Preface

These are exciting and challenging times for the fields of telecommunications and networking. They are exciting because we are witnesses to an explosion in technological developments in almost all aspects of the fields. "Convergence" is now the watchword when speaking of telecommunications and networking. The coming together of telecommunications and computing technologies portends a future of ubiquitous, high-bandwidth multimedia communications. Such a scenario was almost undreamed of a few years ago. However, developments in wireless telecommunications, fiber optics, along with advances in Internet-related technologies have opened new vistas for growth in modern communications (Adam, 2000). These times are challenging in that these same developments in technology emanate from a variety of technological paradigms and are occurring at a furious pace. It is therefore difficult to know which technologies will survive the almost inevitable shakeout that must occur.

The battle to survive and dominate is fierce. Incumbent telecommunication and networking technology and service providers are working vigorously to retrofit their existing networks to supply next-generation broadband services. Digital subscriber line (DSL) and cable modem technology have been developed to leverage the existing telephone and cable television networks. These technologies, while effective in the short term, suffer from a variety of shortcomings that make it difficult for widespread deployment to occur rapidly and cost effectively. DSL requires relatively clean circuits to carry data at high speeds. However, the copper wires in the telephone system suffer from high levels of electromagnetic interference. This means that circuits have to be rigorously tested before they can be used. This makes deployment expensive.

Cable modem service has an advantage over DSL in that the cable networks are simpler and they can carry more information. However, cable has its own drawbacks. It is a shared network, which means that all nodes in a neighborhood must share the same high-speed connection. This means that speed and service can degrade depending on how many people are using the service at a particular point in time. Cable modem service also suffers reliability problems.

Gigabit Ethernet (now 10-Gigabit Ethernet) over dense wave division multiplexed (DWDM) fiber is challenging the hegemony of DSL and cable modems and has the potential to deliver much higher bandwidth and cheaper, more reliable broadband access to consumers. There is explosive growth in fiber-optic technology. Coupled with fiber-optic technology, Ethernet networks can have links of tens of kilometers (Fishburn, 2000). Using Ethernet allows network service providers to move away from more expensive and complex technologies (Phillips & Redifer, 1999). This means that the cost of deploying fiber-based last-mile technology could be even cheaper than that of retrofitting the current telephone and cable networks for high-speed service.

Mobile wireless access promises to be a substantial telecommunications growth area. Increased demand for mobile services is being driven by a number of factors.

On the business side, there is a growing need to connect increasingly mobile workers to backbone networks to provide data input and get updated business information. On the consumer side, businesses are working to provide consumers with access to information at their fingertips such as stock quotes, travel, shopping, and entertainment information. Although mobile wireless appears conceptually simple, it is difficult to implement mainly because of the mobility aspect. A variety of approaches are being suggested to deal with the problems associated with providing highly reliable mobile services. Developments in 3G mobile standards currently underway will "provide increased capacity, data capability, and a far greater range of services using an innovative radio access scheme and an enhanced core network. (Rees, 2000).

The explosive growth in the development of alternative telecommunications and networking technologies has largely been spurred by the significant regulatory changes enacted by governments around the world. In the monopolistic environment that pervaded the old telecommunications industry there was little incentive to move quickly to bring new technologies and services online, since incumbent operators wanted to recoup their investments from already deployed technology. Following the wide-ranging deregulation of the telecommunications industry in North America and parts of Europe, a wide variety of service and equipment providers began delivering radically new products and services to the market.

Although much of the Americas and Europe enjoy a highly deregulated industry, this is not the case in other regions of the world. Many governments are still very cautious about how best to approach deregulation of the telecommunications industry. This caution reflects their unwillingness to allow their local industry to be dominated by bigger foreign players. These countries face a conundrum, however, since the expansion of their telecommunications capabilities requires massive injection of capital, which is most likely to come from foreign investors. The "digital divide" between industrialized and less industrialized regions will continue to grow if ways to benefit from the growth in telecommunications and networking technologies are not found. For this to happen, an appropriate regulatory scheme must be found.

Deploying broadband and wireless technologies poses significant challenges, especially in community and cross-cultural settings. Those engaged in deploying new technologies must recognize and attend to the diverse needs, abilities, and cultural complexities if communities and business organizations are to benefit from the new technologies.

Organization of the Book

It is impossible, in one book, to address all the issues and trends relating to telecommunications and networking. The issues are diverse and wide-ranging. This book is intended to make a small contribution to understanding some of the technologies, issues, and challenges in telecommunications and networking in the early part of the 21st century.

We have divided the book into three sections. In the first section, there are six chapters that focus on current developments in telecommunications and networking technologies. These chapters present us with insights into the evolution of current technologies and their potential impact on the telecommunications indus-

try as well as organizations and individuals. The four chapters in the second section discuss international experiences in telecommunications and networking infrastructure development. These chapters remind us that while there are significant developments taking place in the telecommunications fields, all regions and countries in the world are not benefiting equally from these. There are numerous political, social, legal and technological challenges that need to be addressed. Section three contains three chapters that highlight challenges and impacts of implementing telecommunication and networking technologies to address specific organizational or community issues.

In Chapter 1, Brennan et al. provide an overview of current developments in Intelligent Networks standardization and evolution. The tremendous increase in demand and the commercial potential for integrated multimedia communications have spurred significant interest in leveraging current and future telecommunications infrastructure for delivering converged services. The Intelligent Network (IN) is seen by many as the foundation service delivery platform of the future. The chapter describes the standardization efforts being pursued by various groups. The IETF's PINT and SPIRITS working groups are working on protocols and architectures that will further the internetworking between IP and IN. The Parlay Industry working group (comprising such players as BT, Seimens AG, IBM, Lucent, etc.) is concerned with specifying object-oriented service control APIs designed to support all major middleware technologies and that are independent of the underlying communications infrastructure. The goal is to develop an IN infrastructure that will make the provisioning of telecommunication services seamless and effective. An integrated Intelligent Networks/CORBA infrastructure provides the basis for more open and distributed implementation of IN services as well as facilitating increased interconnection with Internet-based services and private databases. While no one of these approaches in IN standardization predominates, technological developments in IN will continue to accelerate.

Bill St. Arnaud, in Chapter 2, proposes a research program leading to the deployment of a Gigabit Internet to the Home (GITH) network that bypasses the traditional voice- or cable-based networks. The proposal is based on the premise that IP services will dominate in the future. Therefore, a "last mile" solution built from the ground up to support IP services will be best positioned to meet the demands for integrated communication services in the future. A GITH network would allow for the competitive provisioning of communication services based on the principle of equal access. This network would primarily be an optical network applying dense wave division multiplexing (DWDM) technology. This would allow it to be highly flexible and scalable. The building of a GITH network will be an undertaking of the size and scale of previous telecommunications infrastructure projects and will require partnership between governments and the private sector. While the costs involved in implementing such a network are immense, the projected long-term benefits will be significant.

The widely deployed wireless communication facilities in many countries (originally designed to provide voice services) increasingly are being used to provision data services. Both technology and the increased deployment of mobile applications are pushing the need for wireless data. More and more companies are attempting to connect their mobile workers to networked enterprise applications

through a variety of communication links. These links have different capacities and apply diverse protocols and technologies, making the process complicated. Wireless mobile devices are expected to constitute a significant portion of the client devices accessing enterprise networks. However, these devices are limited in their capacity to handle computationally intensive applications. These limitations will continue into the future because functionality requirements of mobile applications are expected to expand. The challenge faced by those deploying mobile applications is how best to manage the complex environment and computational intensity presented by wireless mobile. In Chapter 3, Thomas Kunz presents a promising solution: a new architecture for adaptive mobile applications based on mobile code.

Both Chapters 4 and 5 deal with space and time dimensions of mobile wireless networks. Chapter 4, by Paulraj and Sampath, provides a broad overview of the concepts behind "smart antennas." They describe the four main leverages of smart antennas: array gain, diversity gain, interference reduction, and multiplexing. They conclude by outlining a number of industry trends in the commercialization of space-time processing technology.

In Chapter 5, André Brandão proposes space division multiple access (SDMA) as a “promising technique useful for increasing capacity, reducing interference, and improving overall wireless communication link quality.” While SDMA is not conceptually new, the technique is difficult to apply in wireless mobile environments. The chapter provides a discussion on SDMA and intelligent antennas, conceptually illustrating how the technologies work. Technical difficulties and lack of commercial applications aside, Brandão challenges the reader to apply a business perspective concerning wireless communications akin to that adopted by Marconi almost a century ago. With wireless mobile computing expected to grow exponentially, the current difficulties with deploying the technology should not prevent further research and development efforts about SDMA and intelligent antennas.

Chapter 6 by Lance Pickett and Kathy S. Lassila discusses issues related to the deployment of virtual private networks (VPN) by organizations wanting to increase access to enterprise networks by mobile workers and to provision new mobile services, cost effectively and securely. Virtual private networks allow firms to leverage the public Internet, by using variety of software and hardware technologies to create a secure environment for remote network access. The chapter discusses the technologies and issues relating to VPNs and concludes with a look at future trends in VPN deployment.

The second part of the book shifts the focus away from specific technologies and focuses the reader’s attention on a number of international standardization and public policy issues surrounding the deployment of telecommunication services. This international perspective is important because it alerts the reader to the fact that development and application of telecommunication technologies are not universally comparable. Efforts relating to the standardization of telecommunications technologies as well as public policies relating to the application of those technologies significantly affect their diffusion.

To begin part two, Zixiang Tan discusses the international efforts leading to standardization of wireless communications. Internationally accepted and applied standards are essential for global diffusion of wireless communications technolo-

gies. However, the history of wireless communications demonstrates the highly competitive nature of the standardization process. Tan explores this history, highlighting the issues and challenges faced in first generation (1G) and second generation (2G) standardization efforts. The current efforts by the ITU to guide the development of third generation (3G) wireless communication standards (referred to as IMT-2000) are characterized by an intense mix of international cooperation and competition. The author concludes by suggesting that with the ITU's IMT-2000, global wireless communications may have moved into an era of "de-standardization," where multiple standards are expected to exist yet work co-operatively.

For most of the time since the invention of the telephone, telecommunications services have been operated and governed as a monopoly enterprise. In many countries, even today, the telecommunications industry is highly regulated and telecommunications service provision remains in the hands of a few entities. This is particularly the case in many less emerging and less developed countries. The 1980s and 1990s have witnessed significant moves in Europe and North America to deregulate the telecommunications industry and open it to full competition. The United Kingdom and the United States are examples of two countries that took a somewhat radical approach to telecommunications reform. Other countries followed more gradual approaches. Gao and Lyytinen, in Chapter 8, provide insights into the Chinese approach to telecommunications reform. China's gradual process is viewed as appropriate given the economic, political and social circumstances.

Although now part of China, Hong Kong's telecommunication industry has advanced further in its telecommunications reform process than mainland China. The effect of deregulation has been the introduction of fierce competition in the telecommunications market. By the end of 1999, over 148 external telecommunications service licenses had been issued. One of the consequences of introducing new service providers into a market is the varying levels of service quality. In Chapter 9, Xu Yan and James Y. L. Thong report on an experiment to test the quality of international direct dial (IDD) services in Hong Kong in the deregulated environment. The findings from the experiment suggest that quality of IDD services is probably the most enduring determinant of competitive success in deregulated market although price is important in the early stages. One implication of the study is that regulators should consider introducing facilities-based competition early in the reform process as incumbent operators will tend to create an artificially high barrier for new entrants, thus denying consumers the full benefits of deregulation.

Fola Yahaya's chapter on *new connectivity options for information infrastructure development in Sub-Saharan Africa* introduces the reader to some of the issues faced in developing information infrastructure in Africa. The author highlights the many projects, planned or underway, to radically develop the continent's telecommunications and networking infrastructure. These include satellite and submarine cable projects as well as projects focusing on wireless local loop. Most of the most publicized projects are being proposed by external parties, particularly private telecommunications consortia, hoping to capitalize on what is perceived to be a high pent-up demand for telecommunication services. Given the high involvement and power of external parties the author suggests that public policy must play a pivotal role in determining the most beneficial route to pursue. Since there is no quick or universal solution to challenges in developing information infrastructure

in Africa, choices as to which connectivity solution is best should only be made after careful and in-depth analysis.

Part three of the book focuses on the impacts and challenges of implementing telecommunications and networking technologies in particular settings. This section begins with Venkatesh's case description of the issues and challenges in implementing broadband networks for community-based organizations in the state of New York. The state-funded program described in the case was designed to bridge the digital divide between economically advantaged and disadvantaged areas of the state. Venkatesh highlights a number of issues relating to the deployment of broadband networks including "last mile" access, integration of software applications, and challenges in acquiring technical support services. One of the key findings is that know-how barriers are pervasive in the context of broadband networks and that these barriers increase in smaller organizations. The author suggest the use of application prototypes to help network owners develop an understanding of the proposed technology before adoption decisions are made.

In another case study from New York State, Dawes and Oskam describe efforts to create an Internet-based GIS Clearinghouse for the state in keeping with the statewide information policy. The state has instituted a policy for sharing of data, including GIS data. The New York State Library plays a pivotal role in this program. The provision of online services for accessing GIS data is a key objective of the clearinghouse.

A number of issues arise when communications technology is being applied in a variety of cultural settings. In the final chapter, Chapter 13, the authors compare efforts to adopt cellular phones in France and the United States. The results of the study show that culture plays a major role in explaining the different results from adopting cellular phone technology.

Conclusions

The telecommunications and networking field is experiencing tremendous growth in technologies and services. This is at the same time exciting and challenging. It is exciting because the new developments open the potential for many new advanced products and services. They are challenging because of the complex nature of the technologies themselves and the environments in which they are being deployed. This book presents some insights into these issues and developments.

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