

**Toward a New Definition of Infrastructure**

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**Toward a New Definition of Infrastructure**  
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"Infrastructure," like "universal service," is a catch-phrase that telecommunications policy specialists have imbued with a variety of meanings, almost none of them self-evident. Perhaps the most prevalent vision of telecommunications infrastructure is based on the assumption that, as the rapid transmission and processing of information becomes increasingly important to U.S. consumers and businesses, telecommunications itself is an essential component of this society. But this conventional wisdom poses more questions than it answers. For example, what attributes of telecommunications are, in fact, "essential" to society? And what does "telecommunications" mean, to begin with? It is common for telecommunications policy analysis to begin by defining the term "infrastructure" in order to frame an answer to these questions.

The National Telecommunications and Information Administration (NTIA), with which we are associated, has grappled with these issues over the past four years. The focus of NTIA's interest has been on using the infrastructure concept as a vehicle for analyzing telecommunications policy options. It is worthwhile to examine

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<sup>1</sup> The authors are employed by the National Telecommunications and Information Administration, U.S. Department of Commerce, Washington, D.C. The views expressed in this paper are solely those of the authors and do not necessarily represent the views of NTIA, the U.S. Department of Commerce, or any other employees thereof. We would like to thank James McConaughy for his input on this paper.

NTIA's treatment of the "infrastructure" concept in conjunction with other recent thinking on the significance of different infrastructure definitions, as a way of refining the basis for further policy discussion.

Telecommunications in the Age of Information: NTIA's Infrastructure Definition and Alternatives

In October 1991, NTIA released a policy report that considered the state and future direction of the U.S. telecommunications system - what is commonly referred to as the "infrastructure."<sup>2</sup> The report reflected NTIA's analysis of approximately 10,000 pages of comments from telecommunications users, regulators, industry, and academics, in an effort to examine government's role in promoting the best and most affordable telecommunications system for the American public.

As one may suspect, the numerous public comments filed with NTIA on this topic provided a variety of means of defining infrastructure. After considering these comments, NTIA defined the "telecommunications infrastructure" for purposes of its analysis as the collection of facilities and serving arrangements that are used to provide point-to-point, two-way transmission of information of

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<sup>2</sup> See National Telecommunications and Information Administration, U.S. Dep't of Commerce, The NTIA Infrastructure Report: Telecommunications in the Age of Information, NTIA Special Pub. 91-26, Chapter 2 (October 1991) (Infrastructure Report).

the user's choosing.<sup>3</sup> This definition was controversial. Some groups expressed concern that such a definition excluded specific important industries, such as some parts of the mass media.<sup>4</sup> Moreover, parties also expressed concern that this definition signalled support for a particular technological deployment strategy, s.g., the public switched network vis-a-vis alternative systems such as area networks (MANs, LANs), cellular radio, satellites, and private networks.<sup>5</sup> In short, commenters raised the issue of how a particular definition of telecommunications infrastructure could affect the outcome of the report's findings and recommendations.

Recent work by Dr. Carl Danner suggests that different definitions for infrastructure can in some circumstances lead to different policy prescriptions.<sup>6</sup> Danner proposes three different definitional starting points for considering this issue:

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<sup>3</sup> See id. at 14, 17.

<sup>4</sup> Id. at 14-15. As NTIA stated in the Infrastructure Report, practical limitations coupled with the differing regulations and market environments prompted the focus on telecommunications. Id. at 15-16.

<sup>5</sup> Id. at 17. Although the Infrastructure Report recognizes the importance of these alternative systems, it particularly concentrated on the local public switched network because of extensive regulation and the unique issues that the network raises, such as universal service. Id. at 18.

<sup>6</sup> See C. Danner, "Infrastructure" and the Telephone Network: Defining the Problem, Incidental Paper, Harvard Program on Information Resources Policy, at 1 (July 1992) (Danner).

infrastructure as inventory, the industry as a public good, and the industry as a ubiquitous input. He argues that these different formulations may lead to different policy prescriptions. This paper will test Danner's framework against the concepts of infrastructure and the resulting findings and recommendations presented in the Infrastructure Report.

NTIA's facilities-based definition is derived from general concepts of infrastructure as a nation's stock of physical capital, used to provide the underlying foundation for private sector activities or essential services.<sup>7</sup> Such a facilities-based definition would be considered under Danner's framework as "infrastructure as inventory." Danner's definition of "inventory" generally focuses on the attributes of fixed capital investment available to serve the demands of an industry. Those attributes often include capacity, age, cost, and performance.<sup>8</sup>

Danner also discusses infrastructure as a public good -- a good that "if [it] is supplied at all, excluding potential customers

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<sup>7</sup> See Fox, Public Infrastructure as Economic Development, in U.S. Dep't of Agriculture, Rural Economic Development in the 1980's: Prospects for the Future, Research Report No. 69, at 282 (Sept. 1988). See also J. Gwartney & R. Stroup, Economics: Private and Public Choice 768 (4th ed. 1987) (infrastructure is the "provision of a legal, monetary, educational, transportation, and communication structure necessary for efficient operation of an exchange economy.").

<sup>8</sup> See Danner, supra note 6, at 2.

from using it is either impossible or impractical."<sup>9</sup> Although telecommunications is not a "pure" public good,<sup>10</sup> it arguably shares some characteristics attributable to public goods. For example, some employ an externality argument to contend that the value of the network increases with each additional telephone subscriber, which benefits society at large. NTIA's treatment of telecommunications infrastructure as one in which additional use can often increase its benefits to society<sup>11</sup> is consistent with this notion.

Danner also notes that infrastructure can be defined in terms of the industry as a ubiquitous input, which, in turn, is based on the assumed importance of telecommunications to a wide array of other industries.<sup>12</sup> The Infrastructure Report touches on this aspect of infrastructure by discussing the critical role of telecommunications in promoting economic development, and permitting U.S.-based firms to operate efficiently and effectively in the global marketplace.<sup>13</sup>

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<sup>9</sup> See id. at 4.

<sup>10</sup> For example, telecommunications is not a "commodity" which if supplied to one person can be made available to others at no cost.

<sup>11</sup> See Infrastructure Report, supra note 2, at 21-34 (use by businesses), 292 (residential service).

<sup>12</sup> See Danner, supra note 6, at 6.

<sup>13</sup> See Infrastructure Report, esp. Chapters 3 and 5.

Redefining Infrastructure: Facilities versus Services

Although aspects of all three of Danner's infrastructure formulations appear throughout the Infrastructure Report, that report expressly uses a facilities-based definition as its starting point, which seems closely related to an inventory model. This can also be considered as a "technically-oriented" definition -- at least with respect to telecommunication systems, the emphasis can be on relatively tangible units, such as the number and age of switches or transmission equipment. However, careful selection of such units is necessary for them to have relevance for policy analysis. NTIA has found this to be true especially in attempting to compare the stock of U.S. telecommunications facilities with those of other countries. A major issue in those comparisons was the treatment of private networks, which are more widely available in the United States than in any other country. NTIA decided to exclude private networks from such comparisons because of the lack of available comparative data on such networks. This could well understate the telecommunications resources available in the United States relative to those of other countries. More generally, there are major difficulties in obtaining timely data for intercountry comparisons of facilities and performance characteristics. Thus, readers of the section of NTIA's report on international comparisons have been treated to a feast of caveats and qualifications.<sup>14</sup>

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<sup>14</sup> See id. at 141-195 and App. D.

An alternative definition of infrastructure could be based on services, rather than facilities. Such a definition could include the cumulative product offerings that facilitate data, voice, and video dissemination for point-to-point public communications -- essentially, "what users need." A services-based definition would seem to include aspects of both the "ubiquitous input" model (since services are the "output" of the telecommunications industry) and the "public good" model, particularly when considering the pricing and cost issues associated with the provision of universal residential telephone services.

But would such an alternative definition matter? Would a services-based definition for infrastructure tend to lead to policy recommendations that, for example, differ from those based on a facilities inventory?

According to Danner, analyses based on different concepts of infrastructure can lead to conflicting policy recommendations.<sup>15</sup> In comparing the cases of infrastructure as a public good and as a ubiquitous input, for example, Danner notes that policy conflicts may arise concerning the practicality of external funding (which may be of great importance for appropriate output of a public good) versus emphasizing market demands as a means of ensuring appropriate levels of output (which is of interest if a ubiquitous input model is used). We now contrast the implications of using a

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<sup>15</sup> See Danner, supra note 6, at 7.



facilities-based versus a services-based definition in the Infrastructure Report.

The Effects of Using a Facilities-based Definition

The Infrastructure Report employed its facilities-based definition in detailed discussions of technological trends, as well as the international comparisons mentioned above.<sup>16</sup>

One pitfall that NTIA recognized and sought to avoid was the potential temptation to progress from a facilities-based starting point to policy recommendations based solely on the quantity and quality of those facilities.<sup>17</sup> Commenters alerted the agency to this possibility by stressing their opposition to proposals to deploy particular technologies, like fiber optics, according to government-mandated deadlines, or to adopt policies that seek to "match" purported technological progress in other countries.

Instead, NTIA's policy recommendations stem from a fundamental proposition that competition in the provision of telecommunications services can, with limited exceptions, determine the "best" -- most efficient -- levels of technological development and facilities deployment. This proposition, on its face, does not depend on a facilities-based definition. Indeed, it relies on competition in

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<sup>16</sup> See Infrastructure Report, supra note 2, Chapters 4 and 5.

<sup>17</sup> See Danner, supra note 6, at 2.

the provision of services to allocate resources and determine the proper level of investment in telecommunications facilities. Why, then, not a services-based infrastructure definition?

#### The Effects of Using a Services-Based Definition

One difficulty that researchers face in using a services-based starting point for policy analysis is that useful data about the quality and quantity of service available in the United States is difficult to collect and even more difficult to analyze. Greater study of the substitutability of various types of service offerings and also of the best measures of performance of various types of services would be an area for further research. Regulatory agencies have increasingly grappled with these types of problems, with mixed success.<sup>18</sup> On the federal level, the Federal Communications Commission has been performing such analyses in attempting to develop policies to govern AT&T's Tariff 12 offerings,<sup>19</sup> in attempting to develop tariffing policies for

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<sup>18</sup> Although massive amounts of tariff data for various regulated services are available in state and federal agencies, that data is difficult to use, let alone gather, for many of the policy analyses of interest to researchers.

<sup>19</sup> AT&T Communications Revisions to Tariff F.C.C. No. 12, 4 FCC Rcd 4932, recon. denied, 4 FCC Rcd 7928 (1989), remanded sub nom. MCI Telecommunications Corp. v. FCC 917 F.2d 30 (D.C. Cir. 1990), AT&T Communications Revision to Tariff FCC No. 12, Memorandum Opinion & Order on Remand, 6 FCC Rcd 7039 (1991), appeal pending sub nom. Competitive Telecommunications Ass'n v. FCC, No. 92-1013 (D.C. Cir. 1990).

switched and special access services<sup>20</sup> and, in a broad sense, in its Open Network Architecture (ONA) proceedings.<sup>21</sup> Definitional problems also arise in determining exactly what is a service: for example, Caller Identification<sup>22</sup> is widely considered to be a service, while Automatic Number Identification, which businesses widely use for many of the same purposes, has been labeled variously as a "function" or "feature" of larger service packages.<sup>23</sup>

These data collection and definitional issues are daunting, and

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<sup>20</sup> See Expanded Interconnection for Interstate Switched Transport and Competitive Switched Access Networks, CC Docket 91-141 (FCC News Release Sept. 17, 1992).

<sup>21</sup> Filing and Review of Open Network Architecture Plans, 4 FCC Rcd 1 (1988), recon., 5 FCC Rcd.3084 (1990). Amendments of Part 69 of the Commission's Rules Relating to the Creation of Access Charge Subelements for Open Network Architecture, 6 FCC Rcd 4524 (1991). It is of note that all of these proceedings involve the tariffing of services either subject to competition or used in the provision of competitive offerings.

<sup>22</sup> The basic caller ID service "permits the recipient of a telephone call (the subscriber to the service) to view the calling party's telephone number via customer-owned display equipment." See Comments of National Telecommunications and Information Administration, Rules and Policies Regarding Calling Number Identification Service, CC Docket No. 91-281 at 1.

<sup>23</sup> Automatic Number Identification (ANI) is a feature provided by local exchange carriers and interexchange carriers, which serves a function similar to Caller ID, but permits the recipient of a telephone call to view a billing telephone number, rather than the calling party's originating phone number. See Rules and Policies Regarding Calling Number Identification Service, Notice of Proposed Rulemaking, CC Docket No. 91-281 at 6753 ¶ 5 (1991).

they can affect a researcher's initial definitional choice. However, emphasis on services rather than facilities in discussing infrastructure can more directly lead to recommendations that consider the "ubiquitous input" and "public good" aspects of telecommunications, both of which are important in gaining a complete picture of the role of telecommunications in society.<sup>24</sup>

Because telecommunications services have become important to the operation of virtually all businesses in the United States, a services-based definition can be viewed as a "ubiquitous input" formulation of infrastructure. Thus, a services-based definition can enable a researcher to focus analysis on the end result of an efficient deployment of telecommunications facilities. Danner suggests that a "ubiquitous input" definition may emphasize the effects of consumer demand of services on the development of or investment in transmission facilities which deliver services to the end-user.<sup>25</sup> The Infrastructure Report's emphasis on market-based policies largely adopts this "demand-pull" approach.

As to the "public good" aspect of a services-based definition, Danner's emphasis on external funding immediately leads to analysis of the degree of such funding necessary to support traditional

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<sup>24</sup> The Infrastructure Report overcame this difficulty by explicitly discussing the use and future of U.S. telecommunications services in conjunction with the facilities that support them.

<sup>25</sup> See Danner, supra note 6, at 6-7.

universal service goals as well as the widespread deployment of advanced voice, data and information services.<sup>26</sup> The area in which this tendency has been most apparent to us concerns the future of "universal service."<sup>27</sup> A spirited debate took place among commenters regarding the appropriate lists of "basic" services that should be universally available. NTIA's approach toward redefining universal service focused, not on such a list, which could become dated quite rapidly, but on the additional costs of providing those services. NTIA proposed that a "basic package" of such services should include all regulated services that can be provided at, or close to, zero marginal cost.

#### Toward a New Definition of Infrastructure

Regardless of the different infrastructure definitions that we have explored, any sound policy analysis must consider both social concerns and economic efficiency. However, as distillations of a researcher's assumptions about the state of the telecommunications industry, such definitions clearly affect the path traveled toward developing recommendations. Accordingly, it is essential that a "redefinition" of infrastructure have multiple facets -- that is, it should include consideration of the models discussed above. For example, the inventory-based model of infrastructure reflected in

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<sup>26</sup> See id. at 7-8.

<sup>27</sup> As Danner notes, as virtually all homes and businesses have access to telephone service, the focus of universal service has shifted to "upgrading the capacity or capabilities of a network." See id. at 5.

NTIA's use of a "facilities" definition acknowledges the need for capital assets to be in place to support the services actually used by customers. Furthermore, the concept of telecommunications as a public good has important implications for recommendations on the adoption of interoperability and interconnection standards for public and private networks. Similarly, thinking of telecommunications as a "ubiquitous input" may best reflect reality if it recognizes, and analyzes the effects of providers offering a variety of services to U.S. industries and individuals.

In the last analysis, the greatest utility of the infrastructure concept may be as a symbol, like the "universal service" term, of the important role of telecommunications in the life of the nation. "New" definitions of infrastructure for future policies can best harness that symbolism by describing all relevant aspects of the telecommunications industry. That will be a dynamic process, as the telecommunications industry itself is redefined by social and economic forces.