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IEEE Communications Surveys & Tutorials

WELCOME to the second issue of 2011 of the IEEE Communications Surveys and Tutorials. Paper in this issue survey the research effort in several areas such as peer-to-peer networking, energy efficient networking, sensors networks, mesh networks, security, spectrum management and meter protocols.

Peer-to-peer (P2P) technology has triggered a wide range of distributed applications beyond simple file-sharing. Despite of the diversity in applications, these systems share a common problem regarding searching and discovery of information. This commonality stems from the transitory nodes population and volatile information content in the participating nodes. In such dynamic environment, users are not expected to have the exact information about the available objects in the system. Rather queries are based on partial information, which requires the search mechanism to be flexible. On the other hand, to scale with network size the search mechanism is required to be bandwidth efficient. In "A Survey of Distributed Search Techniques in Large Scale Distributed Systems" Reaz Ahmed and Raouf Boutaba identify the search requirements in large scale distributed systems and investigate the ability of existing search techniques in satisfying these requirements.

Utility companies (electricity, gas, and water suppliers) and governments have been urging to deploy communication-based systems to read meters, known as automatic meter reading (AMR). An AMR system is envisaged to bring benefits to customers, utilities, and governments. The advantages include reducing peak demand for energy, supporting the time-of-use concept for billing, enabling customers to make informed decisions, and reducing the cost of meter reading, to name a few. A key element in an AMR system is communications between meters and utility servers. Though several communication technologies have been proposed and implemented on a small scale, with the wide proliferation of wireless communication, it is the right time to explore new possibilities for the next generation AMR. In "A Survey of Communication Protocols for Automatic Meter Reading Applications", Tarek Khalifa, Kshirasagar Naik and Amiya Nayak provide a comprehensive review of the AMR Technologies proposed so far. They present how future AMRs will benefit from third generation (3G) communication systems, the Data Language Messaging Specification/Companion Specification for Energy Metering standard and Internet Protocol-based SIP (Session Initiation Protocol) signaling at the application level.

Exchanging cryptographic keys to encrypt the media stream while preserving the features of the protocol (e.g., forking, re-targeting, request recursion, etc.) is quite challenging. In "A Survey and Analysis of Media Keying Techniques in the Session Initiation Protocol (SIP)", Vijay K. Gurbani and Vladimir Kolesnikov survey three key management protocols — SDES, ZRTP and DTLS-SRTP that have been proposed for media keying, and evaluate them for use with SIP. To aid in the evaluation, the authors first extract (and justify) a core feature set from SIP. Then they survey each key management protocol in detail and analyze the cores of the three protocols against this feature.

The Border Gateway Protocol (BGP) is the Internet's inter-domain routing protocol. One of the major concerns related to BGP is its lack of effective security measures, and as a result the routing infrastructure of the Internet is vulnerable to various forms of attack. In "Securing BGP — A Literature Survey", Geoff Huston, Mattia Rossi, and Grenville Armitage examine the Internet routing architecture and the design of BGP in particular, and surveys the work to date on securing BGP. To date no proposal has been seen as offering a combination of adequate security functions, suitable performance overheads and deployable support infrastructure. Indeed, the inter-domain routing environment remains a major area of vulnerability since BGP mutual trust model involves no explicit presentation of credentials, no propagation of instruments of authority, nor any reliable means of verifying the authenticity of the information being propagated through the routing system.

Besides the widespread sensitivity to ecological issues, interest in energy-efficient networking also stems from economic needs, since both energy costs and electrical requirements of telcos and Internet Service Providers infrastructures around the world show a continuously growing trend. The sole introduction of low consumption silicon technologies may not be enough to effectively curb energy requirements. Thus, for disruptively boosting the network energy efficiency, these hardware enhancements must be integrated with ad-hoc mechanisms that explicitly manage energy saving, by exploiting network-specific features. In "Energy Efficiency in the Future Internet: A Survey of Existing Approaches and Trends in Energy-Aware Fixed Network Infrastructures", Raffaele Bolla, Roberto Bruschi, Franco Davoli, and Flavio Cucchietti explore current perspectives in power consumption for next generation networks. Three main issues are explored in the paper: re-engineering architectural elements of networking equipment, dynamic adaptation of network device resources and network connectivity to traffic load and service requirements and exploitation of sleeping/standby states.

The shared nature of the medium in wireless networks makes it easy for an adversary to launch a Wireless Denial of Service (WDoS) attack. Recent studies demonstrate that such attacks can be very easily accomplished by using off-the-shelf equipment. To give a simple example, a malicious

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node can continually transmit a radio signal in order to block any legitimate access to the medium and/or interfere with reception. This act is called jamming and the malicious nodes are referred to as jammers. Jamming techniques vary from simple ones based on the transmission of interference signals, to more sophisticated attacks that aim at exploiting vulnerabilities of the particular protocol used. In "Denial of Service Attacks in Wireless Networks: The Case of Jammers", Konstantinos Pelechrinis, Marios Iliofotou and Srikanth V. Krishnamurthy present a detailed up-to-date discussion on the jamming attacks recorded in the literature. They also describe various techniques proposed for detecting the presence of jammers and survey numerous mechanisms which attempt to protect the network from jamming attacks.

Wireless Mesh Networks (WMNs) have the potential of being a cost effective solution to provide connectivity and coverage in both urban and rural areas. Typically, a WMN is a backbone network that carries high data rate traffic and employs Time Division Multiple Access (TDMA) like access mechanisms. For a WMN to provide high throughput, the design of an efficient link scheduling algorithm is of paramount importance. In "Link Scheduling Algorithms for Wireless Mesh Networks", Ashutosh Deepak Gore and Abhay Karandikar provide an overview of link scheduling algorithms in Spatial TDMA wireless mesh networks. These algorithms can be classified into three categories: those based only on a communication graph model of the network, those based on a communication graph model and Signal to Interference and Noise Ratio (SINR) threshold conditions at receivers and those based on an SINR graph model of the network. A framework for modeling STDMA networks is provided including the description of algorithms from each of these classes.

Given the rigidity of current allocations, several spectrum occupancy studies have indicated a low utilization over both space and time. Hence, to satisfy the demands of applications it can be inferred that dynamic spectrum usage is a required necessity. Centralized Dynamic Spectrum Allocation (DSA) and Distributed Dynamic Spectrum Selection (DSS) are two paradigms that aim to address this problem, thus, DSS (distributed) is used as an umbrella term for a range of terminologies for decentralized access, such as Opportunistic Spectrum Access and Dynamic Spectrum Access. In "A Comparison Between the Centralized and Distributed Approaches for Spectrum Management", Gbenga Salami, Olasunkanmi Durowoju, Alireza Attar, Oliver Holland, Rahim Tafazolli, and Hamid Aghvami survey these methods. They introduce, discuss, and classify several proposed architectures, techniques and solutions. Moreover, they provide a baseline for systematically comparing the two approaches, revealing the pros and cons of DSA (centralized) and DSS (distributed) as methods of realizing spectrum sharing.

The computational and memory resources of wireless sensor nodes are typically very limited, as the employed low-energy microcontrollers provide only hardware support for 16 bit integer operations and have very limited random Access memory (RAM). These limitations prevent the application of modern signal processing techniques to pre-process the collected sensor data for energy and bandwidth efficient transmission over sensor networks. In "Low-Memory Wavelet Transforms for Wireless Sensor Networks: A Tutorial", Stephan Rein and Martin Reisslein introduce communication and networking generalists without a background in wavelet signal processing to low-memory wavelet transform techniques. They first explain the one-dimensional wavelet transform (including the lifting scheme for in-place computation), the two-dimensional wavelet transform, as well as the evaluation of wavelet transforms with fixed-point arithmetic. Then, the authors explain the fractional wavelet filter technique which computes wavelet transforms with 16 bit integers and requires less than 1.5 kByte of RAM for a 256×256 gray scale image and present case studies illustrating the use of these low-memory wavelet techniques in conjunction with image coding systems to achieve image compression competitive to the JPEG2000 standard on resourceconstrained wireless sensor nodes. C-code software for the techniques introduced in this tutorial freely available.

I hope that you found the articles of this issue informative and useful. Please bear in mind that we have an open call for submissions of surveys and tutorials on any communications or networking related topic. I hope that you will consider developing and submitting an article. In addition, we would appreciate if you could please encourage others to develop an article whenever you believe sharing their expertise would be valuable to our community. Please refer to the Author Guidelines at http://www.comsoc.org/pubs/surveys for detailed submission instructions and submit your paper at http://mc.manuscriptcentral.com/comst-ieee.

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