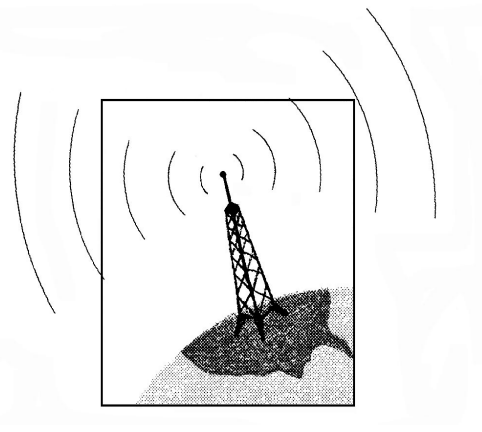# Executive Summary

Over the next five to 10 years, wireless technologies will dramatically reshape the communications and information infrastructure of the United States. New radio–based systems now being developed will use advanced digital technologies to bring a wide array of services to both residential and business users, including ubiquitous mobile telephone and data services and many new forms of video programming. Existing wireless systems, including radio and television broadcasting, cellular telephony, and various satellite and data networks, will also convert to digital technology. This will allow them to improve the quality of their services, expand the number of users they can serve, and offer new information and entertainment applications. Before the benefits of these wireless systems can be realized, however, technical, regulatory, and economic uncertainties must be resolved. This report examines the role wireless communication technologies will play in the evolving National Information Infrastructure (NII), examines the challenges facing policymakers and regulators as wireless becomes a more integral part of the telecommunications and information infrastructure, and identifies some of the longer term implications of the widespread use of wireless systems and services.

BACKGROUND

The public's imagination has been captured by notions of an "information superhighway." Newspaper articles, television advertisements, and technical journals are filled with visions of communication services that allow people to transmit and receive phone calls, computer files, images, and even movies; people working anywhere—at the beach, in their homes, or in their cars; and hundreds of channels of entertainment programming, includ-

ing movies on demand. The foundation for these visions, the technologies that will make them possible, is formally known as the National Information Infrastructure. The NII is conceived as a ubiquitous, interconnected series of telecommunications networks and computer–based services that will allow every home and business in the nation to access a never–before–seen array of advanced communication, information, and entertainment services and applications. Some also see the NII as part of a larger Global Information Infrastructure (GII) that would link the countries of the world in an even wider network.

Wireless technologies will play an important role in realizing these visions. In the past several years, wireless technologies and services have become one of the fastest growing segments of the telecommunications industry. U.S. cellular phone companies add 28,000 customers each day, and in recent years have achieved annual growth rates that, in some cases, surpass 40 percent. The Federal Communications Commission (FCC) recently raised almost $10 billion for the U.S. Treasury from auctions of radio frequencies that will be used to deliver next–generation mobile telephone and data services. Sales of small dishes to receive television programming directly from satellites have been brisk, and large businesses have been installing computer networks connected by satellites to keep track of sales and to deliver interactive employee training.

ADVANTAGES OF WIRELESS TECHNOLOGY

Consumers and businesses have found that wireless technologies have unique capabilities that allow them to do things they either cannot do with wire–based systems, or cannot do efficiently and/or cost–effectively. First and foremost, wireless technologies make mobile communication possible. People can use cellular telephones to make and receive phone calls while they are walking, driving, flying, in a boat, or on a train. They can use computers equipped with radio modems to send and receive data and electronic mail. They can stay connected wherever they are.

Second, radio–based systems can offer more flexible and affordable access to the nation's information/communication resources—not only for mobile users, but also for those who may be tied to a particular location. Wireless technology can extend wire–based (telephone, cable television, and computer network) systems and provide services to people who could not receive them before. Satellites already deliver video—television programs, movies, and special events—directly to homes, and many new systems and services are being developed that could make portable phones and computers as ubiquitous as today's wired phones. Broadcasting technology will continue to be one of the easiest methods for delivering information to large numbers of people over a wide area.

WIRELESS TECHNOLOGIES AND THE NII

In order to realize the benefits these technologies offer, many technical, economic, regulatory, and social issues will have to be addressed as new wireless technologies and systems are integrated into the nation's communication and information infrastructure. For residential and business users, the influx of wireless service alternatives will magnify and intensify the changes brought about by the breakup of the Bell Telephone System in 1984. New entrants will challenge the historical monopolies in local phone and cable television service, offering comparable packages of services at similar or lower prices using satellites or land–based radio towers. In the near future, users will have a dizzying range of services to choose from, but not all systems will be compatible, and moving information between networks may be difficult. Standards that will allow this diverse mix of networks to interoperate are still several years away. As a result, however, confusion may be common as users are confronted with choices unknown in the past.

Rapid technological change, uncertainty about what customers really want and will pay for, and an outdated regulatory structure that is in the process of being overhauled all contribute to a dynamic, but chaotic, marketplace. Despite the "hype"

surrounding new services, many of the systems that get the most attention—personal communications services (PCS) and low–Earth orbiting satellites (LEOs), for example—are not yet operational, although some experiments have been conducted. Technical challenges still exist in deploying new wireless systems, and, as one executive put it: "Much of the Buck Rogers stuff is going to take awhile."[1] Customer demand continues to be unfocused. Service providers believe there is a great untapped demand for wireless—and especially mobile—services, but no one knows exactly what customers want and will be willing to pay for. From a regulatory and economic standpoint, the role of wireless in the NII is similarly unclear. Companies will compete in some markets while cooperating in others, and the structure of the industry and its relation to the wireline network and companies will likely change in response to market forces.

The evolution to a competitive environment will be challenging for the different segments of the wireless industry. Competition for customers in the future NII is expected to be fierce—profit margins are likely to be low, many service providers may not survive, and industry consolidation is likely. Some analysts have questioned whether existing populations can support a plethora of mobile service providers that includes cellular, specialized mobile radio (SMR), paging, PCS, and satellite–delivered communications. The economics (cost structure and demand) of some of these services are poorly understood, and researchers are just beginning to explore systems and services that have not even begun operating.

In part because of these underlying uncertainties, the structure of the industry is likely to be remarkably fluid. Over the next several years, many new companies will enter the various wireless markets—some will fail, some will succeed, and some will be bought up by larger concerns or merge with competitors. This dynamism will be fueled by changing economic conditions, changes in regulation, and technical opportunities for integrating systems and services. Administration policies, legislation now being debated in Congress, and evolving state and local regulations will have an important impact on how competition will develop and the role of wireless technologies in the NII.

IMPLICATIONS AND POLICY ISSUES

As the United States becomes a more mobile and information–intensive society, policymakers and regulators will face a number of challenges in bringing the benefits of wireless and the NII to all potential users. This report identifies a number of issue areas that policymakers should be aware of as the NII develops and wireless technologies become a more integral part of it. In general, given the recent successes of some wireless industry segments, and the nascent state of development in other segments, government action currently is indicated in only a limited number of areas.

- **Universal service.** Wireless technologies can extend service to those who do not have it. Through competition with established providers, they may lower prices for many different applications, making a wider range of services affordable to many people. The evolving definition of universal service, however, is critical for wireless providers. If universal service comes to be defined as ubiquitous two–way broadband access, as some groups propose, almost all wireless systems will be disadvantaged because they currently are unable to provide this level of service.
- **Interconnection and standards.** To realize the vision of the NII, the various systems and networks that comprise today's communications infrastructure—telephone, cable television, satellites, broadcasters, and cellular telephony—will have to connect with each other and with the new wireless communications systems now being developed. While this may

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[1]Comments of John Clendenin, *Radio Communications Report*, vol. 13, No. 7, Apr. 11, 1994, p. 27.

not be technically difficult, the process of developing the standards that will govern these interconnections and allow different networks to work together is becoming increasingly difficult. The result may be a patchwork of systems that do not work together or that makes it difficult for users to exchange information across multiple networks.

- **Wireless and NII policymaking.** Early plans for the NII were dominated by visions of fiber-optic networks crossing the nation and linking every home and business; as a result, the unique contributions of wireless technologies went largely unnoticed. On the other hand, policies guiding the development of wireless systems were actively formulated, but generally were not placed in an NII context. Today, policymakers in Congress, the FCC, and the executive branch are more actively promoting wireless as an integral part of the NII.

- **Spectrum policymaking.** The rush to wireless technologies and systems has created congestion in many popular bands of radio frequencies. Given the potential demand for wireless—especially mobile—services, it is likely that spectrum will continue to be in short supply for some applications. Policymakers are having difficulty balancing the needs of existing services with emerging applications. New ways of managing the spectrum may be needed.

- **Research.** The uncertainties surrounding almost all aspects of wireless development and use are exacerbated by the lack of research on fundamental issues, including the characteristics of mobility, the economics of the wireless industries, and the possible health effects of wireless devices and systems. The longer term implications of the use of wireless services on personal lives and business productivity and organization are unknown. Especially important are questions relating to scale—as more people and businesses use wireless services, new and unexpected effects are likely to emerge. For example, interference between different wireless devices could become a more serious problem.

- **Federal/state/local jurisdiction.** As wireless systems have become more common, questions relating to regulation and jurisdiction have grown more controversial. The federal government has a long–standing responsibility to promote nationwide communications systems that benefit the public. This goal, however, is increasingly coming into conflict with the historic rights of states to govern communications services within their borders and the efforts of local governments to maintain control over how local lands are used. Finding locations for the antennas required to provide cellular or future personal communication services, for example, is becoming more difficult as communities seek to exert control over where the towers can be built.