Preface

There is little doubt that Pervasive Computing (PervComp) is on the brink of becoming an integral part of the everyday lives of a vast number of people. It has found its way into the everyday fabric of our society. The social consequences of this development are difficult to predict, but the technological trends are in place. Several interesting technological innovations provide the possibility of extending the networking environment to traditionally non-networked devices (e.g., microwave ovens and temperature sensors). The cheap and high-speed wired-cum-wireless infrastructure, combined with low-cost handheld devices, appears likely to translate the technological promise of pervasive computing (*PervComp* in short) into a viable economic reality.

This book is a comprehensive guide to tomorrow's world of PervComp in which users can access and manipulate information from everywhere at every time, i.e., every time/everywhere→ every device → every network → every data. Computing devices and networks are becoming ubiquitous. In this new world, computing will no longer be tethered to desktops: users will become increasingly mobile. As users move across environments, they will desire to remain connected all along so that they can continue to access to a dynamic range of application and software services. They will want to carry with them (logically) their unfinished/scheduled tasks including computing, sensing, communicating, etc. Today's infrastructure for networking and communication does not support this model of PervComp very well. Now a days, if a mobile user wants to use the computing resources of a new environment, he/she has to manually figure out how to be connected first and

then to perform a computing task using local resources and/or to migrate his/her computing context from another environment. Such manual operation is unacceptable in a pervasive computing world because it does not scale with the increasing amount of different services, user mobility and resource dynamism.

PervComp defines a paradigm shift from mobile computing by introducing the vision of "pervasiveness" i.e., all-time everywhere access to information, communication, services and computing. There are already a host of players in this "business of the millennium". There is the communication industry, the networking industry, the computing industry, the wireless mobile industry, and the Internet industry. However, the interplay amongst these industries in the marketplace is yet to be figured out.

Assuming that the goal is pervasive computing i.e., to turn the computing omnipresent, the technological advances, that are needed to build a PervComp environment, can be framed into four broad areas: networking, middleware, applications and users. This book is primarily concerned with networking technology because the first problem that must be addressed in realizing PervComp is how to establish the necessary underlying infrastructure, known as Pervasive Networking (PervNet). PervNet infrastructure ties different sets of smart nodes together, allowing them to communicate with one another to provide ubiquitous computing services to users. There are several characteristics of the network environment that provide challenging research issues.

Much has changed in the networking world since the inception of the last decade. Advances in wireless and mobile communication have realized "anywhere anytime" connectivity. Optical networks have increased the bandwidth by several orders of magnitude. The requirement of PervNet will sustain and bolster this networking boom in the current decade too. However, a number of issues must be resolved before PervNet burst into picture. There are many technical obstacles- issues of connectivity, levels of service, performance, and reliability and fairness- that stand between the current state-of-art in networking industry and the sort of PervNet that we believe is possible and desirable. These are the challenges that are the focus of this book. Intuitively, PervNet ought to be global, ubiquitous and heterogeneous, and it must have the potential to support diverse applications. But how is it possible to achieve them? What are the available off-the-shelf technologies that would serve as the building

blocks? What kind of software architecture is needed to integrate these building blocks into an effective networking platform? Answering these questions is the primary objective of this book- to describe the existing enabling technologies and then to show how these systems can be used to construct a PervNet from the present state.

This book is a uniquely comprehensive study of the major networking technologies and systems that will assist in forming the future PervNet. We first describe the technologies that will help create PervNet, explain the mechanisms that operate them and their current status. Then we discuss the existing systems for these technologies, their operational details and how they can be used in the PervNet environment. We have written the book for those professionals and students who want such a comprehensive view of PervNet technologies and systems.

The book is divided into four parts, namely PART I: PERVASIVE COMPUTING, PART II: ENABLING TECHNOLOGIES, PART III: SYSTEMS and PART IV: SUMMARY AND FUTURE. The first part consists of Chapters 1 and 2, which provide an introduction to pervasive computing and pervasive networking respectively. Chapter 1 includes Introduction, Evolution of Computing Paradigm, Pervasive Computing, Issues in Pervasive Computing, Application Potential and Current Status. Chapter 2 covers pervasive networking including Networking infrastructure, Managing Pervasiveness, Mobility Management and other issues. The second part consists of Chapters 3, 4 and 5. Chapter 3 demonstrates backbone technologies to be used in the backbone of the pervasive network; for example The Internet, Optical Networks (SONET/SDH, WDM), Satellite Networks, Point-to-point microwave and Fibreless optics. Chapter 4 presents the technologies to be used in the access part of the pervasive network. This includes Fixed wireless (WLL, laser), Short-range wireless (WLAN, cordless, infrared), Single-hop wireless (cellular) and Multi-hop Wireless (ad hoc). Chapter 5 describes interface technologies such as Interoperability and Internetworking, Middleware, Intelligent Networking and Smart adapters. The third part, consisting of Chapters 6 and 7, provides the description of the systems corresponding the technologies described in Chapters 3 and 4 of Part II. In particular, Chapter 6 gives an extensive coverage of the Internet including IP enhancements (IPv6, mobile IP, RSVP, MPLS), Internet Telephony and IP over WDM. Chapter 7 describes the Wireless standards such as CT, DECT, PHS, WLAN, PCS, GSM, IMT, 3G, GPRS and

Bluetooth. Finally, Part IV unites future directions in Chapters 8 and 9. Chapter 8 describes issues like Transparency Scalability, Security, Power/Energy and QoS. Chapter 9 provides a vision of the future discussing various projects under the heading of Data-centric Networks, Ubiquitous Computing, Wearable computers and Smart environment.

The book acts as a general introduction to the exciting and rapidly advancing field of PervComp as well as provides the system level details of PervNet upon which stands the success of tetherless ubiquity. In about 300 pages, it covers past, present and future of the area. The emphasis is given on networks, systems and standards rather than detailed physical implementations so that readers can gain familiarity with this upcoming field and its associated issues without getting bogged down in too many details. It discusses numerous potential applications and projects undertaken in these fields at different academics and industries, reviews relevant concepts and examines the various approaches that define emerging PervComp technologies. In a word, it covers everything you can think of in the realm of pervasive computing infrastructure. Throughout the book, important issues- scalability, transparency, security, energy management, QoS provisioning, fault tolerance, disconnected operation etc.- are taken up; possible solutions to these challenges are also presented.

Since very few books exist on this challenging topic, *NETWORKING INFRASTRUCTURE FOR PERVASIVE COMPUTING: Enabling Technologies & Systems* will serve as an excellent foundation on which future and current researchers can build a solid knowledge base of PervNet technologies. It is a must have reference work for PervComp visionaries who are shaping our computing future. It also should prove useful to a graduate course in Computer Science, or Electrical Engineering, or Telecommunication Engineering. In summary, this book provides a research and development perspective on the field of PervNet in particular (and PervComp in general) by describing the recent research developments in this area and also by identifying key directions in which further research is needed.