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The First 100 Feet: New Options for Internet and Broadband Access

Final Report

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Lewis Branscomb, Deborah Hurley, and James Keller

**Harvard University
Cambridge, MA 02138**

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This project was undertaken to explore new options for connecting homes and small businesses to high-speed communications networks, such as the Internet. Fundamental to this inquiry was an interest in looking at options which are newly enabled through changes in technology and regulation, and which go beyond the traditional top-down, centralized model for local access. In particular, we focused on opportunities for end-user and community-level investment.

The market for high-speed Internet backbone services is maturing rapidly, but in most areas options for extending connectivity to the home are limited and expensive. Very large investment by incumbent communications carriers has until recently been viewed as the necessary step to providing advanced communications services to individuals and small enterprises. This project was intended to investigate the opportunities presented by the decreasing cost of computing and networking platforms, the unbundling of local exchange network elements, and the intelligent endpoints model of networking best exemplified by the Internet. Do these factors, along with communications technologies such as spread spectrum wireless, digital subscriber line services, and the ability to modulate a communications signal over the electric power line infrastructure, enable new models for end-user investment in intelligent infrastructure as a leverage point for accessing the broadband network?

This question was first explored through a two-day conference held at the Freedom Forum in Arlington, Virginia, October 29 and 30, 1996. This conference was convened jointly by the Harvard Information Infrastructure Project, the Freedom Forum, the National Economic Council, and the U.S. Department of Energy. Development of the

workshop, including the review and selection of presented papers was guided by a Steering Committee (Robert Aiken and John Cavallini of the U.S. Department of Energy, Brian Kahin, founding director of the Harvard Information Infrastructure Project (HIIP), and now Senior Policy Advisor for Information Infrastructure at the White House Office of Science and Technology Policy, Tom Kalil of the National Economic Council, James Keller, HIIP Associate Director, Adam Powell of the Freedom Forum, Mary Anne Scott, U.S. Department of Energy, and Steven Rivkin, Attorney). A copy of the workshop call for papers, agenda, and attendee list are attached.

The workshop addressed issues in the consumer adoption of new communications technologies, use of the electric power line infrastructure, the role of municipalities, and the use of alternative technologies, such as XDSL, satellite, spread spectrum wireless, LMDS, and others. The best of these papers have been further developed, with editorial guidance provided by Harvard, and compiled in the form of a book (*The First 100 Feet: New Options for Internet and Broadband Access*, Deborah Hurley and James Keller, eds., MIT Press, 1998) to be published as part of the MIT Press Spring 1998 catalogue. Refinement of the workshop materials into a form suitable for publication took longer than originally anticipated, due to the nascent state of technology and policy development in the subject matter areas covered. A pre-publication copy of the manuscript is provided as an addendum to this report.

The end-user investment model is the model around which Internet connectivity for large institutions has developed. In contrast to traditional telecommunications, the history of the Internet can be described as a case of bottom-up infrastructure investment. Internet technology allows end-users to make their own investments in intelligent

infrastructure as leverage points for accessing the rest of the world. The vast majority of Internet investment is user investment in computers and local networking equipment. The incremental cost that an institution typically pays to connect to the Internet is tiny compared to the investment made in these local resources. The cost of Internet connectivity to a large institution is typically on the order of \$10-15 per user per year. The amortized cost of local computing and communications resources is in excess of \$1,000 per person per year. Extending the bottom-up model to residential and small business users offers an opportunity to explore local access alternatives beyond the traditional view of large centralized investment.

The book resulting from this activity is intended to challenge business and policymakers to rethink fundamental issues in telecommunications policy by recasting the "problem of the last 100 feet" as "opportunities for the first 100 feet." The book surveys alternative options for local connection to the Internet from the perspective of homeowners, apartment owners, small businesses, and others with an interest in investing in end-user equipment and real estate. It considers prospects for broadly distributed infrastructure investment and potential roles for utility companies, municipalities, PCS providers, CAPs, IXCs, and Internet access providers, as well as telcos and cable companies. The book investigates constraints on and incentives for user infrastructure investment at federal, state, and local levels; whether and how unbundling can promote consumer/property owner investment and competition among heterogeneous providers; and the need for and feasibility of interconnection at third-party or publicly maintained neighborhood access points. It looks at synergy with other policy goals and economic interests, such as energy demand management.

This analysis of "the first hundred feet" recognizes that need and demand will naturally vary greatly from home to home and from neighborhood to neighborhood. Much depends on whether there are business or telecommuting needs that can be met by individual investments in upgraded access. While this analysis looks to the Internet, it raises the issue of how the bottom-up model will affect the traditional model of a centrally provided universal service. Given basic technology that is non-proprietary and virtually commoditized, some argue that Internet service is becoming the common denominator platform on which all other services can be carried. If so, it may be that the current universal service model will keep service prices artificially inflated.

The first section of the book explores market issues associated with bottom-up infrastructure development and market demand. The first chapter by Milton Mueller and David Gabel describes issues related to user investment in infrastructure development. This chapter takes an historical perspective, describing the development of rural telephony at the turn of the century. A key difference between this system and today's Internet is the reliance on centralized network intelligence — often in the form of an operator switching calls by hand. On the Internet, connectivity can be managed from intelligent endpoints allowing users to invest independently without the transaction costs of coordination, but requiring greater technological savvy to configure CPE and to interact with various access media.

In the next chapter Branko Gerovac and Dave Carver present a set of criteria for evaluating infrastructure development options. This includes both traditional factors related to technology architecture, as well as business and policy criteria. These criteria are applied to a series of deployment scenarios, ranging from top-down fiber to the home

investment to a scaleable, peer to peer microcellular model. The last chapter in this section by John Carey describes adoption patterns for new technology as further background for understanding issues in the deployment of new types of Internet access. Carey explores the price patterns and penetration rates for each of the major innovations in information and communications. Carey presents a set of lessons drawn from these other technology areas to evaluate the potential for adoption of new access technologies.

The second section of the book looks at a variety of models for bottom-up investment in the first 100 feet. In each case, these are models that look beyond the traditional telecommunications network infrastructure to leverage new technical opportunities. Solutions explored include spread spectrum wireless, satellite, and the use of electric power networks.

In Chapter 4, "The Local Wireless Option," Dave Hughes describes license-free spread spectrum radio frequency as a low-cost, scaleable access solution. The spread spectrum model is very much counter to the traditional telecommunications services model, where, as in the case of cellular telephony, the equipment is given away and network access is sold at a premium. With spread spectrum, wireless radio receiver/transmitters are sold and the spectrum is free, perhaps the ultimate in bottom-up investment. Radios are currently in the \$2,000+ range, but sub-\$500 radios are now in development. Even at the higher rate, the radio costs less than several months of comparable speed access. The following chapter by Beyer, Vestrich and Garcia-Luna-Aceves takes the spread spectrum model a step further, describing how it can be deployed to create roof-top community networks which leverage Internet connectivity throughout a

neighborhood. This model brings the same type of scale economies that have benefit universities and large organizations to networks of homes and small businesses.

Michael Propp explores the use of electric power lines for data communications. Propp describes how a communications signal can be modulated over existing power line infrastructure. This includes an overview of existing applications in Europe and opportunities for future deployment. Markets already exist for communications applications such as energy demand management, which can help justify the investment required to upgrade the grid for data communications.

The last set of options presented are satellite broadband, described by Brian Vu. Vu describes the various satellite proposals and evaluates them relative to one another and to existing terrestrial services. He also describes the regulatory hurdles these systems will face.

The final section of the book describes the opportunities and challenges faced by two non-traditional providers — cities and utilities — in becoming providers of telecommunications services. This includes the institutional and regulatory hurdles that local communities and electric utilities will face in providing solutions to the first 100 feet challenge. The section begins with a chapter by Andrea Johnson describing the role of cities as developers, regulators and users of telecommunications networks. These networks can support city functions, promote economic development, and expand universal access. The chapter pays particular attention to the implications for cities of the Telecommunications Act of 1996.

In chapter 9, Steven Rivkin builds on Propp's description of the ability to modulate a communications signal over a power line, to explore the role for electric utilities as

providers of communications services. Rivkin describes the shared histories of the communications and electric power industries and the implications of current regulatory change and market development in each industry to conclude that power companies are well-positioned to play an important role as providers of communications services. This story is further elaborated in chapter 10, by Bernice McIntyre. McIntyre provides more detailed background on the changing regulatory environment and the regulatory challenges utilities may face in becoming communications services providers. The chapter provides an overview of initiatives now underway by both public and private utilities to provide communications services and describes the factors that must be considered to ensure fair competition amongst industries governed by different laws and regulations.

The final chapter of the book, "Exploring the Emerging Municipal Infrastructure" (Lon Berquist and August Grant), looks in depth at the experience of cities in developing their own advanced information infrastructure for the benefit of their citizens. The chapter uses the city of Austin, Texas as a case study and using this example, combined with the experience of several other municipalities that have been early movers, presents a set of lessons for the development of municipal infrastructure.

As with many areas of innovation, institutional and policy issues are as critical (and in some ways more so) as issues of technological know-how in advancing the wide-spread availability of affordable high-speed communications services. Spectrum allocation, unbundling requirements, network interconnection policies, and the ability of utilities to adapt to new market opportunities will be important factors in the development of new options for broadband access. It appears that investment in the first 100 feet can become a sound approach to improved local access options, but this opportunity is currently

inhibited by regulatory uncertainty. Despite this, some sophisticated users employ PCs as intelligent endpoints to arbitrage network pricing through Internet telephony and parallel signaling for call set-up. These are low-bandwidth, sub-optimal solutions, but policy development motivated by the first 100 feet model can enable a healthy environment for user investment in intelligent infrastructure.