Preface

This book contains articles from the four issues of Volume 2 of the *International Journal of Interdisciplinary Telecommunications and Networking* (IJITN). As was the case with *Interdisciplinary and Multidimensional Perspectives in Telecommunications and Networking: Emerging Findings*, our book of articles from IJITN Volume 1, this book reflects the journal’s mission of publishing high-quality original interdisciplinary academic and practitioner research, surveys, and case studies that address telecommunications and networking issues, answer telecommunications and networking questions, or solve telecommunications and networking problems. The articles also reflect the journal’s objective of covering a wide variety of topics related to telecommunications and networking technology, management, policy, economics, and social impact from a diversity of disciplinary viewpoints, including electrical engineering, computer science, operations research, business, and law.

The first article of Volume 2, Issue 1, examines the implementation of VoIP using open source architecture. The Asterisk open source architecture is implemented and tested by the authors utilizing such common telephony and mobile telephony features as: Call Forward, Caller ID, Remote Call Pickup, Voicemail, etc. A comparison is then made between an Asterisk-based system and a proprietary telephone system. In particular the authors note that “Even the most sophisticated, industrial strength PC is far less expensive than any traditional PBX”. The authors study found that Asterisk provided many features that would cost hundreds or thousands of dollars in a traditional PBX-based system and had the ability to easily add services on an ad hoc basis with almost zero cost to the user.

The second article of this issue deals with a very “hot” topic in wireless communications: ad hoc networks. The lack of fixed infrastructure in an ad hoc network complicates routing tremendously. A topology can change in an instant and a routing protocol must adapt to such changes or the entire network may suffer disconnection. Another problem with such networks is the potential for interference between links. This problem would be especially acute if bandwidth is limited or transmit power management cannot be easily achieved. The authors present a routing approach that takes link interference into account while seeking to minimize end-to-end delay for all traffic in the ad hoc network. A potential route is evaluated based on the potential interference associated with all of the links that belong to it. It is assumed that the less interference along an entire route equates to minimization of the delays encountered along that route. The authors then use simulation to compare their routing approach with another “interference aware” routing algorithm with very favorable results.

The third article of the issue deals with another “hot” topic: processing video imagery for the creation of real time information. With cameras proliferating in both public and private spaces, the utilization of the technology for facial recognition, intelligence gathering, security monitoring and a whole host of other uses hinges on the ability to analyze what is being captured in a succinct and rapid manner. In order to process video in such a manner, the authors proposed the development of a live video database
management system (LVDBMS) in order to store “events” as they occur. Once stored in such a manner, queries against the video data repository can be made in order to glean useful information. Included in their proposed LVDBMS are query optimization techniques that allow for efficient video stream computations.

The final article of this issue is an overview of the competitive landscape for mobile telecommunications tower companies in India. N.P. Singh provides not only a description of the various business models associated with mobile communication tower-owning companies in India, but also a description of various actual companies that compete in this market.

The first article of Volume 2, Issue 2, is entitled “An Analysis of Traffic and Throughput for UMTS Packet Core Networks” by Ye Ouyang and M. Hosein Fallah, both of Stevens Institute of Technology. UMTS (Universal Mobile Telecommunication System) is a third generation (3G) mobile telecommunication technology architecture. Like its 2G predecessor Global System for Mobile Communications (GSM), both packet switching and circuit switching are involved in the operation of the overall architecture. In this article, the authors explore the design of the Core Network (CN) for UMTS, which is responsible for such functions as mobility management, call and session control, switching and routing, charging and billing, and security protection. This work focuses specifically on the algorithms used for dimensioning the various aspects of the CN for UMTS. After discussing these algorithms, the authors provide a case study analysis of the dimensioning for a prospective CN. The contribution of the work is that it provides an overview of the real-world process for dimensioning such networks; a process that if done incorrectly could have very costly results for network providers in terms of network capabilities and customer service.

The second article of the issue is written by Emin Koksal of Bahcesehir University in Turkey. The paper presents a very novel look at how network operators (NO) deviate from the theoretical ideal of “Net Neutrality” and how such deviations can create benefits and costs to the general public. The author first points to the apparent fact that a violation of the Net Neutrality concept is a form of discrimination where certain types of network traffic are monitored and affected in some way. Another key concept discussed is the concept of “vertical foreclosure” where a dominant firm in a market segment utilizes its position to deny access to other firms in an adjacent “downstream” market. Such an example would be a cable television provider that also provides Internet access through its network may limit the ability of its subscribers to access Netflix (an online streaming movie service) in order to encourage them to utilize its own “pay-per-view” movie service. In this example an NO is denying network access to a content and application provider (CAP) and violating the Net Neutrality concept. The author then puts forth price discrimination models for monopolies and duopolies under this framework with NO’s, CAP’s and end users (EU’s). The author also introduces the notion of “welfare” in the models.

The third article, of which one of the journal editors (Bartolacci) is a coauthor, presents a rigorously derived algorithm for multicast streams of traffic. In this work the authors’ goal is to reduce latency. Such types of multicast streams are seen in the delivery of multimedia content on the Internet and over private networks. A multi-pass algorithm is proposed that changes the routing tree in order to reduce delays (latency) for traffic.

The fourth article of the issue by two authors from Malaysia puts forth a methodology for analyzing network performance in a campus environment. The authors created the analysis software utilizing Oracle Enterprise 2009 and tested it using real network data as well as against the OPNET network simulation package. Their methodology performed comparably well against OPNET.
The final article of the second issue of 2010 is entitled “Users’ Perceptions of Wireless Network Usage” and is written by three authors from Illinois State University. Their study seeks to determine how user responses such as the actual usage of wireless networks, in particular Wi-Fi, is affected by different factors related to the user’s level of knowledge of wireless networks. Another response that the authors looked at was user anxiety related to wireless networks. Their methodology for determining the relevant factors involved three different types of studies: a focus group discussion, a pilot study survey, and a final survey. The first part, the focus group discussion, sought to develop questions that would be utilized in the other two parts.

The first Volume 2, Issue 3 article, “A Data Gathering Algorithm Based on Energy-Aware Connected Dominating Sets to Minimize Energy Consumption and Maximize Node Lifetime in Wireless Sensor Networks” by Natarajan Meghanathan, investigates energy consumption in wireless sensor networks. A wireless sensor network is a distributed system of smart sensor nodes that collect data about the ambient environment and propagate it to one or more control centers where the end-user can access the data. The control centers are usually far away from the sensor nodes, which operate typically with very limited battery power, computing capability, and memory capacity. Since direct communication among the sensor nodes and the communication centers consumes a great deal of energy and bandwidth, it is desirable to minimize the amount of information that is gathered at the sensor nodes and transferred over the network. In his paper Meghanathan considers a wireless sensor network where the data is reported from the sensor nodes periodically and collected, aggregated, and transferred in rounds. The paper presents an algorithm aimed at simultaneously reducing the amount of energy consumed per round of data communication as well as maximizing the number of rounds of communication before the sensor node fails due to a loss of battery charge. Simulation results indicate that this algorithm performs very well compared with other well-known data gathering algorithms.

In “Why Mobile Carriers Share Networks and Services Provisioning,” the second article in Volume 2, Issue 3, Hemant Sabat formulates a theory for why network operators and service providers share networks. The theory draws on the author’s research into this subject based on his industry experience along with data drawn from secondary sources. Extensive use is made of case studies to support the findings. The paper asserts that there are five key drivers for network sharing: the type of network infrastructure expense; the function of a network component; the partner operators’ business drivers; the type of network and radio interface technology; and a region’s regulatory environment. The author concludes with a series of recommendations for network operators as well as regulatory agencies and governmental policy-makers.

In the third article in Volume 2, Issue 3, “Performance Analysis of Optimum Interleaver based on Prime Numbers for Multiuser Iterative IDMA Systems,” Shukla and Gupta propose user-specific interleavers to remove the problem of high consumption of bandwidth. In interleaving the input data to a system is arranged such that consecutive data are split among different blocks at the output the interleaved data is re-arranged into the original sequence. With interleaving correlated noise such as burst error or fading introduced in the transmission channel appears to be statistically independent permitting better error correction. Simulation results indicate that the prime interleaver proposed in the article outperforms random or any other interleavers with respect to bandwidth consumption.

In “Optimizing the Traffic of Voice Core Domain in UMTS Network through RNC Re-Homing,” the first paper in Volume 2, No. 4, Ouyang and Fallah investigate the basic architecture and topology of UMTS networks and how the core networks can be optimized using re-homing techniques. Re-homing can provide cost savings since the investment in capacity expansion for high loading switches is no longer or only partially needed.
In the second paper in Volume 2, No. 4, “Fractional Reuse Partitioning Schemes for Overlay Cellular Architectures,” Aki, Erturk, and Arslan examine three schemes for partitioning cells in order to increase capacity and improve the grade of service. The partitioning schemes, which are based on adaptive clustering with fractional frequency reuse, exploit the high level of signal to interference ratio and apply dynamic resource allocation methods within concentric signal to interference regions. Simulation is used to compare performance with conventional cellular architectures.

The third article in Volume 2, No. 4 is “A Mobile Service Recommendation System Using Multi-Criteria Ratings” by Shao, Chen, and Huang. Although mobile devices and services offer users a great deal of convenience, they also overload them with information. In this article the authors propose a multi-criteria recommendation system that reduces the amount of information and uses the rank aggregation method to rank alternatives. A prototype of the recommendation system is implemented and illustrated with an example.

In order to cut costs and offer bundles of voice, data, text, and video services to their customers, telecommunications service providers have been re-organizing, integrating their fixed-line and mobile operations. In “An Analysis of the Latin American Wireless Telecommunications Market Portfolios of Telefonica and America Movil,” the fourth paper in Volume 2, No. 4, one of the preface co-authors (Powell) examines two of these companies, Telefonica and America Movil, both of which have extensive operations in Latin America. Telefonica’s re-organization was internal; America Movil’s by means of acquisition of Telmex International and Carso Global Telecom. The paper, which was written shortly after America Movil’s re-structuring was announced, provides background for the companies’ reorganizational and strategic actions. In particular, it compares the companies’ wireless portfolios with respect to their market attractiveness and competitive positions in 2008 relative to 2002. The portfolio analysis technique employed in the paper may have wider applicability for formulating corporate strategy.

The articles in this compendium display a broad range of cutting edge topics in telecommunications, computer networking, and electronic commerce. One of the preface authors (Bartolacci), believes that wireless communications is poised to play an ever-increasing role in the world with respect to an area that has been in news constantly in the last few years: emergency-disaster planning and management. From Hurricane Katrina to the earthquake in Haiti to the Japanese earthquake/tsunami, emergency-disaster planning and management has come to the forefront as an area in need of cutting edge systems and technology to save lives and property. Emergency management relies on information dissemination and decisions made from timely data. Sensor networks, especially in an environmental context, are a source of real-time data, but unfortunately their use outside of the battlefield is not pervasive. In particular, the approach being proposed by Bartolacci and his co-researchers incorporates a novel strategy for maintaining battery life and connectivity among sensors and related portable communication devices within a routing architecture that is especially adapted for crisis management applications where maintaining connectivity is critical.

Sensor networks, a subset of Mobile Ad Hoc Networks (MANETs), are by definition a network of portable devices. All types of Ad Hoc Networks lack fixed infrastructure and therefore do not have fixed network connection points and a corresponding fixed topology linking these points. Sensors networks have a flexible network topology that can change with the positions of each member device and differ from MANETs in two important aspects: their primary functionality and device sophistication. MANET nodes may consist of devices that may range from sophisticated workstations with impressive computing capabilities, large storage abilities and wireless communication technologies such as Wi-Fi to Bluetooth-based devices that have very limited computing and storage abilities and a 10 meter range of commu-
The design of a MANET’s topology at any given point in time is only limited by the mobility, communication range, and bandwidth (capacity and channels) available to each network node. Sensor networks, on the other hand, almost always use devices with limited computing and storage abilities and a sole function: measurement of some environmental variable or variables. Unlike most MANET nodes which may be a source, a destination, or an intermediate point for network traffic, most sensor network devices are only sources or intermediate points in what is traditionally a hierarchical network structure. Sensor network devices, often called “Motes”, usually have no external power source and rely on internal batteries for operation. This fact severely limits their computing, storage, and communication abilities. Thus, motes often operate on a periodic basis and are not in full operating mode all of the time. For this mode of operation, they “wake up” to measure, and possibly perform some limited preprocessing of, a designated environmental variable. The next step is that they transmit the resulting data to one or more nodes on the network. This action is then followed by reverting back to “sleep” mode where battery usage is minimal. This model of operation conserves battery life and prolongs the independent deployment life of the device since wireless transmission and computationally processing each require a relative large consumption of battery power to be carried out. A node may also “wake up” to act as an intermediate point on the transmission of data from other nodes in the network along what is traditionally a hierarchical network topology that feeds all data collected to a central point for processing. The root node for a sensor network may actually be a connection point to a fixed network infrastructure or a very sophisticated node for the processing of data collected throughout the sensor network.

The assumptions regarding the nature of “sensor” devices for such a strategy put forth in Bartolacci’s work on emergency management architecture are twofold. The first is that sensors within an emergency management system can be one of three types: traditional automated, battery-powered sensing and communication devices commonly known as motes (which are primarily transmitters of collected data or intermediate points for traffic along routes in a sensor network), sophisticated sensor devices (that has much more half-duplex, or possibly even full-duplex, type communications and would includes automated, battery-powered sensing devices that may approach the capabilities of a wireless-enabled PDA with their storage, processing, and communication capabilities), less sophisticated, purely mobile communication devices (similar to those in the second category but with less sophistication such as a mobile phone).

“Human sensors” operate the third category of devices in order to sense the environment and report data. They may use specialized, non-communications equipment for sensing and merely report their findings with a purely mobile communication device. An alternative device could be one from the second category with the human merely fixing its temporary location for sensing. A third possibility for this category is that the sensing capability of a “human sensor” may simply be a human’s ability to observe with their senses, process observations with their brain, and report findings with a handheld wireless communication device. All of the possibilities in this category would be more mobile in nature and less reliant on a finite battery life than the other two categories of devices. Human users of this third category of devices could take measurements with the device and activate a signal or even use other sensing instruments and simply report their findings with the mobile device. Such devices could have their batteries recharged by the human user or have a redundant power source available if needed, such as a spare charged battery.

Bartolacci’s work in this emerging area also deals with the nature of routing for such emergency management architecture. An assumption regarding the nature of sensors for this routing architecture is that they have the capability to know where they are located. This assumption requires that either GPS
chipsets are built into the mobile devices or that they are placed precisely at fixed known locations. Currently, most mobile handsets and many other types of portable communication devices have such location tracking capabilities. For emergency management purposes, the usage of unmanned, location-aware sensor devices and specialized mobile handsets/devices for human use is not an unrealistic assumption since the technology for both types currently exists. The fact that many traditional sensors types, also called motes as previously described, are built with very limited processing and storage capabilities for cost and battery conservation reasons requires that sensors used in emergency management be necessarily more sophisticated. An alternative to adding location-aware capabilities to such sensors would require the precise placement of unmanned, automated sensors at known locations. Realistically speaking, an emergency management system would probably not utilize a large number of simplistic sensors of the mote variety due to the gravity of their impact on the system’s reliability and functioning.

The routing aspect of this architecture proposed by Bartolacci is termed a “Virtual SONET”, taking a term from high speed fiber optic networks that are used primarily for backbones in wide area networks. The term “virtual” implies that a ring type structure will be utilized for routing of wireless nodes in emergency management architecture. Such a ring structure allows routing to be done on a ring of connected nodes in a clockwise or counter-clockwise fashion, thus allowing for some fault tolerance in the event of a disconnection of a single link or node in the virtual ring used for routing. Much like the hard-wired fiber SONET rings, the rings in Bartolacci’s structure would be interlocked meaning that some nodes are members of multiple rings, thus facilitating routing between nodes and ideally providing additional fault tolerance.

This discussion of the work by one of the authors of this preface highlights work in an emerging area of wireless telecommunications that has come to the forefront over the past decade. The articles in this text span a great deal more of cutting edge areas that are truly interdisciplinary in nature.

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