\_history/index.phtml](http://www.wcom.com/about_the_company/cerfs_up/internet_history/index.phtml)>; *A Brief History of the Internet and Related Networks* (visited Apr. 23, 2000) <<http://info.isoc.org/internet/history/cerf.html>>; Jay P. Kesav & Rajiv C. Shah, Fool Us Once Shame On You – Fool Us Twice Shame On Us: What We Can Learn From the Privatizations of the Internet Backbone Network and the Domain Name System (2001) (unpublished manuscript, on file with author). See also *ACLU v. Reno*, 929 F. Supp. 824 (E.D. Pa. 1996); SRI International, *The Internet*, in THE ROLE OF NSF’S SUPPORT OF ENGINEERING IN ENABLING TECHNOLOGICAL INNOVATION ch. 4 (1997).



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the bounds of public funding and gradually led to increased reliance on private funds.<sup>15</sup>

### A. *Pre-NSFNET*

Prior to the creation of NSFNET, substantial developments were made by government contractors, academic researchers, and industry that set the stage for the evolution of the Internet. One influential development was the creation of a computing network.<sup>16</sup> The first

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<sup>15</sup> For an analysis of the important public choice dynamics surrounding these shifts, see Kesan & Shah, *supra* note 14.

<sup>16</sup> A second influential development was the evolution and adoption of the Transmission Control Protocol/Internet Protocol (“TCP/IP”) through the joint efforts of Robert Kahn at ARPA and Vinton Cerf at Stanford. See SRI International, *supra* note 14, at ch. 4; Kahn, *supra* note 13, at 14; ABBATE, *supra* note 1, at 122. For a more detailed account of the development of TCP/IP, see *id.*, at 127-133. TCP/IP allows information packets to be transported across *different* networks, despite differences in bandwidth, delay, and error properties associated with different transport media (*e.g.*, telephone line, radio, satellite). See NRC, *supra* note 2, ch. 7. TCP/IP concepts were translated into operative protocols under ARPA contracts; see *id.* Other interconnection protocols were also developed, but the NSF eventually chose TCP/IP as the primary protocol for the NSFNET and correspondingly for the Internet. Primarily, the protocols and software development proceeded through an open, collaborative effort among government, academic, and industry networking researchers. See *e.g.*, ABBATE, *supra* note 1, chs. 2-4 (describing interactions among different groups); see also *id.*, ch. 5 (describing the development of international standards).

Not all of the early research was orchestrated by government for government purposes. While ARPA researchers experimented with distributed networks over dedicated phone lines, other researchers in academia and industry experimented with local area networks (LAN’s) utilizing other transmission media. For example, researchers at the University of Hawaii, who were funded by the Navy and ARPA, developed a system for shared radio and shared satellite networks that efficiently handled simultaneous users. See ABBATE, *supra* note 1, at 115-17. The academic researchers also focused initially on providing remote access to computing resources. See *id.* See also NRC, *supra* note 2, ch.7. Industry researchers worked with coaxial cable as a shared transmission medium for networking computing resources. The resulting Ethernet technology facilitated computer to computer communications within a local area. See ABBATE, *supra* note 1, at 117-18; NRC, *supra* note 2, ch. 7. Although some of the early research in computing and networking technologies was conducted “openly” and cooperatively – through collaboration and standard-setting at workshops and conferences – a significant amount of research was independently and competitively undertaken. For example, many major industrial entities “largely ignored” the process; other industrial entities offered “competitive,” “proprietary networking solutions” rather than applying

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experimental testbed involved government contractors that conducted research for the Advanced Research Projects Agency (“ARPA”).<sup>17</sup> The “ARPANET” network was primarily developed to facilitate the “sharing [of] expensive computing resources among ARPA research contractors.”<sup>18</sup> Accordingly, access was restricted to ARPA contractors.<sup>19</sup> As was and continues to be a common theme with the Internet, the originally envisioned applications for which significant investments in network infrastructure were made, such as applications that facilitated sharing of expensive resources by remote researchers, were subsumed by unanticipated, yet “more popular” applications like File Transfer Protocol (“FTP”) and electronic mail (“email”).<sup>20</sup> These unanticipated applications facilitated communication and collaboration among geographically distributed researchers in an unprecedented

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“the ARPA-developed technologies”; and the emerging networks themselves were initially closed. NRC, *supra* note 2, ch. 7; *see* Bickerstaff, *supra* note 1, at 43. Eventually, the ARPA-developed networking solutions were broadly accepted, the emerging networks became interconnected, and the major industrial entities became active participants. However, coordination was largely the product of the NSFNET and the cooperative involvement of government, industry, and academia during its formation.

<sup>17</sup> *See* each of the sources cited *supra* note 14. For a detailed history, *see* ABBATE, *supra* note 1, chs. 1 & 2. ARPA fostered a research environment involving government contract managers, academic researchers, and graduate students that “helped build the community that would lead the expansion of the field and growth of the Internet during the 1980s.” NRC, *supra* note 2, ch. 7. For a more general discussion of ARPA and its use of flexible contracting arrangements to stimulate innovation, *see* Nancy K. Sumption, *Other Transactions: Meeting the Department of Defense’s Objectives*, 28 PUB. CONT. L.J. 365 (1999). *See also* Mark Stefik, *Strategic Computing at DARPA: Overview and Assessment*, 28 COMMUNICATIONS OF THE ACM 690 (1985).

<sup>18</sup> NRC, *supra* note 2, ch. 7. The first ARPANET node was created in 1969 at UCLA. *See id.* Soon afterwards, three additional nodes were built at the Stanford Research Institute, the University of California at Santa Barbara, and the University of Utah. By 1975, ARPANET had nearly 100 nodes. *See id.* *See generally* CSCB, *supra* note 2, App. A; ABBATE, *supra* note 1, chs. 1 & 2.

<sup>19</sup> *See* NRC, *supra* note 2, ch. 7.

<sup>20</sup> *See id.* This is not meant to say that resource sharing became obsolete. It remained an active application of the emerging Internet technology, but it no longer took center stage. *See* ABBATE, *supra* note 1, at 104-111.

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manner.<sup>21</sup>

The early networks were mission-oriented or application-based: networks were built to facilitate government provision of public goods and services;<sup>22</sup> networks were built to facilitate academic research – basic and applied, computing/network-oriented and otherwise;<sup>23</sup> and networks were built to facilitate commercial provision of private goods and services.<sup>24</sup> Interconnection of these networks did not necessarily facilitate the same ends. For example, the Department of Defense (“DOD”) recognized a potential conflict between its primary mission of military defense and the network externalities of a broader network base. In the early 1980s, the DOD concluded that “if its use of networking were to grow, it needed to split the [ARPANET] in two. One of the resulting networks, to be known as MILNET, would be used for military purposes and mainly link military sites in the United States. The remaining portion ... would continue to bear the name ARPANET and still be used for research purposes.”<sup>25</sup>

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<sup>21</sup> See NRC, *supra* note 2, ch. 7. Similar developments were taking place among computer science academics during the 1970s. Networking efforts by computer science researchers allowed users to remotely access computing resources through time sharing arrangements, to share software, and to communicate with each other. *See id.*

<sup>22</sup> See CSCB, *supra* note 2, at 241 (“Mission agency networks serve specific communities: space and earth scientists in the case of the NASA Science Internet; scientists doing energy-related research in the case of Esnet; defense-related researchers and others in the case of the various networks of ARPA, including DARTnet and especially the Terrestrial Wideband Network TWBnet; and the broadest assortment of scientists and disciplines in the case of NSFNET. Some agencies, such as the National Institutes of Health and within it the National Library of Medicine (NLM), have launched network-based information services that depend on additional commercial networks for access”); NRC, *supra* note 2, ch. 7 (“During the late 1970s, several networks were constructed to serve the needs of particular research communities”; the section goes on to describe various networks).

<sup>23</sup> *See id.*

<sup>24</sup> *See e.g.*, ABBATE, *supra* note 1, at 118 (discussing the emergence of private networks; 3Com introduced its Ethernet product for workstations in 1981 and for personal computers in 1982); NRC, *supra* note 2, ch. 7 (discussing local area networks).

<sup>25</sup> Kahn, *supra* note 13, at 16; *see also* ABBATE, *supra* note 1, at 185-86 (discussing the ARPANET/MILNET split).

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### B. NSFNET

To better facilitate coordination among the various government and academic networks, the NSF gradually took the reigns from the ARPA and became the central funding and decision-making agency for interconnecting networks. By the mid-1980s, numerous *different* networks serving various agencies and academic communities connected to ARPANET.<sup>26</sup> The ARPA and the NSF jointly promoted continued expansion of the ARPANET. By providing both funding and access to computing resources, e.g., to NSF supercomputer centers, ARPA and NSF increased interest in the ARPANET among academic, industrial, and government researchers.<sup>27</sup> In the mid-1980s, the NSF created an independent network to connect the five NSF supercomputers and the National Center for Atmospheric Research.<sup>28</sup>

After significant congestion problems due to “overwhelming demand for networking services [that] saturated the backbone” in 1987,<sup>29</sup> a “very high speed” network was installed under a cooperative agreement between NSF and Merit, Inc. (“Merit”).<sup>30</sup> This upgraded backbone

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<sup>26</sup> See Kahn, *supra* note 13, at 16-17; CSCB, *supra* note 2, 237-239 (discussing various networks connected to ARPANET).

<sup>27</sup> See Kahn, *supra* note 13, at 17; CSCB, *supra* note 2, at 238. The NSF not only allowed researchers limited access to its supercomputer centers over the ARPANET, it actively promoted and funded efforts to get universities connected. See *id.*; see also ABBATE, *supra* note 1, at 191 (same).

<sup>28</sup> See FRAZER, *supra* note 2, at 11; Kahn, *supra* note 13, at 17-18; CSCB, *supra* note 2, at 238. The initial NSFNET utilized either 56 or 64 kbps lines. Cf. Kahn, *supra* at 18 n.1 (56 kbps), with CSCB, *supra*, at 239 (64 kbps). It was first upgraded to a T1 line (1.5 Mbps) and later to a T3 line (45 Mbps). See CSCB, *supra* at 239. The network grew to 19 nodes, with 16 nodes sponsored by NSF and the remaining 3 nodes “serving interagency communication needs.” *Id.* For a detailed history of the NSFNET and its upgrades, see generally FRAZER, *supra*; Kesan & Shah, *supra* note 14, Pt. II.

<sup>29</sup> FRAZER, *supra* note 2, at 16.

<sup>30</sup> See CSCB, *supra* note 2, at 238-39; Kahn, *supra* note 13, at 18. Merit Inc. was a joint venture of IBM, MCI, and the University of Michigan. See SRI International, *supra* note 14, ch. 4. In 1990, Merit, IBM and MCI formed a nonprofit organization, Advanced

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network, NSFNET,<sup>31</sup> eventually displaced the slower ARPANET backbone and became the interconnection backbone for the early Internet.<sup>32</sup> Importantly, the primary objective behind the initiative remained “getting researchers access to supercomputers and large databases, and facilitating collaboration via electronic communication.”<sup>33</sup>

The use of a cooperative agreement marked a transitional point in the evolving government-industry relationship. The NSF needed to have a flexible arrangement to be able to maintain its active role in the rapidly evolving technological environment without being subject to the cumbersome procurement process.<sup>34</sup> At the same time, the cooperative agreement allowed private funds to be leveraged, lessening the pressure on limited NSF funds and improving the incentives for all stakeholders.<sup>35</sup> Finally, industry participants obtained significant know-how advantages that facilitated technology transfer, which would rapidly increase during

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Networks and Services Inc. (“ANS”), to fulfill Merit’s ongoing obligations under the cooperative agreement with the NSF. *See id.*; NRC, *supra* note 2, ch. 7.

<sup>31</sup> There are three primary “components of the [NSFNET] basic architecture...: the packet-switching nodes, called the Nodal Switching Subsystem, the circuit switches interconnecting these nodes, called the Wide Area Communications Subsystem, and a network management system.” FRAZER, *supra* note 2, at 20. To run the backbone, a Network Operation Center was staffed 24 hours a day, seven days a week. *See id.* at 23, 26.

<sup>32</sup> *See Kahn, supra* note 13, at 14-19. ARPANET was completely decommissioned in 1990. *Id.* at 18.

<sup>33</sup> FRAZER, *supra* note 2, at 16.

<sup>34</sup> “A cooperative agreement was chosen as the award instrument for the NSFNET backbone because a contract is used only when procuring specific goods and services for the government, and a grant does not allow the government to significantly guide the management of a project.” *Id.* at 13.

<sup>35</sup> *See id.* at 19. In the Merit proposal to NSF, IBM committed to \$10 million in “equipment, installation, maintenance, and operation”; MCI committed to \$6 million in “reduced communication charges”; and the State of Michigan committed \$5 million “for facilities and personnel.” CSCB, *supra* note 2, at 198 n.8. In the end, IBM and MCI “invested far more time, money and resources than was required....” FRAZER, *supra* at 2.

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the upcoming privatization and commercialization stage.<sup>36</sup> Conversely, many of the technologies upon which the NSFNET depended were introduced by the industrial partners, including, among many others, IBM mainframes and workstations and MCI's digital cross-connect system.<sup>37</sup> While the shift from a procurement relationship to a cooperative agreement enabled private funding and expertise to be better leveraged to the government's benefit, the shift also brought commercial interests and objectives into the planning process.<sup>38</sup>

Complementing the NSFNET backbone initiative in the mid-1980s, NSF increased funding for various regional and local networks to serve the research and educational communities.<sup>39</sup> At first, individual local networks were being directly connected to the NSFNET under NSF's Connections Program.<sup>40</sup> Later, the NSF shifted course and began to fund intermediary, regional networks, leading to the emergence of a three-tiered structure: The NSFNET interconnected regional networks and the regional networks interconnected local networks.<sup>41</sup> On the backbone tier, the NSFNET "act[ed] as a generic transit, routing, and switching network for research and education networks."<sup>42</sup>

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<sup>36</sup> See *id.* at 8-9 ("The NSFNET project helped to distribute technical knowledge and skills among the Internet community, by training personnel in Internet engineering, routing, and network management. Finally, IBM and MCI also were able to gain valuable experience with high-speed networking technology, which later helped them to create commercial products and services....").

<sup>37</sup> *Id.* at 30.

<sup>38</sup> The justifications for shifting the roles of government and industry are analyzed in Part III. See *infra* Part III.

<sup>39</sup> See CSCB, *supra* note 2, at 239.

<sup>40</sup> See *id.*; NRC, *supra* note 2, ch. 7.

<sup>41</sup> See CSCB, *supra* note 2, at 239; NRC, *supra* note 2, ch. 7.

<sup>42</sup> CSCB, *supra* note 2, at 239, quoting Robert Aiken et al., *NSF Implementation Plan for the Interim NREN*, GA-A21174, GA Project 3900, San Diego Supercomputer Center, draft (May 1992).

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The NSF enforced an Acceptable Use Policy (“AUP”) that only allowed transport or interconnection services on the backbone for purposes “in support of Research and Education.”<sup>43</sup> The AUP generally prohibited any commercial traffic, although commercial researchers could utilize the backbone.<sup>44</sup> This restriction gave rise to significant tension because (1) local and regional networks desired commercial traffic to spread their costs and thereby lower subscriber prices and (2) commercial interests desired access to the backbone.<sup>45</sup> The next section discusses each of these sources of tension.

### C. Privatization and Commercialization of the NSFNET

While the cooperative agreement between NSF and Merit, Inc. had proven to be sufficient for the installation, maintenance and improvement of the initial NSFNET backbone,<sup>46</sup> the government-industry relationship continued to evolve as congestion on the backbone necessitated another upgrade.<sup>47</sup> The upgrade presented significant technical and financial challenges that stimulated (1) a shift away from the cooperative agreement towards privatization and (2) a shift away from the dominant government objective of research and education towards commercialization.<sup>48</sup>

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<sup>43</sup> See *NSFNET Backbone Services Acceptable Use Policy*, (visited Apr. 23, 2000) <<http://www.creighton.edu/nsfnet-aup.html>>. See also *Acceptable Use Policies for NSFNET Program Backbone Network Services* (visited May 25, 2001) <[http://www.nlanr.net/VBNS/vbns\\_aup.html](http://www.nlanr.net/VBNS/vbns_aup.html)> (AUP for very high speed backbone network service (“vBNS”)); see also Brian Kahin, *Commercialization of the Internet: Summary Report*, RFC 1192, at 3 (Nov. 1990) (discussing evolution of AUP); Kesan & Shah, *supra* note 14, at 21-24 (same).

<sup>44</sup> See sources cited *supra* note 43.

<sup>45</sup> See FRAZER, *supra* note 2, at 33.

<sup>46</sup> The initial upgrade installed a backbone of T1 lines for speeds of 1.5 Mbps. See *supra* note 28.

<sup>47</sup> This time to a backbone relying on T3 lines for speeds of 45 Mbps. See *supra* note 28.

<sup>48</sup> See FRAZER, *supra* note 2, at 29-33; ABBATE, *supra* note 1, at 196 (“At the beginning of the 1990’s the NSF had to make difficult decisions about the future of the Internet, some having to do with the network’s users [(commercialization)] and others with the

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The devolution of management and control of the NSFNET from government to industry, *i.e.*, privatization, gathered momentum in the late 1980s and early 1990s as the industry participants in the cooperative agreement leveraged their unique position with respect to the NSFNET backbone.<sup>49</sup> A “new corporate structure [for] the NSFNET project” emerged in 1990 when various members of the NSFNET team created Advanced Network & Services, Inc. (“ANS”) to upgrade the NSFNET backbone and provide interconnection services under a subcontract to Merit.<sup>50</sup> ANS also took over the Network Operation Center responsibilities.<sup>51</sup> IBM and MCI contributed private funds (\$4-6 million), personnel and equipment to ANS and obtained a significant equity interest in the upgraded network.<sup>52</sup>

In parallel with the momentum towards privatization, commercialization of the Internet emerged as an important objective for government and industry. For example, as it worked on the Merit subcontract, ANS established a commercial backbone service through a for-profit subsidiary, ANS CO+RE Systems, which was formed in 1991.<sup>53</sup> This development gave rise to considerable (and justifiable) concerns among commercial network service providers who protested the shift in control of the backbone from a pure nonprofit, Merit, to a

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contractors who operated it [(privatization)]”). *See also infra* notes 63-65 and accompanying text.

<sup>49</sup> This is not meant to deride the industry participants or to suggest “foul play.” Given the expanding scope of commercial expectations for the emerging Internet and their advantageous position, both in terms of their relationship with the relevant government actors and their technical expertise, it makes sense that the industry actors sought to capitalize on their significant investments. For a detailed analysis of the “backroom” dynamics and the “ANS debacle,” see Kesan & Shah, *supra* note 14, Pt. III.

<sup>50</sup> FRAZER, *supra* note 2, at 32. *See id.* at 31.

<sup>51</sup> *Id.*

<sup>52</sup> *Id.*

<sup>53</sup> *Id.*



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nonprofit with a commercial subsidiary, ANS.<sup>54</sup> While IBM and MCI leveraged their “insider” position with regard to the NSFNET, which was still governed by the AUP, the NSF encouraged the local and regional networks “to seek commercial, non-academic customers, [to] expand their facilities to serve them,” and [thus, to] exploit the resulting economies of scale to lower subscription costs for all.”<sup>55</sup> Not surprisingly (and as NSF intended),<sup>56</sup> pent-up demand for transport or interconnection services led to the emergence of “competitive, long-haul networks such as PSI, UUNET, ANS CO+RE, and (later) others.”<sup>57</sup> Notably, both PSI and UUNET were privately funded spin-offs of government programs, and, as mentioned above, ANS CO+RE was a subsidiary of ANS, the subcontractor on the Merit contract.<sup>58</sup>

Although interconnection services between commercial networks still presented a problem to the emerging commercial networks,<sup>59</sup> a joint venture between commercial backbone operators PSINet, CERFNet, and Altnet led to the creation of a Commercial Internet Exchange (“CIX”).<sup>60</sup> The participants financed the joint venture through membership fees, thus removing the need to meter traffic across the member networks.<sup>61</sup> Other members soon joined the CIX

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<sup>54</sup> See ABBATE, *supra* note 1, at 196.

<sup>55</sup> Leiner et al., *supra* note 14. See FRAZER, *supra* note 2, at 33; Bickerstaff, *supra* note 1, at 43.

<sup>56</sup> See Leiner et al., *supra* note 14.

<sup>57</sup> *Id.* See ABBATE, *supra* note 1, at 197 (discussing other spin-offs and the dramatic growth in commercial network service providers).

<sup>58</sup> See Kahn, *supra* note 13, at 19.

<sup>59</sup> See ABBATE, *supra* note 1, at 198 (“One handicap for these service providers was that the only connection between their various networks was the [NSFNET] backbone, which was off limits to traffic from commercial customers”).

<sup>60</sup> See ABBATE, *supra* note 1, at 198; KENDE, *supra* note 8, at 5; Chinoy & Salo, *supra* note 11; NSF, *supra* note 11. For more information on the CIX, see <<http://www.cix.org/>>.

<sup>61</sup> See ABBATE, *supra* note 1, at 198.

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arrangement to take advantage of the commercial interconnection services.<sup>62</sup> Importantly, “the CIX became, in effect, a commercial version of the Internet, offering the same set of connections to a different clientele.”<sup>63</sup> While the AUP prohibited commercial traffic on the NSFNET backbone, the NSF, its contractors under the cooperative agreement, their subcontractors, and numerous other market and non-market actors began to see the tremendous commercial potential of the Internet looming in the near future, ripe for exploitation.<sup>64</sup>

For the NSF, a primary impetus for the shifts toward privatization and commercialization was the need to leverage public funds with private funds. The high fixed costs of building the necessary Internet infrastructure could increasingly be borne by industry rather than government *if* government allowed commercial interests in: “[T]he commitment to commercial provision of high-speed networking would attract corporate customers, which would in turn provide more funds to support the backbone from which the research and education community benefited.”<sup>65</sup>

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<sup>62</sup> See *id.* at 198-99.

<sup>63</sup> See *id.* at 199. Considering that commercial interconnects and backbones arose prior to privatization, it is not clear that the NSFNET -- a separate interconnection infrastructure dedicated to particular public goods applications via the Acceptable Use Policy -- should have been privatized and commercialized. Oddly, this suggests that some balkanization of the Internet based on application-type and end-user demands may have been desirable, provided that government continued to support the NSFNET.

<sup>64</sup> In the early 1990s, there was a significant discussion among interested parties in government, academia, industry, and the not-for-profit sector concerning privatization and commercialization. See *e.g.*, Kahin, *supra* note 43 (summarizing and synthesizing issues presented at the Harvard Science, Technology and Public Policy Workshop held at the John F. Kennedy School of Government, Harvard University, March 1-3, 1990); Kesan & Shah, *supra* note 14, Pt. II.D.

<sup>65</sup> See FRAZER, *supra* note 2, at 31. As Steve Wolff explained the NSF philosophy, “NSF recognizes limitations and only has so much money. If you don’t stop doing old things, then you can’t start any new things. And when something gets to the point that it becomes a commodity product, there is no reason for NSF to be supporting it.” *Id.* at 43. Although this philosophy seems to make sense for NSF, it does not necessarily follow that the market should replace the NSF as interconnection service provider; other forms of government support may be required. Are interconnection services really a “commodity product”? *Cf.* Kahin, *supra* note 43, at 4-5 (noting NSF’s concerns over

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The trend towards privatization culminated with the emergence of a “new architecture” for managing interconnection services.<sup>66</sup> Between 1992 and 1995, the NSF worked with the NSFNET community to plan for this “new architecture.”<sup>67</sup> After incorporating substantial public comments into a draft solicitation,<sup>68</sup> the NSF released its four-part solicitation, *Network Access Point Manager, Routing Arbiter, Regional Network Providers, and Very High Speed Backbone Network Service Provider for NSFNET and the NREN Program*,<sup>69</sup> which facilitated the complete transfer of the Internet infrastructure to industry.<sup>70</sup> The “generic transit, routing, and switching [services] for research and education networks” provided through the NSFNET backbone gradually shifted to a commercially owned and operated backbone.<sup>71</sup> First, Network Access Points (“NAPs”) were created to serve as interconnection nodes between commercial networks.<sup>72</sup> Second, NSF

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congestion and the perception that various networks were free riding on costless access to the backbone). Part III considers this justification for privatization and commercialization in more detail.

<sup>66</sup> The Merit cooperative agreement continued to be the instrument through which the government-industry relationship evolved. Although originally a five-year contract scheduled for completion in 1992, the cooperative agreement was extended a few times, ultimately through April 1995. See FRAZER, *supra* note 2, at 43-44.

<sup>67</sup> See *id.*

<sup>68</sup> See *id.*

<sup>69</sup> NSF Solicitation 93-52 (1993). See FRAZER, *supra* note 2, at 44. “[T]he NSF sought awardees to provide the main structural elements of the next generation of high-speed networking in the U.S. as well as internationally.” *Id.* at 45.

<sup>70</sup> For a more detailed discussion, see Kesan & Shah, *supra* note 14, Pts. II & IV.

<sup>71</sup> CSCB, *supra* note 2, at 239, quoting Robert Aiken et al., *NSF Implementation Plan for the Interim NREN*, GA-A21174, GA Project 3900, San Diego Supercomputer Center, draft (May 1992). See FRAZER, *supra* note 2, at 44; Chinoy & Salo, *supra* note 11, at 3-4; Kahn, *supra* note 13, at 13.

<sup>72</sup> See FRAZER, *supra* note 2, at 44. NAP Manager awards were given to different private companies, for example, to Sprint for the New York City NAP and to MFS Datanet for the Washington, D.C. NAP. *Id.*

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funding for connections to the Internet was phased out, forcing the regional and local networks to pay commercial internet service providers for interconnection services.<sup>73</sup> Finally, a Routing Arbiter would manage the “ever-growing routing tables and databases for the providers connecting at the NAPs.”<sup>74</sup> Thus, the NSF “successfully” transferred the financing and management of the backbone infrastructure to industry.<sup>75</sup> On April 30, 1995, the NSFNET backbone was decommissioned, fully replaced by commercial backbones.<sup>76</sup>

### D. *An Explosion in Private Investment, Internet Applications, and Internet Use*

The privatization and commercialization of the NSFNET in 1995 was followed by exponential growth in both private investment and Internet use.<sup>77</sup> Between 1995 and 2000, private investors poured a

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<sup>73</sup> *See id.*

<sup>74</sup> *See id.*

<sup>75</sup> The NSF continues to support high-end, cutting edge networking research. A Very High Speed Backbone Network (“vBNS”), connecting five NSF supercomputer centers at “minimum speeds of OC-3 (155 Mbps), would offer a high-speed, high-bandwidth virtual infrastructure for networking research, including advanced applications.” *Id.* Not surprisingly, given its extensive experience with the NSFNET, MCI won the award to operate the vBNS. *Id.* Moreover, the NSF plays an active role in many of the federal government’s initiatives relating to computing and networking. *See e.g.*, National Coordination Office for Computing, Information, and Communications (“NCOCIC”), *Next Generation Internet Implementation Plan*, §2.2.4 (Feb. 1998) (visited Apr. 23, 2000) <<http://www.ccic.gov/ngi/implementation>> (detailing NSF’s role in the Next Generation Internet initiative); Next Generation Internet Research Act of 1998, 112 Stat. 2929, Public Law 105-305 (Oct. 28, 1998).

<sup>76</sup> *See* FRAZER, *supra* note 2, at 44.

<sup>77</sup> As a rough gauge of increased Internet use, consider the following statistics: The number of Internet users worldwide is estimated to have grown from 26 million users in 1995 to 400 million users in 2000. *See Nua Internet Surveys* <[http://www.nua.ie/surveys/how\\_many\\_online/world.html](http://www.nua.ie/surveys/how_many_online/world.html)> (last modified Jan. 10, 2001). Moreover, “[i]n 1995 only 14 percent of Americans said they went online to access the Internet or to send or receive e-mail. By 1997 that share had more than doubled, to 36 percent, and today more than half (54 percent) go online.” *See* Robert J. Blendon et al., *Whom to Protect and How?* 19 BROOKINGS REV. 44, 44-48 (Winter 2001).

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tremendous amount of resources into all sorts of Internet-related ventures, ranging from infrastructure to applications. Consequently, the NSFNET blossomed into the Internet as we know it today, with a host of communications, entertainment, electronic commerce, information, multimedia, and other applications made accessible to millions of users. Without doubt, this evolution has had profound effects on society and culture in the United States and worldwide.

While some might argue that this rapid evolution confirms that society ought to rely fully on the market (and not on the government) to guide the development and provision of the Internet, such an argument assumes and proves too much. On one hand, the Internet we know today is not the product of free market competition alone; the government played an active and critical role in much of its early stages. On the other hand, there is no reason to believe that the market will continue to pour money into Internet-related investments. In fact, the surge of money into Internet stocks in recent years is considered by many to have been a fit of “irrational exuberance,”<sup>78</sup> because the stock prices of various companies were inflated when judged on traditional market-based valuation principles – for example, profits. Over the long-term, and perhaps after various “bubble-bursting corrections,” the market will presumably allocate capital based on the fundamental principle of profit maximization (or the rate of return attainable by investors), although the risk preferences and time horizons for investors may shift.<sup>79</sup> Thus, while the stock market may have allocated “enough” (or even more than enough) capital into (some) Internet-related investments in the short-term, the same cannot be said with confidence for the long-term.<sup>80</sup> This

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<sup>78</sup> In his famous 1996 speech, Federal Reserve Board Chairman Alan Greenspan warned that “unduly escalated” stock prices reflected “irrational exuberance” on the part of investors.

<sup>79</sup> See Michael E. Porter, *Strategy and the Internet*, HARV. BUS. REV. 63, 64-66 (Mar. 2001). Professor Porter explains that distorted market signals associated with Internet ventures, including distorted revenues, costs and share prices, will eventually give way “as market forces play out” to fundamentals, which ultimately boil down to “sustained profitability.” *Id.* at 65. Cf. Saul Hansell, *Free Rides Are Now Passe On Information Highway*, N.Y. TIMES, May 1, 2001, at A1 (discussing the replacement of free online services with fee-based services).

<sup>80</sup> Cf. Thomas E. Weber, *Will Potholes Develop In Information Highway If Economy Slows?* WALL ST. J., Jan. 22, 2001, at B1 (raising concerns over the impact that an

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argument is addressed in more detail in Part III.

Finally, it is not clear that commonly held expectations and even current beliefs regarding Internet infrastructure build-out, a bandwidth explosion, and a market-driven reduction in prices for bandwidth have been or will be met.<sup>81</sup> Nonetheless, this empirical question is beyond the scope of this article; whether or not the market has allocated too little, enough, or too much capital to Internet infrastructure build-out can only be looked at from an empirical perspective on a relatively short-term basis. As the Internet's history has proven, the build-out/upgrade process is dynamic and a function of end-user demand. This article is concerned with whether the market, even if idealized to be efficient, will meet society's demand over the long-term.

### E. *Today's Market for Internet Interconnection Infrastructure*

Today, the interconnection of commercial backbone networks is unregulated and primarily subject to a private system of self-regulation through "peering" and "transit" relationships among networks.<sup>82</sup> What

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economic slowdown, with particular emphasis on private investment, could have on Internet infrastructure).

<sup>81</sup> See Douglas A. Galbi, *Growth in the "New Economy": U.S. Bandwidth Use and Price Across the 1990s*, 25 COMM. POL'Y No. 1/2, Pt. I (Feb./Mar. 2001) (explaining expectations); *id.* (concluding that expectations of a "bandwidth revolution have not yet been fulfilled" and that a "rapid increase in bandwidth in use and a rapid reduction in bandwidth prices . . . did not occur"). *But cf. Telecoms in Trouble*, THE ECONOMIST, Dec. 16, 2000, at 93 ("The fear is growing among investors that the flood of money that went to fund the building of new capacity for the Internet will result in a bandwidth glut that will ensure measly returns right across the industry").

<sup>82</sup> See KENDE, *supra* note 8, at 2, 5; Michael Kende & Jason Oxman, *The Information Interchange: Interconnection on the Internet*, 1999 PROCEEDINGS OF 27TH ANNUAL TELECOMMUNICATIONS POLICY RESEARCH CONFERENCE 1-2. On peering and transit arrangements, see KENDE, *supra* note 8, at 5-8; Rob Frieden, *Without Public Peer: The Potential Regulatory and Universal Service Consequences of Internet Balkanization*, 3 VA. J. L. & TECH. 8 (Fall 1998) <[http://vjolt.student.virginia.edu/graphics/vol3/home\\_art8.html](http://vjolt.student.virginia.edu/graphics/vol3/home_art8.html)> ("Sender-Keep-All," "Peer-to-Peer Bilateral," "Hierarchical Bilateral," and "Third Party Administrator"); Joseph Bailey & Lee McKnight, *Scaleable Internet Interconnection Agreements and Integrated Services* (last modified Mar. 26, 1997), <<http://www.ksg.harvard.edu/iip/cai/mcknight.html>> (same, also discussing "Cooperative

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began as reciprocal, traffic-sharing arrangements between networks that interconnected at the centralized NAPs has developed into a number of innovative traffic sharing and pricing arrangements and the emergence of decentralized, private interconnections between networks.<sup>83</sup> Although the range of bilateral and multilateral peering schemes is beyond the scope of this paper, it should suffice to say that peering relationships have evolved over time, in large part due to congestion problems.<sup>84</sup> As experienced in the past, congestion on the networks and at interconnection nodes increases the demand for upgrades to the infrastructure, and upgrades require high fixed costs that investors would like to recover. At the same time, the number of different end-uses has grown considerably, leading to significant variance in the quality and type of service demanded. Consequently, infrastructure cost recovery and the expanding range of end-users has driven the (interconnection) market towards more elaborate usage-based pricing schemes between interconnecting networks.<sup>85</sup> Thus, the same pressures that prompted the shifts in the government-industry relationship have prompted shifts in the relationships among commercial backbone networks, the lower tier

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Agreement” and pricing policies); Kenneth Neil Cukier, *Peering and Fearing: ISP Interconnection and Regulatory Issues*, (last modified Mar. 12, 1998) <<http://www.ksg.harvard.edu/iip/iicompol/Papers/Cukier.html>> (discussing definition, history and current characteristics of peering); Joseph P. Bailey, *Economics and Internet Interconnection Agreements* (last modified May 18, 2000) <<http://www.press.umich.edu/jep/works/BailEconAg.html>>.

<sup>83</sup> See KENDE, *supra* note 8, at 5-8; FRAZER, *supra* note 2, at 44. As Michael Kende explains, “[a]nother result of the increased congestion at the NAPs has been that many backbones began to interconnect directly with one another.” KENDE, *supra*, at 6.

<sup>84</sup> See FRAZER, *supra* note 2, at 6 (discussing emergence of private interconnection nodes due to congestion at NAPs); KENDE, *supra* note 8, at 6 (discussing evolution of commercial backbone interconnection relationships caused by congestion at the NAPs). Congestion will be discussed in more detail *infra* Part II.

<sup>85</sup> See sources cited *supra* note 82. For an article discussing the competitive picture among commercial backbone providers, see Joan Engebretson, *Will the Oligopoly Prevail*, BANDWIDTH Aug. 23, 1999 (visited Apr. 29, 2001) <<http://www.telecomclick.com/magazinearticle.asp?releaseid=2864&magazinearticleid=16387&magazineid=7>>.

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networks and ultimately the end-user.<sup>86</sup>

### II. ECONOMIC MODEL OF THE INTERNET INTERCONNECTION INFRASTRUCTURE

Two sets of related questions need to be formulated and answered to assess whether society will be adequately supplied with Internet infrastructure: First, what do end-users need to be supplied with? How can we characterize the Internet infrastructure? Is it a public good, a common pool resource, a private good, or something else? And second, how do the provisional mechanisms (*i.e.*, the government vs. the market) perform? Is social welfare maximized such that the demands of the full range of end-users are met dynamically over time? Are some end-users benefited at the expense of others? Of course, these questions are not answerable with any sort of mathematical precision in this article, but they remain worth asking and analyzing in the abstract, given the tremendous expectations society has for the Internet. This Part addresses the first set of questions by providing a model of the Internet relating its value to its end-users; the next Part addresses the second set of questions concerning provisional mechanisms. To cabin the analysis, the focus is generally on the Internet interconnection infrastructure.<sup>87</sup> The incredibly

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<sup>86</sup> To conceptualize the complicated web of actors, the market for Internet services “can be thought of as a hierarchy consisting of three levels of participants: end users, Internet service providers (ISPs), and Internet backbone providers (IBPs)... IBPs own or lease high speed fiber optic networks connected together by routers, which they use to deliver traffic to and from their customers. IBPs primarily sell wholesale Internet connectivity to ISPs that essentially resell this connectivity to their customers...” Kende & Oxman, *supra* note 82, at 1-2. Because end-users demand access to the entire Internet, a market for interconnection services arises between IBPs and ISPs. *See id.* (discussing end-user demand and network externalities).

<sup>87</sup> Interconnection between networks occurs at a node through the use of computing equipment and various communications protocols. For “maps” of the Internet, see *An Atlas of Cyberspaces* (visited May 20, 2001) <<http://www.cybergeography.org/atlas/atlas.html>>; KEVIN WERBACH, DIGITAL TORNADO: THE INTERNET AND TELECOMMUNICATIONS POLICY app. A (Federal Communications Commission OPP Working Paper No. 29, 1997). Because “envisioning” the Internet is not an easy task, it may be helpful to think of it by analogy to other transportation or distribution systems by which people, goods, or services, rather than information packets, travel.



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complicated and multifaceted nature of the Internet precludes a detailed discussion of each of its components. However, much of the analysis can be extended to cover the other components, such as the networks themselves.

### A. *The Intrinsic Nature of Internet Infrastructure*

The Internet infrastructure is a “sometimes rivalrous,” nonexcludable good that is dependent upon rapidly evolving

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[N]etworks are nothing new. “Hard” networks, such as road and rail systems, power grids, and water and gas distribution networks have been with us for a century. These networks connect customers to suppliers, or other customers, with physical facilities. “Soft” networks, such as computer hardware and software, and automobile service and parts systems, depend upon shared standards and protocols to link products and their uses and are a barely noticed part of our lives. Telecommunications networks have also been with us for a century, from early telephone networks, local in scope, to the emergence of the current globally connected telephone system. In the 1920s, radio networks emerged, followed by television networks in the 1940s and 1950s. Somewhat later, cable television networks grew, slowly at first, but now passing over 90% of U.S. homes. In other countries, satellite television distribution networks perform much the same role. More recently, cellular telephone networks have also grown, illustrating the point that telecommunications networks, though “hard” in the sense used above, can be wireless links, without a continuous physical connection.

Gerald R. Faulhaber, *Public Policy for a Networked Nation*, 8 J.LAW & PUB. POL’Y 219, 220 (1997) (citing 1995 FCC Second Ann. Rep. on Cable Competition 2 app. B, tbl. 1). Consider the similarities between an interconnection node and an airport. Information and people that need to get from Rochester, New York to Houston, Texas may rely on a regional transport system to first get to a node where they can connect with a national transport system in order to reach Houston (either directly or through another regional system). At the node, interconnection involves coordination of both information (people) and the various network carriers (airlines/airplanes). Due to the multilayering of networks in certain locales, *i.e.*, multiple internet service providers (“ISPs”) in a given geographic locale, transporting information to your next-door neighbor may also require the use of an interconnect if you and your neighbor use different ISPs. See Mark Cooper, *Open Access to the Broadband Internet: Technical and Economic Discrimination in Closed, Proprietary Networks*, 71 U. COLO. L. REV. 1011, 1045 n.88 (2000) (discussing example and citing Jerome H. Saltzer, “*Open Access*” is Just the Tip of the Iceberg (Oct. 22, 1999) <<http://web.mit.edu/Saltzer/www/publications/openaccess.html>>). The interconnection may be accomplished through the use of a private bilateral interconnection between the two local ISPs or through the use of a multilateral interconnection.

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technology.<sup>88</sup> These characteristics are, to a large extent, a function of the manner in which the infrastructure has evolved, and, as this and later Parts explain, the characteristics of the Internet infrastructure are subject to change, particularly during upgrades. The Internet infrastructure seen today has evolved with the “end-to-end principle” as a central tenet; this essentially means that the infrastructure does not discriminate (or differentiate) among data packets it carries.<sup>89</sup> This design principle

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<sup>88</sup> Pure public goods are both nonrivalrously consumed and nonexcludable while private goods are both rivalrously consumed and excludable. These economic characteristics are described below:

*Rivalrous Consumption:* A good is rivalrously consumed when consumption by an individual depletes the amount of the good available for others to consume. When a person eats an apple, the apple is depleted, and it is no longer available for anyone else to eat. By contrast, when a person listens to a song, reads an article, or views an outdoor fireworks display, that person’s consumption does not reduce the amount of the song, article or fireworks display available for others to consume. Goods that are not rivalrously consumed should be produced to the extent that the combined benefits to all possible consumers equal or exceed the cost of production. Markets generally fail to produce nonrivalrously consumed goods at the socially efficient level because, in the absence of perfect price discrimination, market-based investment and production (made on the basis of expected returns) will not include benefits to consumers that are priced out of the market and will not fully allocate investment for consumers who realize benefits that exceed the market price. See Brett Frischmann, *Innovation and Institutions: Rethinking the Economics of U.S. Science and Technology Policy*, 24 VT. L. REV. 347, n.35 (2000).

*Nonexclusion:* For some goods, it is difficult to prevent nonpaying persons from consuming the goods. It may simply be too costly to build the necessary “fences” to keep free-riders from consuming without paying. Market provision of such goods is significantly hampered because investors recognize that free-riding will limit their ability to appropriate the benefits of the goods. On one hand, this leads investors to invest less in the production of nonexcludable goods. On the other hand, investors sink costs in “fencing off” would be free-riders. See W.H. Oakland, *Theory of Public Goods*, in HANDBOOK OF PUBLIC ECONOMICS v.2 485, 486 (Auerbach et al. eds., 1987); ROBERT COOTER & THOMAS ULEN, *LAW AND ECONOMICS* 40-41 (2d ed. 1997); Frischmann, *supra*, at 358-69.

<sup>89</sup> See generally Mark A. Lemley & Lawrence Lessig, *The End of End-to-End: Preserving the Architecture of the Internet in the Broadband Era*, 48 UCLA L. REV. 925 (2001) (discussing value of end-to-end architecture and the risk of losing it); *Upgrading the Internet*, THE ECONOMIST (TECH. Q.), Mar. 24, 2001, at 32 (same). See also Cooper, *supra* note 87.

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promotes the open interconnection of networks and focuses application development and innovation on the demands of end-users. The Internet infrastructure is essentially nonexcludable because of the widespread, relatively seamless interconnection among networks that is a consequence of the Internet's end-to-end architecture. It could have been designed otherwise and have developed into a system of fenced off networks where interconnection involved terms and conditions based on discriminating among data packets. However, for the most part, interconnects and networks are ignorant of the identity of the end-users and end-uses, and at the same time, end-users and end-uses are ignorant of the interconnects and various networks that transport data packets. In a sense, this shared ignorance is "built" into the infrastructure to preclude exclusion of end-users or end-uses on an individualized basis.

Internet infrastructure consumption is often nonrivalrous; for example, during off-peak hours. At these times, it is essentially a public good because users drawing upon the Internet's capacity do not impose costs on other users.<sup>90</sup> At some threshold, determined in terms of aggregate capacity being used, however, nonrivalrous consumption turns rivalrous and congestion problems arise. As Rob Frieden describes the congestion problem:

The growing ranks of Internet subscribers threaten to convert the World Wide Web into the "World Wide Wait" absent substantial and expedited upgrades in bandwidth, modem banks, routers and the variety of facilities that make up the Internet.... The potential for congestion and degraded service over the Internet results from both the aggregate increase in demand and specific traffic routing and switching requirements

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<sup>90</sup> Generally, each individual choosing to consume capacity will obtain some independent private benefit without imposing any costs on other users. In addition, the Internet also exhibits network externalities such that the individual benefits to each user may increase as a function of the number of users. See Nicholas Economides, *The Economics of Networks*, 14 INT'L J. INDUS. ORG. 673 (1996); Mark Lemley & David McGowan, *Legal Implications of Network Economic Effects*, 86 CALIF. L. REV. 479 (1998). The network externalities seem, for the most part, to be extrinsic rather than intrinsic; the applications themselves, e.g., email, are more valuable as a function of the number of users. See *infra* section B.

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on particular routes, routers and servers.<sup>91</sup>

Thus, the Internet infrastructure may be characterized as a commons,<sup>92</sup>

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<sup>91</sup> Rob Frieden, *When Internet Peers Become Customers: The Consequences of Settlement-Based Interconnection*, 1999 PROCEEDINGS OF 27TH ANNUAL TELECOMMUNICATIONS POLICY RESEARCH CONFERENCE 16. The author goes on to describe the congestion experienced when Victoria's Secret broadcast its fashion show over the Internet. *Id.* at 17. "What is amazing is not that the Internet is congested, which it clearly is, but that it has not collapsed under the crushing weight of unprecedented traffic volumes." Faulhaber, *supra* note 87, at 237 (footnote omitted). "Some parts of the Internet are highly congested, especially the public peering points [and] the NAPs..." Andrew Odlyzko, *The Internet and other networks: Utilization rates and their implications*, at 5 (last modified Oct. 2, 1998) <[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=132770](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=132770)>. Odlyzko goes on to say that the backbones themselves are "relatively lightly loaded," suggesting that the interconnection nodes act as bottlenecks. *Id.* See J. Gregory Sidak & Daniel F. Spulber, *Cyberjam: The Law and Economics of Internet Congestion of the Telephone Network*, 21 HARV. J.L. & PUB. POL'Y 327, 353-54 (1998) [hereinafter *Cyberjam*]; Jeffrey K. MacKie-Mason & Hal R. Varian, *Economic FAQs About the Internet*, J. ECON. PERSP. 75 (1994). See also J. Gregory Sidak & Daniel F. Spulber, *The Tragedy of the Telecommons: Government Pricing of Unbundled Network Elements under the Telecommunications Act of 1996*, 97 COLUM. L. REV. 1081, 1160-61 (1997) (noting August 1996 network outage experienced by AOL). See *supra* Part I.B & C.

<sup>92</sup> See e.g., Alok Gupta, Dale O. Stahl, Andrew B. Winston, *The Internet: A Future Tragedy of the Commons?* (last modified July 7, 1995) <[http://cism.bus.utexas.edu/alok/wash\\_pap/wash\\_pap.html](http://cism.bus.utexas.edu/alok/wash_pap/wash_pap.html)>; Peter Kollock & Marc Smith, *Managing the Virtual Commons: Cooperation and Conflict in Computer Communities* (last modified Jan. 31, 1994) <<http://www.sscnet.ucla.edu/soc/csoc/papers/virtcomm/>>; Sidak & Spulber, *Cyberjam*, *supra* note 91, at 353-54. See also *id.* at 368-69 (noting that "free" provision of water, electricity, pollution, and data transmission leads to overuse). Cf. Yochai Benkler, *Overcoming Agoraphobia: Building the Commons of the Digitally Networked Environment*, 11 HARV. J.L. & TECH. 287, 359 (1998). There is an ample literature on this issue from a number of different perspectives. The commons dilemma can be thought of in game theory terms as a coordination or prisoners' dilemma game; in environmental circles, it may be called a common pool resource. For an excellent discussion, see ELINOR OSTROM, GOVERNING THE COMMONS: THE EVOLUTION OF INSTITUTIONS FOR COLLECTIVE ACTION (1990); ROBERT AXELROD, THE EVOLUTION OF COOPERATION (1984); DAVID BOLLIER, PUBLIC ASSETS, PRIVATE PROFITS: RECLAIMING THE AMERICAN COMMONS IN AN AGE OF MARKET ENCLOSURE (2001); Edward B. Rock, *The Logic and (Uncertain) Significance of Institutional Shareholder Activism*, 79 GEO. L.J. 445, 453-57 (1991) (discussing collective action problem in corporate law context); Richard W. Parker, *The Use and Abuse of Trade Leverage to Protect the Global Commons: What We Can Learn From the Tuna-Dolphin Conflict*, 12 GEO. INT'L ENVTL.

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subject to overexploitation unless some form of “coordination” arises.<sup>93</sup>

Due to the transitory nature of rivalrousness and the available responses to congestion problems, the Internet infrastructure can also be characterized as a renewable resource. Like congestion on a highway or at the airport, the passage of time allows traffic to dissipate. Of course, there can be significant costs to the system if accidents occur, but capacity is generally restored.<sup>94</sup>

The theoretically ideal market response to transitory congestion that is predictable, *i.e.*, occurs at certain peak usage times, is to rely on the market’s pricing mechanism to coordinate the timing of traffic. As standard economic theory suggests, Internet users should be charged for the full economic costs of their use, including the externalized marginal costs associated with their contribution to congestion. Paying higher prices for interconnection services during peak hours would force users to internalize the congestion externality.<sup>95</sup> In theory, internalization

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L. REV. 1, 86-90 (1999). *See generally* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1968).

<sup>93</sup> “Coordination” can be accomplished through a number of mechanisms including, for example, the creation of property rights and relying on the market, self-regulation through community-based management, or government regulation. *See e.g.*, OSTROM, *supra* note 92; BOLLIER, *supra* note 92. For an interesting and detailed discussion of coordination issues and options in the digital network context, see Benkler, *supra* note 92.

<sup>94</sup> Yochai Benkler describes the radio spectrum in a similar fashion:

To be precise, if one wishes to treat spectrum as a resource, one must recognize that it is a perfectly renewable resource that is an input into the value sought to be maximized – the capacity of users to send and receive communications. The spectrum is perfectly renewable in that time is one of its defining dimensions; the availability over time of a given frequency/power unit as an input for communications is in no way affected by its use at any previous time.

*Benkler, supra* note 92, at 359.

<sup>95</sup> *See* Sidak & Spulber, *Cyberjam, supra* note 91.

The [enhanced service provider] exemption [from paying interstate access charges], however, creates traffic jams at the on-ramps to the information

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facilitates efficient operation of the markets.<sup>96</sup> The airline industry accomplishes this, to some extent, by raising fares for travelers during peak times. Government entities use similar pricing schemes for highway tolls along commuter routes. The Metro subway system in Washington, D.C. charges higher rates during peak hours to encourage travel during off-peak hours. The model works better for some congestible resources than for others, depending upon, *inter alia*, consumer preferences, demand elasticity, etc. Infrastructures that have a low price elasticity of demand, for example, will require a large price increase to change consumption habits. For both transportation and communications infrastructures, there are daily time periods during which significant traffic flows may be inevitable because consumers may lack the ability to shift their consumption patterns.<sup>97</sup> For the Internet, peak load pricing arguably would moderate user demand and to some extent alleviate congestion.<sup>98</sup> To accomplish such a shift in pricing patterns, however, some form of “coordination” may be necessary<sup>99</sup> to

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superhighway – what we call a “cyberjam.” If access were priced efficiently, consumers would make efficient demand decisions, there would be incentives for the supply of additional capacity, and suppliers of transmission access would have incentives to choose the best transmission technologies.

*Id.* at 329-30. For an excellent analysis of the congestion externalities imposed on the public switched telecommunications network by Internet access providers, *see generally id.*; Bickerstaff, *supra* note 1. *See also* Jonathan Weinberg, *The Internet and “Telecommunications Services,” Universal Service Mechanisms, Access Charges, and Other Flotsam of the Regulatory System*, 16 YALE J. ON REG. 211, 240-41 (1999); MacKie-Mason & Varian, *supra* note 91; INTERNET ECONOMICS (Lee McKnight & Joseph P. Bailey eds., 1997).

<sup>96</sup> *See* Sidak & Spulber, *Cyberjam*, *supra* note 91.

<sup>97</sup> An interesting issue not considered here is the extent to which telecommuting may be a means for alleviating both Internet and transportation congestion because it gives workers the ability to shift their work schedules.

<sup>98</sup> *See e.g.*, Sidak & Spulber, *Cyberjam*, *supra* note 91, at 350; MacKie-Mason & Varian, *supra* note 91; INTERNET ECONOMICS, *supra* note 95. *See also* Sidak & Spulber, *Cyberjam*, *supra* note 91, at 360-70 (discussing pricing of Internet access to ISPs); *id.* at 363 (arguing that “the costs imposed by data calls should be recovered through usage charges on the consumer and access charges on the ISP for originating access”).

<sup>99</sup> *See supra* notes 92-93 (discussing commons and coordination). It may be that the market left alone would (or will) gravitate towards such pricing schemes. *See sources*

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overcome existing consumer preferences for monthly fixed fee pricing.<sup>100</sup> It remains to be seen whether such variable pricing schemes will resolve congestion problems on the Internet; other forms of coordination external to the market may be necessary.<sup>101</sup>

“Coordination” also may be necessary to attract investment in upgrading the Internet infrastructure to expand capacity – the structural response to congestion.<sup>102</sup> Infrastructure investments entail high fixed costs that private investors are reluctant to sink unless beneficiaries contribute to cost recovery.<sup>103</sup> Two conflicting motives arise because, on one hand, investors require exclusion to prevent nonpaying users from using upgraded infrastructure, *i.e.*, to prevent free riding, and on the other hand, end-users demand the broadest base of interconnected networks

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cited *supra* notes 84 & 87. Of course, private coordination on pricing among competing ISBs and/or ISPs raises antitrust concerns, which are beyond the scope of this paper.

However, as described below, usage-based pricing is not a panacea. It does not guarantee that public goods applications will be efficiently supplied with Internet infrastructure; nor does usage-based pricing ensure that the long term investments in infrastructure will be made. *See infra* Parts II.B, III.B, and IV.

<sup>100</sup> *See* Sidak & Spulber, *Cyberjam*, *supra* note 91, at 369; Andrew Odlyzko, *The History of Communications and Its Implications for the Internet* (last modified Aug. 20, 2000) <[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=235284](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=235284)> (concluding based on history of communications networks that customers’ desire for simplicity will override producer incentives to maximize revenues or utilization efficiency).

<sup>101</sup> “Generally, Internet transmission remains a best-efforts delivery system without priority pricing methods. Those users seeking increased reliability or speed transmit on private commercial systems.” Sidak & Spulber, *Cyberjam*, *supra* note 91, at 370.

<sup>102</sup> Capacity expansion may include improvements to the efficiency of existing infrastructure.

<sup>103</sup> *See* Faulhaber, *supra* note 87, at 237, 238 (“The problem is clear: investment in Internet capacity has not kept pace with the growth of demand, leading to a slow-down of the Internet”; advocating pricing and revenue sharing arrangements “to ensure that those who own facilities, such as transmission pipes, servers, and routers, have sufficient incentive to invest in new capacity to handle increased traffic volumes”); Sidak & Spulber, *The Tragedy of the Telecommons*, *supra* note 91, at 1161 (“The tragedy of the telecommons also implies underinvestment in the maintenance, replacement, and enhancement of the local telecommunications network”).

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possible to take advantage of network effects.<sup>104</sup> Accordingly, some investors have created private networks and interconnects, *i.e.*, put up “fences,” to protect their investments.<sup>105</sup> Otherwise, private actors would under-invest in long-term infrastructure maintenance and improvement. If the nonexclusionary nature of the Internet infrastructure is to be maintained, “coordination” on cost recovery will be necessary, perhaps requiring government involvement.

While eliminating congestion so that users consume Internet infrastructure nonrivalrously is in all users’ best interests,<sup>106</sup> it still does not ensure socially efficient provision. Overcoming congestion in this fashion simply shifts the focus to a traditional public goods analysis.<sup>107</sup> Government intervention into the market is typically justified for public goods because firms will under-invest in public goods production for the following reasons: (1) the nonrivalrous consumption attribute causes valuation, cooperation and information problems;<sup>108</sup> and (2) the nonexclusion attribute causes appropriation problems.<sup>109</sup> Under-investment may lead to a reduction in quality, speed, R&D, or other related features that do not implicate congestion but nonetheless remain

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<sup>104</sup> See *supra* notes 88 and 90.

<sup>105</sup> See *e.g.*, Sidak & Spulber, *Cyberjam*, *supra* note 91, at 370; Frieden, *supra* note 82.

<sup>106</sup> “Since the network uses shared resources, increased demands cause those shared resources to become congested. Management of this situation is at once everyone’s problem and no one’s problem; both demand and supply of all network components, not just a few, must be managed to solve this quality-of-service problem.” Faulhaber, *supra* note 87, at 231.

<sup>107</sup> See, *e.g.*, P. A. Samuelson, *The Pure Theory of Public Expenditure*, 36 REV. OF ECON. & STAT. (1954); Oakland, *supra* note 88, at 485.

<sup>108</sup> See Samuelson, *supra* note 107; Oakland, *supra* note 88, at 486 (“The fact that the marginal cost of additional users is zero is itself sufficient to insure market failure”); Frischmann, *supra* note 88, n.35. Government intervention can take many different forms. On one hand, government can subsidize market actors, for example through intellectual property or tax incentives in the context of innovation. On the other hand, the government may supplant the market and produce the public goods directly. See generally *id.*

<sup>109</sup> See *supra* note 88.



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important to users.<sup>110</sup> In assessing whether the market or government will adequately supply society with Internet infrastructure, we must consider whether the full range of features demanded by the full range of end-users will be provided.

This returns our analysis to the basic end-to-end design principle of the Internet. Because the existing Internet infrastructure has been built upon an end-to-end architecture, data packets are indiscriminately delivered regardless of the equipment or applications at the sending or receiving ends of the networks. As Professors Lemley and Lessig describe it, the end-to-end architecture encourages the “intelligence” in a network to be located at the ends, while the infrastructure remains “as simple and general as possible.”<sup>111</sup> This end-to-end design stimulates innovation and encourages the development of applications and end-uses that directly meet the demands of end users.

Finally, the Internet is reliant on dynamic innovation in science and technology. Even after privatization and commercialization of the NSFNET and the relaxing of the R&E limitations on traffic, the Internet has experienced significant technological developments and will likely continue to do so in the future. Innovation entails a degree of uncertainty as to numerous variables that affect private (and public) investments in research. Although beyond the scope of this paper, the magnitude and direction of public and private funding of Internet infrastructure research is an important factor in assessing whether society will be adequately supplied with the Internet.<sup>112</sup>

The intrinsic nature of the Internet infrastructure raises a number

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<sup>110</sup> Of course, over-regulation by government also can have similar adverse effects. *See* Faulhaber, *supra* note 87, at 231 (“For example, in the precompetitive airline market, most scholars agree that airlines over-provided schedule quality, at the cost of higher fares, as a result of the CAB’s regulatory practices. After deregulation, many more routes involved hub-and-spoke connections and fewer nonstop connections, reducing schedule quality to that for which customers were willing to pay”).

<sup>111</sup> Lemley & Lessig, *supra* note 89, at 931.

<sup>112</sup> Analysis of this factor would significantly complicate this article. For an analysis, see Frischmann, *supra* note 88.

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of concerns that affect the analysis of provisional mechanisms in Part III. It is in the best interest of all end-users to minimize the duration of congestion (rivalrous consumption of Internet capacity). Nonrivalrous consumption seems universally favorable because users do not impose costs on each other. But what if users benefit more from the timing of their Internet usage than they lose to congestion? If this were the case, then the “economically ideal” pricing response would not cause a significant shift in traffic patterns, suggesting that structural investments may be the desired response to congestion. Then, traditional commons analysis comes into play, prompting an examination of provisional mechanisms (management regimes) including private networks and interconnects, centralized management by government, and community-based management. The future of the Internet’s end-to-end architecture is also an integral part of the analysis of provisional mechanisms. A fully privatized and commercialized Internet will likely move away from the end-to-end principle towards technologically fenced-off networks that better enable market actors to appropriate the benefits of the Internet. Finally, innovation can be seen as a necessary input for producing the Internet, adding a layer of complexity as to funding for research and development.

### B. *The Extrinsic Nature of the Internet*

The Internet acts as an input for producing a wide range of dependent goods; the mix of outputs includes private goods, public goods, and everything in between.<sup>113</sup> To put it another way, the Internet’s value to users comes from the applications or end-uses that it

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<sup>113</sup> Viewed another way, the Internet facilitates applications that produce both private goods and public goods. Viewed still another way, demand for the Internet comes from different types of end-users, some with commercial or private consumption in mind and others with public or community ends in mind. See Timothy Wu, *Essay, Application-Centered Internet Analysis*, 85 VA. L. REV. 1163 (1999); ABBATE, *supra* note 1, at 3 (discussing the “role of users in determining the features and ultimate success of a technology,” focusing on ARPANET). Cf. Sidak & Spulber, *Cyberjam*, *supra* note 91, at 362; Benkler, *supra* note 92, at 352-359 (considering whether transmission-rights owners or equipment manufacturers and end-users are best suited to make content decisions and concluding in favor of the latter group); Jeffrey K. MacKie-Mason et al., *The Role of Responsive Pricing in the Internet* (visited Apr. 23, 2000) <<http://www.press.umich.edu/jep/works/MackieResp.html>> (emphasizing the importance of heterogeneity of applications, users, and users’ valuations of applications over time).

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facilitates.<sup>114</sup> Similarly, airports and highways also act as inputs into other activities, such as work and vacation,<sup>115</sup> but the Internet is different.

What makes the Internet unique is that “just about any electronic signal can be sent from anybody to anybody else. Rather than [tying] the design of the network ... to a specific purpose, it is a general system, with the potential for its use to be shaped and tailored by the needs and desires of its users.”<sup>116</sup>

Another important difference between the applications facilitated by the Internet and the applications facilitated by airports and highways is the frequent presence of network effects.<sup>117</sup> The value realized by the

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<sup>114</sup> *Maximizing social welfare entails maximizing the value downstream.* See Benkler quote, *supra* note 94; Frischmann, *supra* note 88, at 360 (“Innovation policy must recognize that all innovations are pure public goods and that how well optimal market provision fares against government provision depends in part on the expected uses of particular innovations, *i.e.*, for direct consumption or production of another good”); MacKie-Mason et al., *supra* note 113 (“A communications network is as good or as bad as its users perceive it to be. Network performance should therefore be measured in terms of overall user satisfaction with the service they receive”) (emphasis in original). See generally Frischmann, *supra* note 88 (providing a model for comparative institutional analysis in the science and technology policy context that takes into account the variance across downstream uses). The efficacy of downstream markets depends upon the Internet; interconnection is an essential input. See Carolyn Gideon, *The Interconnection Pricing Problem In Local Telephone and the Internet* (visited Apr. 23, 2000) <<http://www.ksg.harvard.edu/iip/iicompol/Papers/Gideon.html>> (“Firms cannot operate in the downstream market without interconnecting with incumbents, as interconnection is an essential input. In this case, it is clear that the price of interconnection will be a key determinant of the extent of entry and competition in the downstream market”).

<sup>115</sup> Telecommunications networks are not considered here because of the impending convergence of data and voice networks, which is beyond the scope of this paper. Nonetheless, the distinctions highlighted in this section apply generally to those networks traditionally available to the public, *e.g.*, telephone, radio, cable, electricity, etc.

<sup>116</sup> Faulhaber, *supra* note 87, at 221. See Benkler, *supra* note 92, at 368 (discussing the distributed, end-user-dependent nature of the Internet); Wu, *supra* note 113. Cf. Greenstein, *supra* note 3, at 162 (“Internet access technology is not a single invention, diffusing across time and space without changing form. Instead, it is embedded in equipment that uses a suite of communication technologies, protocols, and standards for networking between computers. This technology gains economic value in combination with complementary invention, investment, and equipment”).

<sup>117</sup> See Economides, *supra* note 90; Lemley & McGowan, *supra* note 90.

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end-user of many Internet-dependent applications increases with number of other end-users. Examples include auctions, email, chat rooms, message boards, on-line communities, multi-player games, and information dissemination.<sup>118</sup> Arguably, the prevalence of network effects on the Internet may be a result of its nonexclusionary nature. As Professor Porter recently observed, the “openness of the Internet, with its common standards and protocols and its ease of navigation, makes it difficult for a single company to capture the benefits of a network effect.”<sup>119</sup>

Finally, many applications would not exist or be as widely available without the Internet – e.g., email, chat rooms, and remote access to research facilities. In contrast, people would still go to work and take vacations in the absence of airports and highways (or in the presence of congestion), although the costs may rise if users rely on other means of transportation or the benefits may decrease if users substitute to employment or vacations closer to home. Of course, in the absence of the Internet, people could similarly substitute to “snail” mail, conference calls, and the local library or research center, and perhaps find these next-best substitutes to be satisfactory – “we survived for years just fine with . . . .” But this counterfactual seems unlikely.<sup>120</sup>

A careful analysis of the *mix of outputs* that are dependent upon the Internet infrastructure lends some insight as to what *mix of provisional mechanisms* (or what form of “coordination”) might be necessary to meet society’s needs. Over the course of creating, maintaining and upgrading the Internet infrastructure, at least five

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<sup>118</sup> For an interesting discussion of the relationship between computer networks and social networks, see Andrea Kavanaugh, *The Impact of the Internet on Community Involvement: A Network Analysis Approach*, 1999 PROCEEDINGS OF 27TH ANNUAL TELECOMMUNICATIONS POLICY RESEARCH CONFERENCE, Sect. VI at 1-10.

<sup>119</sup> See Porter, *supra* note 79, at 68.

<sup>120</sup> But see ROBERT J. GORDON, DOES THE “NEW ECONOMY” MEASURE UP TO THE GREAT INVENTIONS OF THE PAST? 6, 39, 42 (National Bureau of Economic Research Working Paper No. W7833, Aug. 2000) (arguing that because of fixed time availability for Internet use, “Internet use simply substitutes for other forms of entertainment and information gathering”). See also *id.* at 40-43.

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objectives surfaced: (1) To establish a secure, reliable communications and control system for national defense purposes, (2) to facilitate cooperative research among government agencies and among academic institutions via better communication of data and more efficient use of expensive equipment (from supercomputers to scanning electron microscopes), (3) to advance the computing and networking technologies themselves, (4) to improve communications in the broadest sense, and (5) to facilitate commercial interactions among businesses and consumers. (Each of these objectives can be broken down further.) Prior to privatization and commercialization, the first three public goods objectives were exclusive. The latter two objectives gradually came to the forefront as expectations for potential communications and commercial applications grew.<sup>121</sup>

Socially efficient production of the Internet ultimately depends upon *social demand* for the downstream, Internet-dependent outputs.<sup>122</sup> The above objectives highlight the variance among the mix of outputs, from public goods such as national defense and research to private goods such as recreation and electronic purchasing. To some extent, the research-oriented and communications-oriented objectives are dual-use applications that produce both public and private goods, depending upon the end-user. While assessing “social demand” for the output mix as an empirical matter is beyond the scope of this paper, traditional public goods arguments, discussed briefly above, justify some form of government intervention to compensate for long-term under-investment by private actors in infrastructure and related features demanded by the full range of end-users.<sup>123</sup>

Figure 1 below illustrates the general upstream-downstream relationships in a flowchart where the top-tier actors are the possible providers of Internet infrastructure; the middle-tier actors are consumers of Internet infrastructure *and* providers of various Internet-dependent public and private goods; and the bottom tier actors are consumers of

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<sup>121</sup> See *supra* Part I.

<sup>122</sup> See *supra* notes 113 and 114 and accompanying text.

<sup>123</sup> See STIGLITZ ET AL., *supra* note 3, at 39-44.

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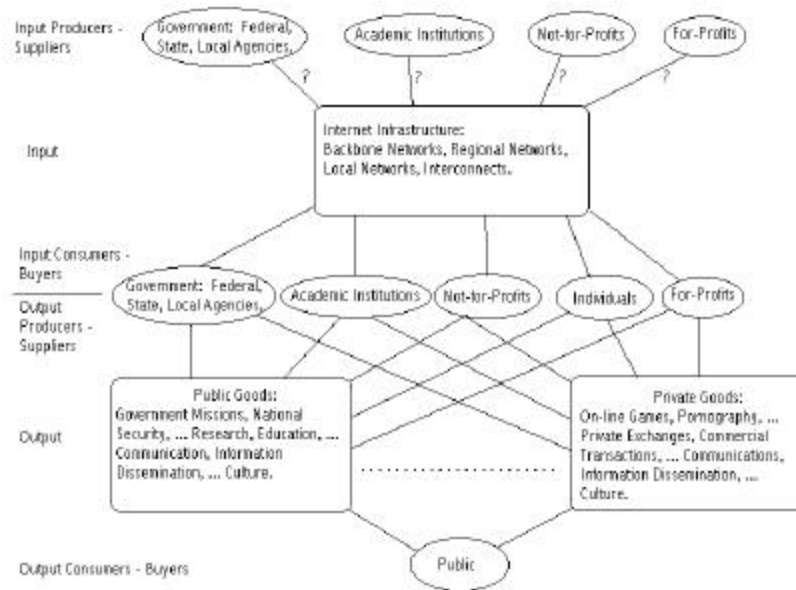
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Internet-dependent goods and services (or end-users of the Internet), represented in aggregate form as the public. The dotted line running between the public and private goods represents a continuum.<sup>124</sup> To keep the diagram simple, however, there are important feedback loops not depicted. For example, bottom-tier individual consumers may purchase a bundled internet access service that provides applications, content and services in addition to access to the Internet infrastructure from a middle-tier, for-profit internet service provider (“ISP”), which in turn may purchase access to the Internet infrastructure through its arrangements with telecommunications, cable and/or satellite companies, regional and/or backbone providers and/or other market actors. Then, these individuals may become middle-tier actors, using their access to the Internet infrastructure to produce public and/or private goods consumed by others downstream. Through this dynamic, the Internet enables individuals to engage in productive, noncommercial activities that are socially valuable. Part IV further explores the synergistic role of the Internet and individuals in producing public goods.

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<sup>124</sup> For a discussion of the manner in which information production and culture are affected by provisional or institutional mechanisms, see Benkler, *supra* note 92, at 369-74.

**Figure 1.**



In summary, the Internet infrastructure is a sometimes rivalrous, nonexcludable good that acts as an input into the production of a mix of outputs. Although the prevailing wisdom seems to hold that commercialization, privatization, and deregulation are in the society's best interest, the analysis of the intrinsic and extrinsic nature of the Internet counsels caution. The Internet is not entirely transactional where users are commercial actors at all times.<sup>125</sup> Government, academic, and not-for-profit institutions use the Internet infrastructure to

<sup>125</sup> Cf. Julie E. Cohen, *Examined Lives: Informational Privacy and the Subject as Object*, 52 STAN. L. REV. 1373 (2000); CSCB, *supra* note 2, at 203 n.57 ("The network is a general-purpose vehicle for many services. Information services are more specific, begging the question of which services might be eligible for coverage in a financial support program"). See also Julie E. Cohen, *Lochner in Cyberspace: The New Economic Orthodoxy of "Rights Management,"* 97 MICH. L. REV. 462, 538-51 (1998) (discussing the positive externalities associated with transactions in creative informational works).

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produce a wide range of public goods. At the same time, individual users are often interacting in a noncommercial manner, whether for educational purposes, to communicate socially, or to vote.<sup>126</sup> Exclusive reliance on the market mechanism would prove unwise for a number of interrelated reasons. First, market actors have insufficient incentives to make investments that are necessary to support public goods applications because they cannot fully appropriate the resulting benefits. Second, end-users (individuals as well as government agencies and non-profit institutions) are not able to accurately value the public goods applications or network effects and therefore do not create an accurate demand pull for Internet services.<sup>127</sup> Third, the high fixed costs associated with Internet infrastructure (and network infrastructure) coupled with potential free-riding problems deter efficient private investment and design. Fourth, some end-users may be “priced out of the market.”<sup>128</sup> It

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<sup>126</sup> See e.g., CSCB, *THE UNPREDICTABLE CERTAINTY: INFORMATION INFRASTRUCTURE THROUGH 2000*, ch. 2 (1999) (discussing individual and organized end users); Christopher T. Hill, *The Public Dimension of Technological Change: Impact on the Media, The Citizenry, and Governments – A U.S. Perspective*, 25 CAN.-U.S. L.J. 153, 160 (1999) (noting the “enormous capability [of the Internet] to influence our lives for the better” in areas ranging from “education, health care, government, politics, the economy, entertainment, cultural enrichment, communications, and so on”); Lewis A. Friedland, *Electronic Democracy and the New Citizenship*, 18 MEDIA, CULTURE & SOCIETY 185-212 (1996); Joseph Janes, *Not-for-Profit Service Organizations and Economic Viability on the Internet*, PROCEEDINGS OF INET96: THE INTERNET: TRANSFORMING OUR SOCIETY NOW (visited Apr. 23, 2000) <[http://info.isoc.org/isoc/whatis/conferences/inet/96/proceedings/f4/f4\\_1.htm](http://info.isoc.org/isoc/whatis/conferences/inet/96/proceedings/f4/f4_1.htm)>. Cf. Benkler, *supra* note 92, at 377-388 (suggesting that an open access or unlicensed regime for wireless communications would better facilitate “robust public discourse and personal autonomy”). See generally *Universal Access* <<http://www.fis.utoronto.ca/research/iprp/ua/usa.html>> (providing expansive listing of hypertext links).

<sup>127</sup> There is an inherent difficulty in determining what the government’s “willingness to pay” is for certain public goods applications, e.g., national defense. See Oakland, *supra* note 88, at 486; cf. Frischmann, *supra* note 88, notes 30-41 and accompanying text, and at 373-74 (discussing inherent difficulty in market provision of innovation inputs for public goods production due to valuation and pricing difficulties). Consequently, aggregate demand reflected in the market will not accurately reflect social demand. See *infra* Part III.B.

<sup>128</sup> Cf. J.H. Reichman & Pamela Samuelson, *Intellectual Property Rights in Data?* 50 VAND. L. REV. 51, 101 n.216 (1997) (pointing out that protecting the public interest in cyberspace entails “ensuring that certain uses and certain users, notably the scientific and



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is rather surprising that commentators seem to focus on the fact that “[i]nstitutions and infrastructure designed to meet the needs of university researchers around the world are quite unsuitable for the high-growth, high-volume, commercialized mass-market service the Internet has become”<sup>129</sup> but do not consider the converse: that institutions and infrastructure designed to meet the needs of the high-growth, high-volume, commercialized mass-market are quite unsuitable for university researchers, governments, not-for-profits, and others around the world.<sup>130</sup>

### III. ANALYSIS OF THE PAST AND FUTURE OF THE INTERNET INFRASTRUCTURE

This Part returns to the basic question under consideration, namely: *Will the full range of end-users be adequately supplied with the Internet to satisfy their particular end-uses if the Internet infrastructure remains privatized and commercialized?* Both the intrinsic and the extrinsic nature of the Internet suggest a negative answer to this question. Recalling the economic model previously discussed, this Part takes a more careful look at the shift towards privatization and

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educational communities, are not priced out of the market or forced to cut back upon the kind of basic research that has heretofore played a crucial role in U.S. economic and technological growth”).

<sup>129</sup> Faulhaber, *supra* note 87, at 237. Professor Faulhaber concludes that the NSF properly privatized and that it “would be inappropriate if the government were to step back into a directive role, having had the good sense to withdraw from such a role some years ago.” *Id.* at 239.

<sup>130</sup> J.H. Reichman and Pamela Samuelson make virtually the same point in an article analyzing the European Commission’s initiative for protecting databases: “First, the Commission seems to have assumed that a more competitive market would intrinsically satisfy the needs of the scientific and educational communities. A National Research Council report shows, however, that basic science has organizational and operational needs that often differ from those a competitive market is geared to meet. Experience demonstrates, indeed, that basic science may not be able to pay market rate ... even when it is competitively determined.” Reichman & Samuelson, *supra* note 128, at 83. The authors go on to highlight numerous problems with the proposed database legislation and then suggest a modified liability regime (as opposed to a property regime) involving robust fair use considerations. *See id.* *See also* LESSIG, *supra* note 7 (discussing how the Internet will change to enable commerce).

commercialization and then considers lessons for the future.

A. *The Past: Justifying Market Intervention into Government*

Neoclassical economics automatically presumes that the default provisional mechanism for a good or service ought to be the market.<sup>131</sup> Government intervention into the market must be justified on grounds that the market will under-supply society with the good or service (or over-supply, for example, in the case of public harms (negative externalities)).<sup>132</sup> The underlying basis for this “automatic presumption” is that through the market mechanism, prices reflect consumer demand for goods and services, and profit incentives motivate commercial actors

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<sup>131</sup> See, e.g., STIGLITZ ET AL., *supra* note 3, at 44 (“[T]he public good nature of production, along with the presence of network externalities and winner-take all markets, may remove *the automatic preference for private rather than public production*”) (emphasis added); *id.* at 46. See also Cohen, *Lochner in Cyberspace*, *supra* note 125, n.36 (providing concise explanation of neoclassical economic theory). This may be an overgeneralization. The point is that efficient supply via the market seems to be the starting point for most analyses. See e.g., Niva Elkin-Koren & Eli M. Salzberger, *Law and Economics in Cyberspace*, 19 INT’L REV. L. & ECON. 553, 555 (1999), and the sources cited in note 132 *infra*. For a thorough critique of the neoclassical model and its application to intellectual property in cyberspace, see Cohen, *supra*. See also Daniel K. Tarullo, *Beyond Normalcy in Regulation of Trade*, 100 HARV. L. REV. 546, 551 (1987) (noting the “self-justifying” nature of statutes aimed at correcting market failure in that “the statutes assume that faithful implementation of their market-based terms will produce efficient outcomes”); Michael Abramowicz, *The Law-and-Markets Movement*, 49 AM. U.L. REV. 327 (1999) (discussing examples of market-based approaches to legal problems). *But see* Yochai Benkler, *Free as the Air to Common Use: First Amendment Constraints on Enclosure of the Public Domain*, 74 N.Y.U. L. REV. 354, 357 (1999) (setting an open access or “free as the air to common use” baseline for information and arguing that government regulation of information production and exchange must be justified).

<sup>132</sup> See e.g., JOSEPH E. STIGLITZ, *ECONOMICS OF THE PUBLIC SECTOR* 71-83 (1988); Samuelson, *supra* note 107; Oakland, *supra* note 88; Laurence R. Helfer, *World Music on a U.S. Stage: A Berne/TRIPs and Economic Analysis of the Fairness in Music Licensing Act*, 80 B.U.L. REV. 93, 107-108 (2000) (copyright/music); William W. Buzbee, *Urban Sprawl, Federalism, and the Problem of Institutional Complexity*, 68 FORDHAM L. REV. 57, 86 (1999) (urban sprawl); Neil Gunningham & Darren Sinclair, *Integrative Regulation: A Principle-Based Approach to Environmental Policy*, 24 LAW & SOC. INQUIRY 853, 882-86 (1999) (environment); Paul A. LeBel & Richard C. Ausness, *Toward Justice in Tobacco Policymaking: A Critique of Hanson and Logue and an Alternative Approach to the Costs of Cigarettes*, 33 GA. L. REV. 693 (1999) (tobacco).

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to meet that demand efficiently.<sup>133</sup> When the pricing or profit incentive components do not work well due to factors such as imperfect or asymmetric information, transaction costs, or attenuated time horizons, government intervention may be appropriate either to “fix” the deficiency in the market mechanism (for example, by providing information or reducing transactions costs) or to directly provide society with the good or service.<sup>134</sup>

In the 1970s and early 1980s, government investment, design, production and management<sup>135</sup> of interconnection infrastructure was justified primarily on traditional public goods rationale. On one hand, research and development activities generated public goods in the form of innovation.<sup>136</sup> On the other hand, the resulting infrastructure and innovation were both inputs into the production of other public goods; for example, those associated with the government agencies’ missions. The market would have grossly under-supplied these services;

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<sup>133</sup> See Sidak & Spulber, *Cyberjam*, *supra* note 91, at 350 (“Among the functions served by market prices are the provision of incentives to consumers for efficient demand decisions; incentives for efficient investment by suppliers; incentives for efficient matching of buyers and sellers; and incentives for the market to select the best access option”).

<sup>134</sup> See Frischmann, *supra* note 88, Pts. II and III (analyzing institutions used to modify or supplant the market); Helfer, *supra* note 132, at 108; Wendy Gordon, *Fair Use as Market Failure: A Structural and Economic Analysis of the Betamax Case and its Predecessors*, 82 COLUM. L. REV. 1600, 1614-15 (1982). See also sources cited *supra* note 132. But cf. Fred S. McChesney, *Economics, Law, and Science in the Corporate Field: A Critique of Eisenberg*, 89 COLUM. L. REV. 1530, 1549 (1989) (“Real-world private markets must be compared with real-world government, not some unrealistically benign caricature thereof. Students of regulation know too much about how government actually works to believe that its coercive intervention in markets will necessarily increase public welfare”).

<sup>135</sup> Hereinafter, “government provision” refers to government investment, design, production and management and “market provision” refers to investment, design, production and management by market actors. This definitional convenience conflates important activities that must be distinguished when assessing the appropriate role of government and market institutions. See *supra* note 6.

<sup>136</sup> See Frischmann, *supra* note 88, Pt. I (modeling innovation).

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government provision was essential if they were to be provided at all.<sup>137</sup>

The shift towards market provision, described in Part I, could perhaps be understood as a weakening of the traditional public goods justification: Government intervention into the market was no longer justified because the market could adequately direct private investment into Internet interconnection infrastructure. However, this explanation seems incomplete. It is not entirely clear that the public goods rationale weakened completely or that the pricing and incentive components of the market mechanism would adequately supply networking and interconnection services over the long term.

Perhaps a better way to frame the question is to consider the justifications for market intervention into government.<sup>138</sup> As illustrated

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<sup>137</sup> The government invested significantly in research and development, the production of networks, and the interconnection of those networks in the 1970s and 1980s with three objectives in mind: (1) to establish a secure, reliable communications and control system for national defense purposes, (2) to facilitate cooperative research among government agencies and among academic institutions, and (3) to advance the computing and networking technologies themselves. These public goods-oriented objectives were not commercially attractive investments. Basically, commercial actors would not invest in these R&D or product development projects in the absence of demand, *i.e.*, a reasonably ascertainable buyer. Without government grants or procurement contracts, there would not be manifestation of demand and certainly no incentive for commercial firms to invest private funds; significant expectations for commercial applications did not arise until the mid-1980s, as described in Part I. *See generally* Frischmann, *supra* note 88, at 373-374.

<sup>138</sup> Although most law and economics analysis considers whether government intervention into the market is justified, *see supra* notes 129-131 and accompanying text, the underlying presumption favoring market provision over government provision seems inappropriate. Perhaps a better mode of analysis begins with an identification of what type of good is being analyzed, and then proceeds by favoring market provision for private goods and government provision (or financing) for public goods. Then, in either case, intervention would require justification due to institutional failure. Both markets and governments falter and even fail. *See* Stiglitz, *supra* note 132, at 71-83, 198-212. At first glance, this proposed analytical shift may seem unnecessary because market failure is generally acknowledged for public goods. But it is the subsequent analytical steps that seem unnecessarily skewed in favor of market provision. That is, the form of government intervention is affected by the underlying presumption: intervention should be minimal or narrowly tailored to meet the market failure; market-based regulatory mechanisms should be used when possible; privatization and commercialization should be favored; etc. *Cf.* Cohen, *Lochner in Cyberspace*, *supra* note 125, at 466, 538 (arguing that the neoclassical models relied on by “cybereconomists” are “neither scientific ... nor neutral, but rather normative and contingent on the very same institutions and

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in Part I, the driving factor behind the shift towards market provision was congestion on the NSFNET backbone, which stimulated demand for expensive upgrades. From the perspective of the government, industry brought additional resources – financial, technical, and human – that complemented government resources.<sup>139</sup> As the fixed costs continued to grow to significant heights with each upgrade, “market intervention” was justified on grounds that limited government resources needed to be leveraged with private funds.<sup>140</sup> This argument is identical to one standard justification for government intervention into the market: When an investment involves sufficiently high fixed costs, government intervention (subsidization) may be necessary because market actors will under-invest due to capital constraints, free-riding risks, and attenuated time horizons for investment recovery.<sup>141</sup> As the standard analysis goes, government intervention is justified on the presumption that government is a larger fiscal actor than most private firms (*i.e.*, government can overcome capital constraints), that government is not concerned with free-riding risks (*i.e.*, government is not motivated by profit incentives), and that government takes into account long-term social welfare. Of course, each of these presumptions is faulty to some extent and subject to dispute.<sup>142</sup>

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arrangements whose absolute efficiency they seek to prove”; suggesting that nonmarket institutions may satisfy “overall social welfare” better than market institutions) and at 555 (concluding that markets are incomplete indicators of individual preferences and that “the term ‘market failure’ is inescapably contingent”).

<sup>139</sup> See *supra* Part I.

<sup>140</sup> See *supra* notes 34-35, 65 and accompanying text.

<sup>141</sup> See *e.g.*, Faulhaber, *supra* note 87, at 237-238; Sidak & Spulber, *The Tragedy of the Telecommons*, *supra* note 91, at 1161.

<sup>142</sup> First, as demonstrated by the leveraging of private funds for upgrading the NSFNET, government resources are limited. Second, governments are concerned with free-riding by other governments. See *e.g.*, Jonathan Baert Weiner, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L.J. 677, 741, 772 (1999) (discussing free riding by nations); Brett Frischmann, *Using the Multi-Layered Nature of International Emissions Trading and of International-Domestic Legal Systems to Escape a Multi-State Compliance Dilemma*, 13 GEO. INT’L ENVTL. L. REV. 463 (2001); Daniel C. Esty, *Revitalizing Environmental Federalism*, 95 MICH. L. REV. 570 (1996); Frischmann, *supra* note 88, at 407-411 (discussing foreign free-riding on U.S. government research investments). Third, as the public choice literature illustrates, government officials face

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That public resources face similar obstacles as private resources is not surprising or novel,<sup>143</sup> but the issue deserves further attention because it is not clear that complete privatization and commercialization are the appropriate responses. What began as cooperative leveraging of resources to support infrastructure investments seems to have resulted in a wholesale “passing of the reins” from government to the market. Of course, government still operates at the fringes, for example, by supporting “next generation” research<sup>144</sup> and retaining implicit subsidies,<sup>145</sup> but it has largely removed itself from the working of the present day Internet infrastructure,<sup>146</sup> which most likely will be the underlying infrastructure for future generations of the Internet.<sup>147</sup>

Having set aside the default rule favoring market provision, one could argue that the use of private resources to leverage public investments ought to be carefully tailored to ensure that the corrective

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short-term political pressures that may undermine long-term planning. *See e.g.*, DANIEL A. FARBER & PHILLIP FRICKEY, *LAW AND PUBLIC CHOICE: A CRITICAL INTRODUCTION* (1991).

<sup>143</sup> That the government has limited funds with which to invest makes sense; that politics affects spending makes sense. Is this a good example of special interest politics or of well-intentioned cooperation between government and industry?

<sup>144</sup> The federal government supports research directed at the Next Generation Internet. *See supra* note 75.

<sup>145</sup> *See* Bickerstaff, *supra* note 1.

<sup>146</sup> *See supra* notes 12 and 13 and the accompanying text.

<sup>147</sup> The Next Generation Internet and Internet2 will not be completely new Internets that replace the existing Internet. For the most part, they are private networks that act as testbeds for developing technologies; in the future, they may be integrated into the existing Internet or they may remain separate. *See* NCOCIC, *supra* note 75; Doug Van Houweling, *Marshall Symposium: Keynote Address* (visited Apr. 23, 2000) <<http://www.si.umich.edu/marshall/docs/p107.htm>> (discussing Internet2 initiative). The existing Internet will remain a part (if not the core) of future generations of the Internet; interconnects, networks, etc. will experience upgrades and additional interconnects, networks, etc. will be connected. Potential balkanization does present risks, however, that some participants will be excluded.

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intervention not overcompensate or cause undue interference with the government provisional mechanism. To be more precise, *market intervention into the government should be limited to correcting the government failure*. The rationale behind tailored or minimal intervention into government is that intervention is costly both in terms of transaction costs and uncertainties faced by relevant actors, such as government officials, citizens, and market actors.<sup>148</sup> Moreover, as seen below, another important social cost at stake is the blurring of objectives or the subjugation of public interest objectives to commercial objectives.

Thus, if the cause for government failure is the high fixed cost of interconnection infrastructure and correspondingly insufficient public funds, then some degree of private subsidization would be justified. How much leverage is unknown, but unless some other form of government failure were present, complete privatization and commercialization seem to have gone too far, given the fact that throughout the shift away from government provision towards market provision, the primary government objectives behind the NSFNET remained (1) to provide interconnection services for research and educational networks and (2) to advance the computing and networking research itself. Privatization of the interconnection infrastructure is analogous to giving away an overly broad intellectual property right in that market actors gain control over an essential input into many downstream goods.<sup>149</sup>

A more complete explanation for market intervention into government must break away from pure government failure and take into account *spillover effects* attributable to dynamic innovation: The expected applications of the developing Internet technologies changed dynamically and came to include the production of both public goods

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<sup>148</sup> “Economic efficiency ... favors minimum incentives to provide the needed investment and services.” Reichman & Samuelson, *supra* note 128, at 56 (concerning government intervention into the market). *Cf.* COOTER & ULEN, *supra* note 88, at 108-18 (making a similar argument but with regard to government intervention into the market).

<sup>149</sup> *Cf.* Reichman & Samuelson, *supra* note 128, at 55-56, Pt. IV (critiquing overly broad database protection).

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and private goods.<sup>150</sup> As government contractors gained experience with the evolving Internet technologies, the commercial potential of the Internet came into view.<sup>151</sup> In exchange for private subsidization to “correct” the “government failure,” the transfer of know-how, technology, and responsibility for the backbone to industry participants incrementally became a third government objective: First with the cooperative agreement, second with the acceptance of the ANS restructuring, and finally with the replacement architecture.<sup>152</sup>

In the end, the choice of which provisional mechanism is “best” suited for providing Internet infrastructure inevitably depends upon the end-uses. Given the wide range of private and public end-uses, it seems doubtful that either the government or the market alone would be ideal. As the number of commercial applications of the Internet grew, so did the case for private investment in Internet infrastructure. Similarly, as the number of noncommercial applications of the Internet grew, so did the case for public investment in Internet infrastructure. Privatization and commercialization of the Internet infrastructure may have gone too far to the market extreme. The next section considers whether market provision will suffice: Is government intervention into the market now justified?

### B. *The Future: Justifying Government Intervention into the Market*

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<sup>150</sup> See e.g., Richard Nelson, *Government Stimulus of Technological Progress: Lessons from American History*, in GOVERNMENT AND TECHNICAL PROGRESS 451, 459 (Richard Nelson ed., 1982) (discussing the spillover effects of government research motivated by national security interests into other applied areas); U.S. Congress, House Committee on Science, UNLOCKING OUR FUTURE: TOWARD A NEW NATIONAL SCIENCE POLICY, at Part II.A.3 (September 24, 1998); Frischmann, *supra* note 88, 364-66, 370-71 (discussing dynamic nature of innovation; discussing importance of capturing spillovers).

<sup>151</sup> Although both government and industry recognized the commercial potential of the Internet, government and academic end-users did not immediately yield to commercial interests. See *supra* Part I.

<sup>152</sup> While some could argue that the third objective was not part of an “exchange,” but rather represented recognition by government of the social benefits of commercialization, this view seems particularly weak in light of the separate emergence of commercial interconnects and commercial backbones. See *supra* Part I.



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Even if limited government resources and spillovers justified market intervention into government provision of Internet infrastructure for research, educational and government networks, complete privatization and commercialization may have gone too far to the market extreme. The efficacy of market provision of the Internet must be evaluated dynamically (*i.e.*, with respect to both the present and the future) and must take into account the full range of end-users. The following concerns highlight potential market failures: (1) congestion problems and (2) public goods problems associated with downstream applications.

*1. The market mechanism may respond inadequately to future rounds of congestion problems and upgrades.*

Congestion problems and the need to upgrade the NSFNET backbone stimulated the major shifts towards privatization and commercialization. Perhaps this (along with other factors, such as a drying up of private capital flows into infrastructure development) will stimulate a shift back towards government provision. Coupled with the demand for high end commercial uses, the government and academic interests in establishing a secure, reliable communications network – for national defense and other governmental purposes, public services like education and medical treatment, and to facilitate cooperative research among government agencies and among academic institutions – have generated significant concerns over future congestion problems.<sup>153</sup> Some would argue that the current Internet infrastructure is in serious need of an upgrade:

Quintessentially modern though it may seem, the Internet is in many respects an example of an overstretched infrastructure built in the 1970s. Like any other piece of infrastructure, whether it is a bridge or a highway, that was designed so long ago, it is groaning under the enormous weight of traffic it has attracted. The Internet now needs an overhaul if it is to cope with

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<sup>153</sup> The Next Generation Internet and the Internet2 initiatives are both premised on this belief. *See* NCOCIC, *supra* note 75.

the mushrooming demand . . . .<sup>154</sup>

The market may fail society in the face of future congestion problems in two ways. On one hand, industry may implement pricing mechanisms aimed at diffusing congestion problems, and on the other hand, commercial interests in control of future infrastructure upgrades may sacrifice the end-to-end design architecture of the Internet infrastructure and opt instead for a more intelligent and balkanized infrastructure.<sup>155</sup> These issues are discussed below.

a. *Market-based pricing mechanisms are an inadequate response to congestion.*

Pricing mechanisms that force end-users to internalize the full economic costs of their Internet use, *i.e.*, to internalize the congestion externality,<sup>156</sup> may be insufficient to ward off congestion problems in the future. If suppliers implement the *theoretically* ideal pricing mechanism to allocate finite Internet capacity (supply) according to fluctuations in demand, and if coordination among (or imposed upon) suppliers prevented strategic under-pricing, congestion would dissipate and private ordering would allocate uncongested capacity to the “highest valued” uses over time.<sup>157</sup>

Besides the numerous barriers to achieving this theoretical ideal in practice, however, it may not really be “ideal” for society as a

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<sup>154</sup> *Upgrading the Internet*, *supra* note 89, at 32.

<sup>155</sup> For discussion of balkanization, see *infra* notes 163-64 and accompanying text.

<sup>156</sup> *See supra* Part II.

<sup>157</sup> According to the basic economic theory, pricing mechanisms that reflect full economic costs (including congestion externalities) cause a shift in the supply curve. Then, end-users’ purchasing decisions will lead to an efficient equilibrium, where the demand curve crosses the supply curve, because end-users are in the best position to make demand-based decisions. However, as explored below, there are inherent problems with relying on end-users to make socially efficient purchasing decisions in the market when public goods are involved.

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whole.<sup>158</sup> First, pricing mechanisms do not necessarily provide private investors with sufficient incentives to invest in infrastructure upgrades that entail high fixed costs and require long-term cost recovery. Second, it seems that congestion costs on the Internet may be shifted to those waiting for prices to drop. The “slow down” costs resulting from on-line congestion and electronic queuing may simply be experienced off-line by those end-users priced out of peak usage times. Rather than spreading congestion costs across all users simultaneously, those end-users with “less valued” uses bear the waiting costs. Finally, there are inherent problems with valuing public goods applications of the Internet. While theoretically ideal pricing mechanisms may reflect the economic costs involved, end-users will not always reflect “social demand” accurately. On one hand, demand tends to reflect the individual benefits realized by a particular user and not take into account positive externalities.<sup>159</sup> On the other hand, end-users cognizant of the public goods applications involved, e.g., government, academics, not-for-profits, or individuals, may run into valuation difficulties or simply be priced out.<sup>160</sup>

“Fixing” the market mechanism through pricing schemes that internalize congestion externalities does not cure the Internet of congestion or society of capacity-based externalities. Congestion is a function of both finite capacity and timing. Curing congestion through pricing ultimately depends upon how consumers react to increases in price during peak usage times. The existence of congestion at a given time is a signal that consumers value using the Internet at that time more than they value the “wasted” time due to congestion. Pricing mechanisms that internalize congestion costs may lead consumers to shift their consumption patterns, but if they do not, it may simply lead to greater wealth extraction by sellers. Thus, in the short term, congestion

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<sup>158</sup> See, e.g., Cohen, *Lochner in Cyberspace*, *supra* note 125, at 466, 538, 555.

<sup>159</sup> Of course, in some cases, individuals do contribute to collective goods and take into account positive externalities. See BOLLIER, *supra* note 92, at 17-26 (discussing gift economies and commons). Part IV discusses one example of an Internet-dependent public good that is closely tied to the individual user, the public domain for information. See *infra* Part IV. Another such example is the community forum for communication, discussed *infra* note 201.

<sup>160</sup> See *supra* Part II.

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may persist but simply lead to higher prices.

More importantly, however, even if some consumers do shift their consumption patterns in response to usage-based pricing and higher prices during peak usage periods, they still bear the costs formerly associated with congestion. The Internet could be a public good, not subject to rivalrous consumption. If society relies on pricing schemes to alleviate rivalrousness, rather than structural investments in capacity (or R&D investments in capacity-expanding technologies), then the costs that would be shared by all users in the form of congestion are externalized by those users willing and able to pay for Internet use during peak times and are internalized by those consumers forced to shift their consumption to less desired timeframes. Thus, the decision to tackle the congestion problem on the Internet through the market mechanism constitutes a distributional choice that ought to be considered more carefully.

*b. Infrastructure upgrades controlled by commercial interests may eliminate the “end-to-end” design principle of the Internet and lead to balkanization.*

The Internet infrastructure will inevitably undergo upgrades. It is not enough to ask whether sufficient investment will be made by market actors to upgrade the infrastructure, but we must also ask whether the infrastructure will be upgraded in a manner that is in the public interest. Professors Lemley and Lessig recently have argued that the end-to-end design principle that guided the evolution of the Internet is at risk in the future because commercial entities, particularly broadband providers, do not necessarily desire the open, end-to-end design and may instead fence off their networks and incorporate “intelligence” into the infrastructure, which could allow networks, interconnects and perhaps others to discriminate among data packets.<sup>161</sup> Upgrading the Internet infrastructure exposes the fundamental conflict between commercial

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<sup>161</sup> Mark A. Lemley & Lawrence Lessig, *supra* note 89. See also LESSIG, *supra* note 7, ch. 4.

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interests and what may be best for the public generally.<sup>162</sup> A few years ago, Professor Frieden (and others) warned of the potential “balkanization of the Internet,” which he described as “the disaggregation of a ‘network of networks’ into an amalgam of networks, with varying degrees of accessibility to other networks,”<sup>163</sup> and suggested that balkanization “would likely trigger the elimination of Sender Keep All (‘SKA’) pricing and a preference for free and open interconnectivity between networks.”<sup>164</sup> While a fully balkanized Internet has not emerged yet, upgrades to the Internet infrastructure may be the catalyst for balkanization and the “end of end-to-end,” as Professors Lemley and Lessig put it. As most people recognize, the stakes are tremendous – “nothing less than the Internet’s ability to support and promote innovation.”<sup>165</sup>

### *2. Public goods problems associated with downstream applications*

While commentators seem to focus on congestion problems and possible responses, an equally, if not more, important problem that remains even in the absence of congestion is ensuring Internet supply to public goods applications. Even if congestion externalities did not

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<sup>162</sup> Cf. *Upgrading the Internet*, *supra* note 89, at 36 (“Clearly, overhauling the Internet’s architecture in a way that balances engineering and commercial concerns is a thorny problem...”).

<sup>163</sup> Frieden, *supra* note 82, at ¶ 4. See Tom Steinert-Threlkeld, *The Balkanization of the Internet*, INTER@CTIVE WEEK (last modified May 6, 1997) <[www.zdnet.com/zdnn/content/inwk/0414/inwk0012.html](http://www.zdnet.com/zdnn/content/inwk/0414/inwk0012.html)>.

<sup>164</sup> Frieden, *supra* note 82, at ¶ 4. “The SKA model allows ISPs to retain all subscriber payments without having to settle accounts with other ISPs who participate in routing and delivering traffic. ... This model has served as the primary template for Internet traffic routing, because of its administrative convenience and the willingness of ISPs to promote network connectivity regardless of whether traffic flows are symmetrical. SKA involves network interconnection without a metering mechanism either because the parties do not care whether traffic symmetry exists, assume that such symmetry exists, or believe that metering and the settlement of financial accounts trigger more cost and inconvenience than a ‘rough justice’ agreement to accept and route onward each others’ traffic.” *Id.* ¶ 12.

<sup>165</sup> *Upgrading the Internet*, *supra* note 89, at 36.

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plague the Internet, relying exclusively on the market could still result in under-supply. This problem is somewhat different from “universal access,” which is an important distributional question.<sup>166</sup> Socially efficient provision of the Internet ultimately depends upon “social demand” for downstream, Internet-dependent outputs. This does not mean that all outputs must be supplied with the Internet; the supply costs and attendant benefits matter. The point is that market demand is a fraction of social demand. The remainder of this Part illustrates this point by focusing on the end-users.

As experienced in the past and present, the government runs the risk that congestion problems will impede its ability to produce certain public goods and services in the future.<sup>167</sup> However, even with the ideal pricing mechanisms, the government faces similar risks brought on by limited public budgets and public goods valuation problems.<sup>168</sup> One could argue that the government is fully capable of demanding the quality of service necessary to satisfy its needs.<sup>169</sup> In fact, the government has increasingly sought to procure commercial products

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<sup>166</sup> A more commonly acknowledged fallacy of relying exclusively on the market has to do with access: many potential users of the Internet do not have the means for obtaining Internet access through the market. See Thomas P. Novak & Donna L. Hoffman, BRIDGING THE DIGITAL DIVIDE: THE IMPACT OF RACE ON COMPUTER ACCESS AND INTERNET USE (Project 2000, Vanderbilt University, Working Paper) (last modified Feb. 2, 1998) <<http://www2000.ogsm.vanderbilt.edu/papers/race/science.html>>; National Telecommunications & Information Administration, U.S. Dep’t of Commerce, *Falling Through the Net II: New Data on the Digital Divide* (last visited May 20, 2001) <<http://www.ntia.doc.gov/ntiahome/net2/falling.html>>. “[I]t is important to note that although consumers may in general be citizens, citizens are not all consumers, and public policy must consider the circumstances of the larger citizenry.” CSCB, *supra* note 126, at 23.

<sup>167</sup> See, e.g., *supra* note 25 and accompanying text (discussing DOD’s separation of MILNET from ARPANET).

<sup>168</sup> As described earlier, the pricing mechanisms would allocate Internet capacity to the most valued uses, which is contingent upon the end-users’ valuation and ability to pay. Even in the absence of congestion altogether, it is not clear that the market would generate the appropriate incentives for private actors to invest in research and other inputs necessary to the long-term success of the Internet.

<sup>169</sup> *But see supra* note 127.

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from commercial vendors in a manner more akin to that practiced in the marketplace.<sup>170</sup> However, the answer to this question largely turns on whether Steve Wolff was correct when he suggested that Internet services have become a commodity product.<sup>171</sup> The Internet is a rapidly evolving, technology-dependent input into a heterogeneous mix of government applications; it hardly seems to be a commodity purchase such as electricity or telephone service. Moreover, the argument generally begs the question as to whether or not the government should pay market rates for something it created.<sup>172</sup>

As is generally true when government, academia, and not-for-profits use the Internet, many of the individual applications facilitated by the Internet produce both public goods and network externalities.<sup>173</sup> To the extent that individuals' willingness to pay for Internet services reflects only the value that they will realize from an application, the market mechanism, through the twin powers of prices and incentives, will not take into account (or provide the services for) the broader set of social benefits attributable to the public goods and network externalities. Consumers will pay for Internet services to the extent that they benefit (rather than to the extent that society benefits). Correspondingly, the degree to which firms will invest their resources depends on the prices

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<sup>170</sup> See, e.g., GAO, SMALL BUSINESS: TRENDS IN FEDERAL PROCUREMENT IN THE 1990S (Jan. 2001); Steven Kelman, *Implementing Federal Procurement Reform* (last modified Spring 1998) <<http://www.ksg.harvard.edu/innovations/occasional/kelman.pdf>>.

<sup>171</sup> See *supra* note 65.

<sup>172</sup> For an argument that the government should have priority rights for public assets that it creates, see Steven Lubet & Cathryn Stewart, *A "Public Assets" Theory of Lawyers' Pro Bono Obligations*, 145 U. PA. L. REV. 1245, 1284-90 (1997) (considering "Conditioned Access to Information-Assets," including the air waves, scientific research, and other areas).

<sup>173</sup> For example, a more informed public can better participate in public and governmental affairs. See e.g., STIGLITZ ET AL., *supra* note 3, at 25-29; Peter L. Gray, *Environmental Data on the Internet: A Wired Public Setting Environmental Policy*, 30 ENV'T L. REP. (ENV'T L. INST.) 10122 (Feb. 2000). The Internet also enhances reporting, disclosure, and dissemination of medical information. See William M. Sage, *Regulating Through Information: Disclosure Laws and American Health Care*, 99 COLUM. L. REV. 1701 (1999).

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that consumers are willing to pay. Of course, some Internet services will be supplied incidentally for the public goods applications, but not enough and certainly not tailored to the public goods applications.<sup>174</sup> To the extent that the government can identify these applications, it may subsidize the end-user as is done, for example, with academic researchers, or government might provide infrastructure directly with limits on its use, as it did with the NSFNET. Of course, directing subsidies at many of the individual applications may prove considerably more difficult;<sup>175</sup> the next Part discusses one such individual application, the public domain for information.

Governments, academics, not-for-profits, individuals, and even for-profit firms produce a wide range of socially valuable public goods and network externalities through their use of the Internet. There is a significant risk that commercialization may drown out these applications, particularly in the face of congestion problems. The price and profit incentive components of the market mechanism do not work well when public goods are involved because the end-users themselves (1) have difficulty assessing “social demand,” (2) in some cases, lack the incentives to pay market rates, and (3) in some cases, lack the means to pay market rates. At a minimum, the justifications for increased (if not absolute) reliance on industry for the provision of interconnection services ought to be reconsidered more carefully. In their recent study of the role of government in the digital age, Joseph Stiglitz, Peter Orszag and Jonathan Orszag observed that “the public good nature of production, along with the presence of network externalities and winner-take-all markets, may remove *the automatic preference for private rather than public production.*”<sup>176</sup>

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<sup>174</sup> See *supra* notes 126-130 and accompanying text.

<sup>175</sup> See Kahin, *supra* note 43, at 2 (noting that privatization could entail a “shifting of the federal subsidy from networks providers to users”); *id.* at 5-6 (discussing direct subsidization of researchers); *id.* at 6 (discussing direct subsidization of institutions); Sidak & Spulber, *Cyberjam*, *supra* note 91, at 389-93 (attacking indirect subsidization of ISPs through ESP exception and suggesting that direct subsidization, for example to end-users, makes more economic sense); Bickerstaff, *supra* note 1 (same).

<sup>176</sup> STIGLITZ ET AL., *supra* note 3, at 44.



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A final lesson for future science and technology initiatives, particularly for the Next Generation Internet and Internet2, concerns the government-industry relationship. Privatization and commercialization of federally-funded science and technology research results can be seen in two ways, as (1) the natural endpoint for technology evolution, or (2) a trade-off between commercialization and other evolutionary tracks.<sup>177</sup> Although the first view is commonly accepted (implicitly if not expressly), the latter view seems more accurate. For example, under the second characterization, privatization and commercialization of the NSFNET can be seen as a trade-off between achieving the initial government objectives more completely and achieving the later recognized commercial potential of the Internet. The trade-off may be the result of technological limitations in bandwidth and the attendant need to prioritize use or as the relinquishment of control over the “backbone” of the Internet.

### IV. INTERNET-DEPENDENT PUBLIC GOODS

Parts II and III, together, presented a theoretical argument, based upon a model of the Internet and its application, that the market alone will undersupply society with Internet infrastructure over the long run.<sup>178</sup> The underlying (simplified) basis for this argument, with regard to downstream Internet-dependent public goods, is that market demand for the Internet infrastructure is a fraction of social demand and correspondingly, that market actors lack the appropriate incentives to supply society at a socially efficient level.<sup>179</sup> The missing fraction of social demand, which is not represented in the market, is a difficult thing

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<sup>177</sup> See Frischmann, *supra* note 88.

<sup>178</sup> See *supra* Parts II (Model) and III (Applying the Model). As noted earlier in various places, the shortcomings of the market extend beyond mere bandwidth to other features that the full range of end-users and end-uses demand.

<sup>179</sup> More generally, many of the imperfections associated with the market – such as a bias towards shorter term investments, capital and cost recovery restraints on high fixed cost investments, and free-riding concerns – further inhibit the market as a provisional mechanism. The emphasis here, however, is on the information and incentive components (price and profit for the market) that stimulate downstream productive activity.

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to measure quantitatively, but it can be qualitatively evaluated by focusing on downstream Internet-dependent public goods that stimulate upstream demand for the Internet.

This Part examines an example of a downstream Internet-dependent public good that is closely tied to the individual user: the public domain for information,<sup>180</sup> which broadly will refer to the agglomeration of intangible resources such as culture, expression, facts, ideas, information, etc., that is not subject to enclosure (or exclusion) by private or public actors. These intangible resources exhibit the characteristics of a classic public good in that they are not depleted when consumed and are not easily subject to “fencing.” This Part first explains the effect of placing information in the public domain. Then, it explores the effect that the Internet has had on the public domain for information. The last section explains how privatization of the Internet may affect the downstream production of public domain information.

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<sup>180</sup> Of course, there are plenty of other important, downstream Internet-dependent public goods, such as collaboration and sharing of R&D among academic and government researchers or the mission-specific goals of government like national security, but academia and the government may be better equipped than individuals – in terms of bargaining power, information, sophistication and resources – to manifest demand for Internet-dependent public goods. Yet the government (and, indirectly, academia) relies to a large extent on the political process to recognize and support public goods that society desires. This complicated wrinkle is left for future work. The point here is that academia and government have their scopes set on public goods applications, and that, ignoring congestion problems (see discussion *supra* Part III.B), their bargaining power, experience, information, sophistication and resources (relative to individuals) may lead to a reasonable approximation of social demand generated from those applications. In fact, in an analysis of Internet-related legislation during the 1990s, Yochai Benkler concludes that one aspect of government regulatory efforts “involves harnessing the Net to enhance fulfillment of traditional government roles, like providing education or facilitating democratic participation. In some cases, the utilization of the technology may do nothing more than make more efficient that which already is. In others, it may actually affect the nature of the government function, as one might hope or suggest would be the case with significant enhancement of opportunities for citizen response and input into government processes.” Yochai Benkler, *Net Regulation: Taking Stock and Looking Forward*, 71 U. COLO. L. REV. 1203 (2000). One important limitation to this point, however, is the process by which government manifests demand, the procurement process. The procurement process may be an inefficient and inaccurate way for the government to purchase rapidly evolving technologies. This additional complication is also left for future work.

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### A. *Public Domain for Information*

Before exploring the public domain and the Internet, it is helpful to first consider what the public domain is. The public domain is a form of social infrastructure, an open-access management or governance regime for resources,<sup>181</sup> that is socially constructed from customs, norms, rules, laws, etc.<sup>182</sup> Resources that “fall within” the public domain, and thus are “governed by” an open-access regime, are openly available to the public without restriction; no one lays claim to such resources – not the government or private parties. Everyone is “equally privileged” to use the resource.<sup>183</sup> Resources within the public domain are often appropriated (or removed from the public domain) by the attachment or imposition of claims/rights – whether by government or private parties – that displace the open-access regime with an alternative management infrastructure.<sup>184</sup> For example, intellectual property laws may be seen as

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<sup>181</sup> It is difficult to separate conceptually the public domain as a management regime from the resources that it governs. In this vein, the public domain is often thought of as the agglomeration of intangible resources governed by an open-access regime. I will maintain the distinction (or conceptual separation) because, as I see it, the management regime for a resource is a *changeable* social construction that generally facilitates or inhibits exclusion, presumably to further socially desired purposes. Yet the underlying nature of the resource itself does not change; for example, this article is a public good, before and after its copyright expires.

<sup>182</sup> In addition to acting as an input into the production of downstream public goods such as information, the Internet also acts as an input into the development of the public domain as a form of social infrastructure. For a discussion, see BOLLIER, *supra* note 92 (discussing gift economies online).

<sup>183</sup> Benkler, *supra* note 131, at 360.

<sup>184</sup> “The general rule of law is, that the noblest of human productions – knowledge, truths ascertained, conceptions, and ideas – become, after voluntary communication to others, free as the air to common use. Upon these incorporeal productions the attribute of property is continued after such communication only in certain classes of cases where public policy has seemed to demand it.” *International News Serv. v. Associated Press*, 248 U.S. 215, 250 (1918) (Brandeis, J., dissenting) quoted and significantly expanded upon in Benkler, *supra* note 131. See also Yochai Benkler, *Constitutional Bounds of Database Protection: The Role of Judicial Review in the Creation and Definition of Private Rights in Information*, 15 BERKELEY TECH. L.J. 535 (2000) (discussing constitutional limitations on the federal government’s ability to “enclose” information with private rights and thereby remove the information from the public domain); Robert C. Denicola, *Freedom to Copy*, 108 YALE L.J. 1661, 1684-86 (1999). I will not venture

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a social infrastructure that temporarily displaces an open-access regime with a private property regime for certain classes of intangible resources, while leaving the remainder in the public domain.<sup>185</sup>

The “public domain for information” refers to the agglomeration of intangible resources – culture, expression, facts, ideas, information, etc. – that are governed by an open access regime.<sup>186</sup> Thus, copyrighted material is generally not included because it is not governed by open access principles; the material has been removed (for a limited duration) from the open access regime of the public domain and is subject to the restricted or limited access regime of copyright.<sup>187</sup> However, fair use, the first sale doctrine and other limitations within the copyright law restrict the range and scope of access restrictions, and allow for public access for certain uses.<sup>188</sup> In a sense, these doctrinal limitations delineate a pseudo-public domain, which will be folded into the public domain for the

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into a First Amendment analysis in this section. It should suffice to say (for the purposes of this article) that the First Amendment is generally directed at maintaining a public domain infrastructure for information by limiting government enclosure of information and government restriction of communications. *See generally* Benkler’s articles *supra* notes 92, 131, 180.

<sup>185</sup> *See* Benkler, *supra* note 184; Reichman & Samuelson, *supra* note 128; Denicola, *supra* note 184, at 1684-86. In addition, the government may directly manage resources that would otherwise fall within the public domain, such as natural resources.

<sup>186</sup> Note that the intangible resources themselves are public goods, irrespective of the management regime.

<sup>187</sup> Yochai Benkler presents a broader “functional definition” of the public domain – “the range of uses of information that any person is privileged to make absent individualized facts that make a particular use by a particular person unprivileged.” Benkler, *supra* note 131, at 362. Thus, he includes uses of copyrighted material protected by fair use in the public domain, coupling the resource (information) with the manner in which it is consumed/used. As a symmetrical counterpart to the public domain, Professor Benkler defines the “enclosed domain” as “the range of uses of information to which someone has an exclusive right,” *e.g.*, through copyright. *Id.* He finds that the public domain is the “legal space” occupied or protected by the First Amendment and explores the conflicts that arise between the First Amendment and copyright. *See id.*

<sup>188</sup> *See e.g.*, Jessica Litman, *Reforming Information Law in Copyright’s Image*, 22 U. DAYTON L. REV. 587, 600-02 (1997) (discussing limitations).

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purposes of this article.<sup>189</sup> Enclosed information, such as copyrighted material, can be released to the public domain when all restrictions are relaxed and open access is allowed. Thus, government-owned information is generally not within the public domain unless actually released to the public.<sup>190</sup>

The public domain for information is an incredibly important public resource that stimulates the creative and productive faculties of society, satisfies the human desire to consume and integrate information, facilitates cooperation and the evolution of community, and generally fulfills our human experience. Retaining the open access regime as the “default rule” for information<sup>191</sup> allows for widespread dissemination and use at no cost, except for peripheral costs such as distribution costs. This rule is “economically efficient,” at least from a static, *ex post* perspective, because information is nonrivalrously consumed.<sup>192</sup> In other words, placing information in the public domain allows it to retain its public goods characteristics. Getting beyond the economics, a robust public domain for information is crucial for the growth of a well-educated public and for its constituents to make deliberate, informed decisions, both in the marketplace and in the democratic process. Much like the model of the Internet presented in Figure 1, information acts as an input into a wide range of downstream applications, including the production of additional information.<sup>193</sup> The dynamicism of information being used to produce information is unconstrained by the public domain infrastructure.

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<sup>189</sup> *Cf. supra* note 187.

<sup>190</sup> Copyrighted material that is “released to the public,” *i.e.*, copyrights are not exercised, may fall similarly within the public domain.

<sup>191</sup> Arguably, the First Amendment sets the default rule. *See supra* notes 184-185 and sources cite therein.

<sup>192</sup> Once information is produced, managing it with an open access regime is optimal. However, production of information would then be suboptimal if society relies entirely on market actors; direct government production or subsidization may be necessary, or an alternative management regime, such as intellectual property, may be necessary, depending on the type (or class) of information. *See Frischmann, supra* note 88.

<sup>193</sup> I have explored this model elsewhere. *See Frischmann, supra* note 88.

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### B. *The Public Domain for Information and the Internet*

The Internet allows users to construct and tap into a wealth of publicly accessible information at considerably lower (distribution) costs than previously known, a virtual “cornucopia of free information.”<sup>194</sup> While the public domain for information itself places no restrictions on access and (in theory) promotes widespread dissemination and use, the distribution costs may be stifling. On one hand, information must be placed in an accessible medium, for example, in print, on video, etc. On the other hand, end-users must search, find and evaluate the information. Although a gross simplification of the distribution process, these two steps may entail significant costs that the information creator, provider and end-user must bear. The Internet – of course, coupled with computer and communications equipment – has enabled individuals to play an ever increasing role as distributor (by lowering the costs of placing information in a publicly accessible medium) and has made searching the public domain more amenable to individuals.<sup>195</sup>

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<sup>194</sup> Mark S. Nadel, *The First Amendment’s Limitations on the Use of Internet Filtering in Public and School Libraries: What Content Can Librarians Exclude?* 78 TEX. L. REV. 1117, 1118 (2000).

<sup>195</sup> While my focus in this section is on individuals, I must note that the public domain for information is affected by the Internet along a number of other important dimensions, particularly where traditional contributors and users of the public domain are involved. For example, academic researchers increasingly utilize the Internet to publish their work and government agencies increasingly make information publicly accessible on the Internet. See Harvey Blume, *Open Science Online*, THE AMERICAN PROSPECT, Mar. 27, 2000, at 44; Judith Axler Turner, *PubMed Central: A Good Idea*, 5 J. OF ELECTRONIC PUBLISHING, Issue 3 (Mar. 2000) <<http://www.press.umich.edu/jep/05-03/turner0503.html>> (discussing the National Institute of Health’s PubMed Central project for electronically publishing peer-reviewed articles); Adrian Alexander & Marilu Goodyear, *Changing the Role of Research Libraries in Scholarly Communication*, 5 J. OF ELECTRONIC PUBLISHING, Issue 3 (Mar. 2000) <<http://www.press.umich.edu/jep/05-03/alexander.html>> (discussing the BioOne project for electronically publishing scholastic articles); *E-conomic Publishing*, THE ECONOMIST, Aug. 5, 2000, at 69 (discussing electronic journals for economics). There are numerous online working paper archives, e.g., the Social Science Research Network at [www.ssrn.com](http://www.ssrn.com), and online journals. Moreover, as the *Economist* stated recently, increased access to information through the Internet may help “to make markets work more efficiently.” *Elementary, My Dear Watson*, THE ECONOMIST, Sept. 3, 2000, at 8. Markets may move “closer to the textbook model of competition, which assumes abundant information, many buyers and sellers, zero transaction costs and no barriers to entry.” *Id.* Finally, the Internet may

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Individuals contribute to the public domain in numerous ways on the Internet. Individuals may create and then disseminate information – commentary, opinions, ideas, creative expressions, music, art, etc. – or they may post “historic documents, classic literary texts, technical information, and other work [already] in the public domain” that would not otherwise be cheaply accessible.<sup>196</sup> Participation in the array of community forums on the Internet, discussed below, generates public domain information; bulletin boards and chat rooms, for example, simultaneously facilitate the creation and the dissemination of public domain information.<sup>197</sup>

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influence social infrastructures in a fashion that promotes sharing of information and collaboration among a broader set of individuals, creating an expanded community. *See* BOLLIER, *supra* note 92 (discussing gift economies on the Internet). These dynamics are perhaps most evident in the scientific fields where information sharing and collaboration among scientists worldwide has thrived online. *See, e.g.*, James Glanz, *The World of Science Becomes a Global Village: Archive Opens a New Realm of Research*, N.Y. TIMES, May 1, 2001, at D1.

<sup>196</sup> Paul Starr, *The Electronic Commons*, THE AMERICAN PROSPECT, Mar. 27, 2000, at 30. Professor Starr delineates four areas of the public domain – the legal public domain, the commercial public domain, the nonprofit public domain and the illegal public domain – that are primarily based on what entity has control over the information. *See id.* Individuals may also distribute materials that were not in the public domain, such as copyrighted material, and essentially put the materials in a de facto public domain created by emerging Internet technologies. *See, e.g.*, A&M Records, Inc. v. Napster, Inc., 239 F.3d 1004 (9<sup>th</sup> Cir. 2001). Of course, the debate surrounding Napster and its progeny centers on whether or not file sharing over the Internet constitutes copyright infringement, which would imply a shift from proprietary to public domain management, or fair use, which would imply that the material was in a pseudo-public domain to begin with. *See supra* notes 188-190 and accompanying text (discussing fair use and the pseudo-public domain). Although a very interesting topic, the file sharing issue is beyond the scope of this article. For an interesting discussion, see Maggie A. Lange, *Digital Music Distribution Technologies Challenge Copyright Law*, 45 B.B.J. 14 (Mar./Apr. 2001); Blaine C. Kimrey, *Amateur Guitar Player's Lament II: A Critique of A&M Records, Inc. v. Napster, Inc. and a Clarion Call for Copyright Harmony in Cyberspace*, 20 Rev. Litig. 309 (Spring 2001).

<sup>197</sup> “Political thought and discourse would not be filtered through powerful, centralized organizations that control access to the national media because, at least theoretically, the Internet ‘gives all candidates, coalitions, and citizens the same public forum to make their voices heard, to become their own publishers and broadcasters, and to air their personal positions on public issues.’” Ryan P. Winkler, Note, *Preserving the Potential for Politics Online: The Internet's Challenge to Federal Election Law*, 84 MINN. L. REV. 1867,

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It is debatable whether removing distribution barriers and opening the information floodgates via the Internet is continuously improving the public domain. It is clear that both the quantity and diversity of publicly available information have grown and that access to an expanding public domain has also grown. However, the search for particularized information may be made more difficult given the expansive sea of information to sort through. Nonetheless, the overall net effect intuitively seems to be a clear improvement to date. An assessment along these lines is impossible without focusing on a particular class of information and the demands of its end-users.

An “improved public domain” is context dependent, varying for academics, consumers, citizens, children, and other classes of users. For example, the peer-review function traditionally provided by journal publishers may be essential to the integrity of academic research and may need to be implemented for electronic journals to gain acceptance, but the filtering process engaged in by the recording industry may be less essential – the public may benefit more from increased access to a wider array of music over the Internet than it suffers from having to perform additional filtering and sorting. The gatekeeping function of many information middlemen has been challenged by the Internet;<sup>198</sup> the Internet allows individuals to contribute to the public domain, to be producers and suppliers of information, and thus to occupy the middle tier position that is shaded in Figure 2.

The Internet also vastly improves the individual’s position as a consumer or end-user of information in the public domain because of the cost reductions passed on through other information producers and suppliers – e.g., commercial, government, individual, and nonprofit information providers. While the average individual gains access to

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1896-97 (2000) (quoting Gary W. Selnow, *ELECTRONIC WHISTLE-STOPS: THE IMPACT OF THE INTERNET ON AMERICAN POLITICS* 107 (1998)).

<sup>198</sup> See e.g., Eric Schlachter, *Cyberspace, the Free Market and the Free Marketplace of Ideas: Recognizing Legal Differences in Computer Bulletin Board Functions*, 16 *HASTINGS COMM/ENT L.J.* 87 (1994).



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considerably more public domain information,<sup>199</sup> there is also hope that a greater number of individuals will gain access through the Internet to the expansive public domain.<sup>200</sup> Computer-driven searching and sorting also reduces costs and expands the reach of individuals. These downstream effects stimulate an expansion in social demand for the Internet that may be under-represented in the market.

### *C. How Privatization of the Internet Affects Downstream Production of Internet-Dependent Public Goods*

The preceding section demonstrated how individuals use the Internet to create, enhance and utilize the public domain for information.<sup>201</sup> Individuals are *Internet consumers/buyers, public goods*

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<sup>199</sup> The Internet has “vastly increased the amount of information available to the ordinary person, who now has access to millions of public documents, academic papers, think-tank reports, scientific studies and political speeches which in pre-Internet days (a mere five or six years ago) only small number of people could easily obtain.” *Web Phobia*, THE ECONOMIST, Mar. 24, 2001, at 99.

<sup>200</sup> See sources cited supra note 166; James L. Esposito, Comment, *Virtual Freedom—Physical Confinement: An Analysis of Prisoner Use of the Internet*, 26 NEW ENG. J. ON CRIM. & CIV. CONFINEMENT 39 (2000) (discussing prisoners’ use of the Internet to communicate with the public).

<sup>201</sup> Another example of an Internet-dependent public good is the community forum for communication. The Internet has and will continue to stimulate the evolution of human communication, exchange and interaction – the evolution of *community*. Whether analyzed as forums distinct from the real world – virtual communities in cyberspace, or as blossoming forums integrated into our real world communities, the community forums that depend upon the Internet have grown increasingly vital to the public. As the commentary on “virtual communities,” Internet forums, etc. is quite extensive, this note simply aims to illustrate the social value and demand for these forums and the simultaneous roles that individuals play as contributors to and consumers of community forums. For an overview, see *Communities Virtual and Real: Social and Political Dynamics in Cyberspace*, 112 HARV. L. REV. 1586 (1999); see sources cited in *id.* Community forums take many forms on the Internet depending upon factors such as the means of communication – for example, email vs. chat room; the type of interactions – for example, deliberation, discussion, exchange, transaction; the subject matter or content involved; and the community norms – for example, whether the forum is open or closed. A taxonomy of community forums could be developed based on any number of unifying themes. See generally *id.* The particular applications available to Internet users expand the interactive possibilities along numerous dimensions, e.g., cost, geographic reach, identity, topic, etc. “Internet technology enables people to ‘meet, and talk, and live in cyberspace in ways not possible in real-space.’ It permits ‘many-to-many

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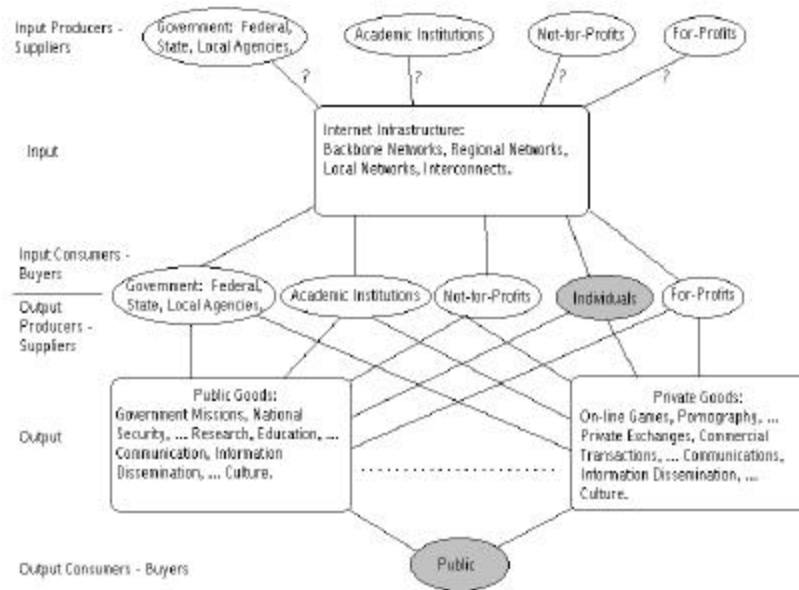
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*producers/suppliers* and *public goods consumers/buyers* (see Figure 2 below, shaded areas). Individuals' willingness to pay for Internet services corresponds to the individual benefits they receive – as a consumer/buyer of the full range of Internet-dependent outputs. As noted earlier, individuals are *less likely* to take into account either the positive network and public goods externalities or the negative congestion externalities associated with their consumption/purchasing decisions – they are less likely to also take into account their role as public goods producers/suppliers when paying for Internet services. Thus, while this seems to be a demand-side failure, it becomes more complicated – both demand- and supply-sided – when individuals are simultaneously consuming and producing Internet-dependent goods.

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communication' unattainable with past technologies, which enabled only one-to-one or broadcast communication." *Id.* at 1586, quoting Lawrence Lessig, *The Path of Cyberlaw*, 104 YALE L.J. 1743, 1746 (1995) and Jonathan Zittrain, *The Rise and Fall of Sysopdom*, 10 HARV. J.L. & TECH. 495, 497 (1997). Moreover, the costs of finding and participating in a desirable forum are reduced by the Internet, enhancing the capacity of individuals to act collectively in forming, contributing to and using community forums. *Cf. supra* discussion concerning individuals' capacity to contribute to and utilize the public domain. Interestingly, participation is simultaneously an act of consumption and production; an individual realizes personal benefits through their participation and also confers benefits to other participants. Of course, as in the real world, these interactions may in fact be costly, for example, in the case of fraud. Ultimately, an analysis of whether the Internet has improved community forums depends on particular forums and the demands of community members (or end-users). The Internet may have expanded the number and diversity of community forums available to the public, but there may be a dilution in quality or an overabundance of wasteful forums. Nonetheless, it is clear that the Internet facilitates the sort of collective action necessary for public forums and that individuals, in particular, are empowered.

**Figure 2.**



A privatized (and commercialized) Internet may stifle downstream production of public goods, particularly by individuals. On one hand, downstream producers can be expected to underinvest in public goods production; absent subsidization, they may be unwilling or unable to pay market rates for Internet service. Correspondingly, upstream Internet producers/suppliers can be expected to underinvest in Internet infrastructure. The price and profit incentive dynamics of the market do not fully capture social demand for the Internet. On the other hand, reliance on upstream market provision may lead to a skewing or prioritization favoring commercial applications. Whether by vertical integration (or other vertical relationships between upstream and downstream commercial entities), the usage-based pricing response to congestion – which may externalize congestion-related costs to those Internet users with less ability to pay,<sup>202</sup> or other similar dynamics,

<sup>202</sup> See *supra* Part III.

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market forces may “squeeze out” important public interests that depend upon the Internet.<sup>203</sup>

### V. CONCLUSIONS

It is important to realize that the Internet infrastructure is a social construction that is not inherently a public good or a private good; ultimately, its nature depends on the manner in which it is designed, managed and operated.<sup>204</sup> In other words, it can be designed, managed and operated to be consumed nonrivalrously or rivalrously, and to be nonexclusionary or exclusionary. On one hand, the universally accepted goal arguably has been to minimize rivalrous consumption (congestion), although the tremendous growth in users and uses makes this extremely difficult in the absence of significant and recurring upgrades. On the other hand, the end-to-end design and open interconnection policies of the Internet, to a large extent, have maintained the nonexclusionary nature of the Internet infrastructure. Thus, for the most part, the infrastructure itself has been designed, managed and operated as a public good. Importantly, this result may simply be a remnant of the government’s earlier efforts with the NSFNET and may be at risk during future upgrades controlled by commercial entities.

The Internet infrastructure will undergo recurring upgrades. During the upgrade process, the design, management, operation and objectives of the Internet infrastructure are susceptible to major shifts in direction. For example, in the past, upgrades to the NSFNET coincided with important shifts in the management, operation and underlying objectives of the interconnection infrastructure. The public goods objectives that originally motivated the transition from the ARPANET to the NSFNET gradually became secondary to commercial objectives that emerged during subsequent upgrades. While the Internet we know today allows many end-users to collectively participate in the production of a wide range of public goods, future upgrades may jeopardize this dynamic. As a recent article in the *Economist* observed, “[t]he Internet is

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<sup>203</sup> For an excellent discussion of these dynamics – between market economies and gift economies and commons – in a number of policy settings, see BOLLIER, *supra* note 92.

<sup>204</sup> See LESSIG, *supra* note 7, ch. 3.

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like an overloaded highway that needs to be upgraded. But if done badly, the Internet's ability to support innovative, as-yet unimagined applications could be in jeopardy."<sup>205</sup> While we certainly should be concerned with the fate of "unimagined applications," the same rationale applies with even greater force to the fate of many existing public goods applications that thrive on the Internet.

Finally, society should question the common assumption that handing off publicly developed resources and technologies to industry is always in the public's best interest and to reevaluate the momentum towards deregulation, privatization and commercialization. Market actors have contributed immensely to the evolution of the Internet in terms of investment, products, services, and infrastructure, and the government's light-handed approach to regulation has given producers and consumers substantial freedom to innovate and to self-regulate with respect to many issues affecting the Internet community in ways that have produced substantial social benefits. Nonetheless, even if the market were to perform perfectly, it still would undersupply society with Internet interconnection infrastructure over the long-run because market demand for the Internet is only some fraction of social demand. Imperfections in the market may accentuate the market's failure to meet social demand (if the imperfections result in undersupply) or they may temper the market's failure (if the imperfections result in oversupply). Nonetheless, there appears to be a reasonable justification for government provision or subsidization of Internet interconnection infrastructure. Government provision of public and private interconnects may be necessary for the following well-understood reasons: network interconnects can cost a lot to build and maintain (depending on their scale), offer valuable services to both networks and their end-users, and are susceptible to free-riding (on the fixed investment to build the interconnect), overexploitation (congestion), and anti-competitive conduct (collusion, refusals to deal, etc.). In addition to these justifications, there are important public goods applications dependent upon the Internet that will be under-supplied with required interconnection infrastructure, whether due to congestion or pricing/valuation difficulties, unless government takes an active role in

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<sup>205</sup> *Upgrading the Internet*, *supra* note 89, at 32.

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ensuring their provision.