CODE	TITLE	YEAR	ABSTRACT
1	A Cloud-Based Architecture for the Internet of Spectrum Devices (IoSD) over Future Wireless Networks	2016	The dramatic increase in data rates in wireless networks has caused radio spectrum usage to be an essentialand critical issue. Spectrum sharing is widely recognized as an affordable, near-term method to address this issue. This article first characterizes the new features of spectrum sharing in future wireless networks, including heterogeneity in sharing bands, diversity in sharing patterns, crowd intelligence in sharing devices, and hyper-densification in sharing networks. Then, to harness the benefits of these unique features and promote a vision of spectrum without bounds and networks without borders, this article introduces a new concept of the Internet of Spectrum Devices (IoSD) and develops a cloud-based architecture for IoSD over future wireless networks, with the prime aim of building a bridging network among various spectrum monitoring devices (SMDs) and massive spectrum utilization devices (SUDs), and enabling a highly-efficient spectrum sharing and management paradigm for future wireless networks. Furthermore, this article presents a systematic tutorial on the key enabling techniques of the IoSD, including big spectrum data analytics, hierarchal spectrum resource optimization, and quality of experience (QoE)- oriented spectrum service evaluation. In addition, the unresolvedresearch issues are also presente
2	Modified AODV Routing Protocol to Improve Security and Performance against Black Hole Attack	2016	A Mobile Ad hoc NETwork (MANET) is a collection of autonomous nodes that have the ability to communicate with each other without having fixed infrastructure or centralized access point such as a base station. This kind of networks is very susceptible to adversary's malicious attacks, due to the dynamic changes of the network topology, trusting the nodes to each other, lack of fixed substructure for the analysis of nodes behaviors and constrained resources. One of these attacks is black hole attack. In this attack, malicious nodes inject fault routing information to the network and lead all data packets toward themselves, then destroy them all. In this paper, we propose a solution, whichenhances the security of the Ad-hoc On demand Distance Vector (AODV) routing protocol to encounter the black hole attacks. Our solution avoids the black hole and the multiple black hole attacks. The simulation results using the Network Simulator NS2 shows that our protocol provides better security and better performance in terms of the packet delivery ratio than the AODV routing protocol in the presence of one or multiple black hole attacks with marginal rise in average end-to-end delay and normalized routing overhead.

3	Self-Sustainable Communications with RF Energy Harvesting: Ginibre Point Process Modeling and Analysis	2016	RF-enabled wireless power transfer and energy harvesting has recently emerged as a promising technique to provision perpetual energy replenishment for low-power wireless networks. The network devices are replenished by the RF energy harvested from the transmission of ambient RF transmitters, which offers a practical and promising solution to enable self- sustainable communications. This paper adopts a stochastic geometry framework based on the Ginibre model to analyze the performance of self-sustainable communications over cellular net- works with general fading channels. Specifically, we consider the point-to-point downlink transmission between an access point and a battery-free device in the cellular networks, where the ambient RF transmitters are randomly distributed following a repulsive point process, called Ginibre _-determinant point process (DPP). Two practical RF energy harvesting receiver architectures, namely time-switching and power-splitting, are investigated. We perform an analytical study on the RF-powered device and derive the expectation of the RF energy harvesting rate, the energy outage probability and the transmission outage probability over Nakagami-m fading channels. These are expressed in terms of so-called Fredholm determinants, which we compute efficiently with modern techniques from numerical analysis. Our analytical results are corroborated by the numerical simulations, and the efficiency of our approximations is demonstrated. In practice, the accurate simulation of any of the Fredholm determinant appearing in the manuscript is a matter of seconds. An interesting finding is that a smaller value of _ (corresponding to larger repulsion) yields a better transmission outage performance when the density of the ambient RF transmitters is small. However, it yields a lower transmission outage probability when the density of the ambient RF transmitters is large. We also show analytically that the power-splitting architecture outperforms the time-switching architecture in terms of transmission outage per-formances. Lastly, our analysis provides guidelines for setting the time-switching and power-splitting coefficients at their optimal values.
4	A Novel Framework to Enhance the Performance of Contention Based Synchronous MAC Protocols	2016	In this paper, We propose a novel framework to improve the end-to-end transmission delay (E2ETD) and packet delivery ratio (PDR) of existing contention based synchronous MAC protocols designed for wireless sensor networks, without increasing the duty cycle (DC). This is achieved by partitioning the *n* deployed sensor nodes into *k* disjoint sets (DSs) which are of almost equal size. It then suitably

			modifies the cycle structure followed by the existing contention based synchronous MAC protocols by mapping the data transmission process of *k* existing cycles into one restructured cycle. To evaluate the performance of this approach, we implement RMAC, PRMAC, and CLMAC protocols in the proposed framework using ns2.35 simulator. Results indicate that our scalable framework reduces the E2ETD and increases the PDR significantly at the cost of a very small increase in average energy consumption.
5	Secret Common Randomness from Routing Metadata in Ad-Hoc Networks	2016	Establishing secret common randomness between two or multiple devices in a network resides at the root of communication security. In its most frequent form of key establishment, the problem is traditionally decomposed into a randomness generation stage (randomness purity is subject to employing often costly true random number generators) and an informationexchange agreement stage, which relies either on public-key infrastructure or on symmetric encryption (key wrapping). In this paper, we propose a secret-common-randomness establishment algorithm for ad-hoc networks, which works by harvesting randomness directly from the network routing metadata, thus achieving both pure randomness generation and (implicitly) secret-key agreement. Our algorithm relies on the route discovery phase of an ad-hoc network employing the Dynamic Source Routing protocol, is lightweight, and requires relatively little communication overhead. The algorithm is evaluated for various network parameters in an OPNET ad-hoc network simulator. Our results show that, in just ten minutes, thousands of secret random bits can be generated network-wide, between different pairs in a network of fifty users.
6	Auction-based Data Gathering Scheme for Wireless Sensor Networks	2016	This paper proposes a novel data gathering scheme for Wireless Sensor Networks (WSN) that limits the energy expenditure, and hence, prolongs network lifetime. Data gathering is modeled as an auction where a node broadcasts its own result only if it is higher than the maximum already-broadcasted result by other nodes. For a WSN of 100 nodes, mathematical and simulation results show that the proposed scheme can save up to 70% of the energy consumption with less than 1% performance loss, compared to the conventional scheme
7	Allocation of Heterogeneous Resources of an IoT Device to Flexible Services	2016	Internet of Things (IoT) devices can be equipped with multiple heterogeneous network interfaces. An overwhelmingly large amount of services may demand some or all of these interfaces' available resources. Herein, we present a precise mathematical formulation of assigning services to interfaces with heterogeneous resources in one or

			more rounds. For reasonable instance sizes, the presented formulation produces optimal solutions for this computationally hard problem. We prove the NP-Completeness of the problem and develop two algorithms to approximate the optimal solution for big instance sizes. The first algorithm allocates the most demanding service requirements first, considering the average cost of interfaces resources. The second one calculates the demanding resource shares and allocates the most demanding of them first by choosing randomly among equally demanding shares. Finally, we provide simulation results giving insight into services splitting over different interfaces for both cases.
8	Energy profiling in practical sensor networks: Identifying hidden consumers	2016	Reducing energy consumption of wireless sensor nodes extends battery life and / or enables the use of energy harvesting and thus makes feasible many applications that might otherwise be impossible, too costly or require constant maintenance. However, theoretical approaches proposed to date that minimise WSN energy needs generally lead to less than expected savings in practice. We examine experiences of tuning the energy profile for two near-production wireless sensor systems and demonstrate the need for (a) microbenchmark-based energy consumption profiling, (b) examining start-up costs, and (c) monitoring the nodes during long-term deployments. The tuning exercise resulted in reductions in energy consumption of a) 93% for a multihop Telos-based system (average power 0.029 mW) b) 94.7% for a single hop Ti- 8051-based system during startup, and c) 39% for a Ti- 8051 system post start-up. The work reported shows that reducing the energy consumption of a node requires a whole system view, not just measurement of a “typical” sensing cycle. We give both generic lessons and specific application examples that provide guidance for practical WSN design and deployment.
9	Distributed Sequential Location Estimation of a Gas Source via Convex Combination in WSNs	2016	Localization of the hazardous gas source plays an important role in the protection of public security, since it can save a lot of time for subsequent rescue works. For gas source localization (GSL), a large number of gas sensor nodes can be rapidly deployed to construct a wireless sensor network (WSN) and cover the whole concerned area. Although least-squares (LS) methods can solve the problem of GSL in WSNs regardless of the distribution of measurement noises, centralized LS methods are not power efficient and robust since they require the gathering and processing of large-scale measurements on a central node. In this paper, we propose a novel distributed method for GSL in WSNs, which is performed on a sequence of sensor nodes successively. Each

			sensor node in the sequence conducts an individual estimation and a convex combination. The individual estimation is inspired by the LS formulation of the problem of GSL in WSNs. The proposed method is fully distributed and computationally efficient, and it does not rely on the absolute location of the sensor nodes. Extensive simulation results and a set of experimental results demonstrate that the success rate and localization accuracy of the proposed method are generally higher than those of the trust-region-reflective method.
10	SRA: A Sensing Radius Adaptation Mechanism for Maximizing Network Lifetime in WSNs	2016	Coverage is an important issue that has been widely discussed in wireless sensor networks (WSNs). However, it is still a big challenge to achieve both purposes of full coverage and energy balance. This paper considers the area coverage problem for a WSN where each sensor has variable sensing radius. To prolong the network lifetime, a weighted Voronoi diagram (WVD) is proposed as a tool for determining the responsible sensing region of each sensor according to the remaining energy in a distributed manner. The proposed mechanism, called SRA, mainly consists of three phases. In the first phase, each sensor and its neighboring nodes cooperatively construct the WVD for identifying the responsible monitoring area. In the second phase, each sensor adjusts its sensing radius to reduce the overlapping sensing region such that the purpose of energy conservation can be achieved. In the last phase, the sensor with the least remaining energy further adjusts its sensing radius with its neighbor for maximizing the network lifetime. Performance evaluation and analysis reveal that the proposed SRA mechanism outperforms the existing studies in terms of the network lifetime and the degree of energy balance. □
11	Cost-Aware Activity Scheduling for Compressive Sleeping Wireless Sensor Networks	2016	In this paper, we consider a compressive sleeping wireless sensor network (WSN) for monitoring parameters in the sensor field, where only a fraction of sensor nodes (SNs) are activated to perform the sensing task and their data are gathered at a fusion centre (FC) to estimate all the other SNs' data using the compressive sensing (CS) principle. Typically research published concerning CS implicitly assume the sampling costs for all samples are equal, and suggest random sampling as an appropriate approach to achieve good reconstruction accuracy. However, this assumption does not hold for compressive sleeping WSNs which have significant variability in sampling cost owing to the different physical conditions at particular SNs. To exploit this sampling cost non-uniformity, we propose a cost-aware activity scheduling approach that minimizes the sampling cost with constraints

			on the regularized mutual coherence of the equivalent sensing matrix. In addition, for the case with prior information about the signal support, we extend the proposed approach to incorporate the prior information by considering an additional constraint on the mean square error (MSE) of the oracle estimator for sparse recovery. Our numericalexperiments demonstrate that in comparison with other designs in the literature the proposed activity scheduling approaches lead to improved trade-offs between reconstruction accuracy and sampling cost for compressive sleeping WSNs.
12	Optimality of Fast Matching Algorithms for Random Networks with Applications to Structural Controllability	2016	Network control refers to a very large and diverse set of problems including controllability of linear time-invariant dynamical systems, where the objective is to select an appropriate input to steer the network to a desired state. There are many notions of controllability, one of them being structural controllability, which is intimately connected to finding maximum matchings on the underlying network topology. In this work, we study fast, scalable algorithms for finding maximum matchings for a large class of random networks. First, we illustrate that degree distribution random networks are realistic models for real networks in terms of structural controllability. Subsequently, we analyze a popular, fast and practical heuristic due to Karp and Sipser as well as a simplification of it. For both heuristics, we establish asymptotic optimality and provide results concerning the asymptotic size of maximum matchings for an extensive class of random networks
13	Mobile Demand Profiling for Cellular Cognitive Networking	2016	In the next few years, mobile networks will undergo significant evolutions in order to accommodate the ever-growing load generated by increasingly pervasive smartphones and connected objects. Among those evolutions, cognitive networking upholds a more dynamic management of network resources that adapts to the significant spatiotemporal fluctuations of the mobile demand. Cognitive networking techniques root in the capability of mining large amounts of mobile traffic data collected in the network, so as to understand the current resource utilization in an automated manner. In this paper, we take a first step towards cellular cognitive networks by proposing a framework that analyzes mobile operator data, builds profiles of the typical demand, and identifies unusual situations in network-wide usages. We evaluate our framework on two real-world mobile traffic datasets, and show how it extracts from these a limited number of meaningful mobile demand profiles. In addition, the

			proposed framework singles out a large number of outlying behaviors in both case studies, which are mapped to social events or technical issues in the network.
14	Nonsmooth Nonconvex Optimization for Low-Frequency Geosounding Inversion	2016	A study of the application of nonconvex regularization operators to the electromagnetic sounding inverse problem is presented. A comparison is presented among three nonconvex regularization algorithms: one smooth usually considered, two nonsmooth, and a convex one, the total variation (TV) operator. One of the nonsmooth nonconvex regularization methods is a novel implementation based on the Legendre–Fenchel transform and the Bregman iterative algorithm. The nonconvex regularization operator is approximated by the convex dual, and the minimization is then implemented considering the equivalence between the Bregman iteration and the augmented Lagrangian methods. The algorithm is simple and provides for better models when applied to synthetic data, than those obtained with TV, and other nonconvex smooth regularizers. Results of the application to field data are also presented, observing that NS2 recovers a model in better agreement with the truth, compared to those obtained with additional magnetometric resistivity data by other researchers.
15	Delay Analysis Of Social Group Multicast Aided Content Dissemination in Cellular System	2016	Based on the common interest of mobile users (MUs) in a social group, the dissemination of content across the social group is studied as a powerful supplement to conventional cellular communication with the goal of improving the delay performance of the content dissemination process. The content popularity is modelled by a Zipf distribution in order to characterize the MUs' different interests in different contents. The Factor of Altruism (FA) terminology is introduced for quantifying the willingness of content owners to share their content. We model the dissemination process of a specific packet by a pure-birth based Markov chain and evaluate the statistical properties of both the network's dissemination delay as well as of the individual user-delay. Compared to the conventional base station (BS)- aided multicast, our scheme is capable of reducing the average dissemination delay by about 56.5%. Moreover, in contrast to the BS-aided multicast, increasing the number of MUs in the target social group is capable of reducing the average individual userdelay by 44.1% relying on our scheme. Furthermore, our scheme is more suitable for disseminating a popular piece of content.
16	Delay-Energy Tradeoff in Multicast Scheduling for Green Cellular Systems	2016	Multicast transmission based on real-time network state information is a resource-friendly technique to improve the energy efficiency and reduce the traffic burden for cellular

			systems. This paper evaluates the effectiveness of this technique for downlink transmissions. In particular, a scenario is considered in which multiple mobile users (MUs) asynchronously request to download one common message locally cached at a base station (BS). Due to the randomness of both the channel conditions and the request arrivals from the MUs, the BS may choose to intelligently hold the arrived requests, especially when the channel conditions are bad or the number of requests is small, and then serve them in one shot later via multicasting. Clearly it is of great interest to balance the delay (incurred by holding the requests) and the energy efficiency (EE, defined as the energy cost per request), and this motivates us to quantify the fundamental tradeoff for the proposed "hold-then-serve" scheme. For the scenario with single channel and unit message sizes, it is shown that for a fixed channel bandwidth, the delay-EE tradeoff reduces to judiciously choosing the optimal stopping rule for when to serve all the arrived requests, where the effect of the bandwidth on the achievable delay-EE region is discussed further. By using optimal stopping theory, it is shown that the optimal stopping rule exists for general Markov channel models and request arrival processes. Particularly, for the hard deadline and proportional delay penalty cases, it is shown that the optimal stopping rule exhibits a threshold structure, and the corresponding threshold in the former case is time varying while in the latter case it is a constant. Finally, for the more general scenario with multiple channels and arbitrary message sizes, the optimal scheduling is formulated as aMarkov decision process problem, where some efficient suboptimal scheduling algorithms are proposed.
17	Link Allocation for Multiuser Systems with Hybrid RF/FSO Backhaul: Delay-Limited and Delay-Tolerant Designs	2016	Abstract—In this paper, we consider a cascaded radio frequency (RF) and hybrid RF/free space optical (FSO) system where several mobile users transmit their data over an RF link to a decode-and-forward relay node (e.g. a small cell base station) and the relay forwards the information to a destination (e.g. a macro cell base station) over a hybrid RF/FSO backhaul link. The relay and the destination employ multiple antennas for transmission and reception over the RF links while each mobile user has a single antenna. The RF links are orthogonal to the FSO link but half-duplex with respect to each other, i.e., either the user-relay RF link or the relay-destination RF link is active. For this communication setup, we derive the optimal fixed and adaptive link allocation policies for sharing the transmission time between the RF links based on the statistical and instantaneous

			channel state information (CSI) of the RF and FSO links, respectively. Thereby, we consider the following two scenarios depending on the delay requirements: i) delay-limited transmission where the relay has to immediately forward the packets received from the users to the destination, and ii) delaytolerant transmission where the relay is allowed to store the packets received from the users in its buffer and forward them to the destination when the quality of the relay-destination RF link is favorable. Our numerical results illustrate the effectiveness of the proposed communication architecture and link allocation policies, and their superiority compared to existing schemes which employ only one type of backhaul link.
18	Fair Routing for Overlapped Cooperative Heterogeneous Wireless Sensor Networks	2016	In recent years, as WSNs (Wireless Sensor Networks) are diffused widely, multiple overlapping WSNs constructed on the same area become more common. In such a situation, their lifetime is expected to be extended by cooperative packet forwarding. Although some researchers have studied about cooperation in multiple WSNs, most of them do not consider the heterogeneity in characteristics of each WSN such as battery capacity, operation start time, the number of nodes, nodes locations, energy consumption, packet size and/or data transmission timing, and so on. In a heterogeneous environment, naive lifetime improvement with cooperation may not be fair. In this paper, we propose a fair cooperative routing method for heterogeneous overlapped WSNs. It introduces an energypool to maintain the total amount of energy consumption by cooperative forwarding. The energy pool plays a role of broker for fair cooperation. Finally, simulation results show the excellent performance of the proposed method.
19	Reverse Update: A Consistent Policy Update Scheme for Software Defined Networking	2016	Policy and path updates are common causes of network instability, leading to service disruptions or vulnerable intermediate states. In this letter, we propose the Reverse Update, an update scheme for Software Defined Networking that guarantees to preserve properties of flows during the transition time. We prove through a formal model that the proposal achieves consistent policy updates, in which in-transit packets are always handled in the next forwarding hops by the same or a more recent policy. The main contributions are: (i) a relaxation of the concept of per-packet-consistency in the data plane of Software Defined Networking; and (ii) a policy update scheme, proved to be consistent and efficient. A Software Defined Networking simulator was developed and validated. The results of our simulations show that the proposed Reverse Update scheme

			is faster and has lower overhead than the current Two-Phase Update proposed in the literature.
20	Queue Stability Analysis in Network Coded Wireless Multicast Network	2016	In this paper we study queue stability in a singlehop packet erasure multicast transmission. A queuing model consisting of several sub-queues is introduced and each packet in sub-queue is associated with an index set. Next, we have to choose our scheduling method for combining the packets from sub-queues and sending a network coded packet out to the desired receivers. We formulate this problem as a linear programming problem whose constrains are the stability conditions of each sub-queue. Our main goal is to have a stable system with highest possible input rate. Hence, we study stability in multiuser scenarios and consequently find the maximum input rate. Finally in the simulation section, our results approves our studies
21	Neighbor-Aided Spatial-temporal Compressive Data Gathering in Wireless Sensor Networks	2016	The integration between data collection methods in Wireless Sensor Networks (WSNs) and Compressive Sensing (CS) provides energy efficient paradigms. Single-dimensional CS approaches are inapplicable in spatial and temporal correlated WSNs while the Kronecker Compressive Sensing (KCS) model suffers performance degradation along with the increasing data dimensions. In this paper, a Neighbor-Aided Compressive Sensing (NACS) scheme is proposed for efficient data gathering in spatial and temporal correlated WSNs. During every sensing period, the sensor node just sends the raw readings within the sensing period to a randomly and uniquely selected neighbor. Then, the CS measurements created by the neighbor are sent to the sink node directly. The equivalent sensing matrix is proved to satisfy both Structured Random Matrix (SRM) and generalized KCS models. And, by introducing the idea of SRM to KCS, the recovery performance of KCS is significantly improved. Simulation results demonstrate that compared with the conventional KCS models, the proposed NACS model can achieve vastly superior recovery performance and receptions with much fewer transmissions.
22	Adaptive and Channel-Aware Detection of Selective Forwarding Attacks in Wireless Sensor Networks	2016	Wireless sensor networks (WSNs) are vulnerable to selective forwarding attacks that can maliciously drop a subset of forwarding packets to degrade network performance and jeopardize the information integrity. Meanwhile, due to the unstable wireless channel in WSNs, the packet loss rate during the communication of sensor nodes may be high and vary from time to time. It poses a great challenge to distinguish the malicious drop and normal packet loss. In this paper, we propose a Channel-aware Reputation System with adaptive detection threshold (CRS-A) to detect selective

			forwarding attacks in WSNs. The CRS-A evaluates the data forwarding behaviors of sensor nodes, according to the deviation of the monitored packet loss and the estimated normal loss. To optimize the detection accuracy of CRS-A, we theoretically derive the optimal threshold for forwarding evaluation, which is adaptive to the time varied channel condition and the estimated attack probabilities of compromised nodes. Furthermore, an attack-tolerant data forwarding scheme is developed to collaborate with CRS-A for stimulating the forwarding cooperation of compromised nodes and improving the data delivery ratio of the network. Extensive simulation results demonstrate that CRS-A can accurately detect selective forwarding attacks and identify the compromised sensor nodes, while the attack-tolerant data forwarding scheme can significantly improve the data delivery ratio of the network.
23	HDEER: A Distributed Routing Scheme for Energy-Efficient Networking	2016	The proliferation of new online Internet services has substantially increased the energy consumption in wired networks, which has become a critical issue for Internet Service Providers. In this paper, we target the network-wide, energy saving problem by leveraging speed scaling as the energy-saving strategy. We propose a distributed routing scheme–HDEER– to improve network energy efficiency in a distributed manner without significantly compromising traffic delay. HDEER is a two-stage routing scheme where a simple distributed multi-path finding algorithm is firstly performed to guarantee loop-free routing, and then a distributed routing algorithm is executed for energy-efficient routing in each node among the multiple loop-free paths. We conduct extensive experiments on the NS3 simulator and simulations with real network topologies in different scales under different traffic scenarios. Experiment results show that HDEER can reduce network energy consumption with a fair tradeoff between network energy consumption and traffic delay.
24	Mobile Coordinated Wireless Sensor Network: An Energy Efficient Scheme for Real-Time Transmissions	2016	This paper introduces the mobile access coordinated wireless sensor network (MC-WSN) — a novel energy efficient scheme for time-sensitive applications. In conventional sensor networks with mobile access points (SENMA), the mobile access points (MAs) traverse the network to collect information directly from individual sensors. While simplifying the routing process, a major limitation with SENMA is that data transmission is limited by the physical speed of the MAs and their trajectory length, resulting in low throughput and large delay. In an effort to resolve this problem, we introduce the MCWSN architecture, for which a

			major feature is that: through active network deployment and topology design, the number of hops from any sensor to the MA can be limited to a pre-specified number. In this paper, we investigate the optimal topology design that minimizes the average number of hops from sensor to MA, and provide the throughput analysis under both single-path and multipath routing cases. Moreover, putting MC-WSN in the bigger picture of network design and development, we provide a unified framework for wireless network modeling and characterization. Under this general framework, it can be seen that MC-WSN reflects the integration of structure ensured reliability/efficiency and ad-hoc enabled flexibility.
25	Enhanced Indoor Location Tracking Through Body Shadowing Compensation	2016	This paper presents a radio frequency (RF)-based location tracking system that improves its performance by eliminating the shadowing caused by the human body of the user being tracked. The presence of such a user will influence the RF signal paths between a body-worn node and the receiving nodes. This influence will vary with the user's location and orientation and, as a result, will deteriorate the performance regarding location tracking. By using multiple mobile nodes, placed on different parts of a human body, we exploit the fact that the combination of multiple measured signal strengths will show less variation caused by the user's body. Another method is to compensate explicitly for the influence of the body by using the user's orientation toward the fixed infrastructure nodes. Both approaches can be independently combined and reduce the influence caused by body shadowing, hereby improving the tracking accuracy. The overall system performance is extensively verified on a building-wide testbed for sensor experiments. The results show a significant improvement in tracking accuracy. The total improvement in mean accuracy is 38.1% when using three mobile nodes instead of one and simultaneously compensating for the user's orientation.
26	Efficient Wireless Multimedia Multicast in Multi-rate Multi-channel Mesh Networks	2016	Devices in wireless mesh networks can operate on multiple channels and automatically adjust their transmission rates for the occupied channels. This paper shows how to improve performance-guaranteed multicasting transmission coverage for wireless multi-hop mesh networks by exploring the transmission opportunity offered by multiple rates (MR) and multiple channels (MC). Based on the characteristics of transmissions with different rates, we propose and analyze parallel low-rate transmissions (PLT) and alternative rate transmissions (ART) to explore the advantages of MRMC in improving the performance and coverage tradeoff under the constraint of limited channel resources. We then apply these

			new transmission schemes to improving the WMN multicast experience. Combined with the strategy of reliable interference-controlled connections, a novel MRMC multicast algorithm (LC-MRMC) is designed to make efficient use of channel and rate resources to greatly extend wireless multicast coverage with high throughput and short delay performance. Our NS2 simulation results prove that ART and LC-MRMC achieve improved wireless transmission quality across much larger areas as compared to other related studies.
27	The Impact of Incomplete Secure Connectivity on the Lifetime of Wireless Sensor Networks	2016	Key predistribution schemes accommodate secure connectivity by establishing pairwise keys between nodes. However, ensuring security for all communication links of a wireless sensor network (WSN) is nontrivial due to the memory limitations of the nodes. If some of the links are not available due to the lack of a primary security association between the transmitter and the receiver, nodes can still send their data to the base station but probably not via the best route that maximizes the network lifetime. In this study, we propose a linear programming framework to explore the incomplete secure connectivity problem with respect to its impact on network lifetime, path length, queue size, and energy dissipation. The numerical results show that if any two nodes share a key with a probability of at least 0.3, then we should expect only a marginal drop (i.e., less than 3.0%) in lifetime as compared to a fully connected network.
28	Game-Theoretic Multi-Channel Multi-Access in Energy Harvesting Wireless Sensor Networks	2016	Energy harvesting (EH) has been proposed as a promising technology to extend the lifetime of wireless sensor networks (WSNs) by continuously harvesting green/renewable energy. However, the intermittent and random EH process as well as the complexity in achieving global network information calls for efficient energy management and distributed resource optimization. Considering the complex interactions among individual sensors, we use game theory to perform distributed optimization for the general multi-channel multi-access problem in an EH-WSN, where strict delay constraints are imposed for the data transmission. Sensors' competition for channel access is formulated as a non-cooperative game, which is proved to be an ordinal potential game that has at least one Nash equilibrium (NE). Furthermore, all the NE of the game are proved to be Pareto-optimal, and the Jain's fairness index bound of the NE is theoretically derived. Finally, we design a fully distributed, online learning algorithm for the multi-channel multi-access in the EH-WSN, which is proved to converge to the NE of the formulated game. Simulation results validate the

			effectiveness of the proposed algorithm.
29	Efficient and Privacy-preserving Polygons Spatial Query Framework for Location-based Services	2016	With the pervasiveness of mobile devices and the development of wireless communication technique, location-based services (LBS) have made our life more convenient, and the polygons spatial query, which can provide more flexible LBS, has attracted considerable interest recently. However, the flourish of polygons spatial query still faces many challenges including the query information privacy. In this paper, we present an efficient and privacy-preserving polygons spatial query framework for location-based services, called Polaris. With Polaris, the LBS provider outsources the encrypted LBS data to cloud server, and the registered user can query any polygon range to get accurate LBS results without divulging his/her query information to the LBS provider and cloud server. Specifically, an efficient special polygons spatial query algorithm (SPSQ) over ciphertext is constructed, based on an improved homomorphic encryption technology over composite order group. With SPSQ, Polaris can search outsourced encrypted LBS data in cloud server by the encrypted request, and respond the encrypted polygons spatial query results accurately. Detailed security analysis shows that the proposed Polaris can resist various known security threats. In addition, performance evaluations via implementing Polaris on smartphone and workstation with real LBS dataset demonstrate Polaris' effectiveness in term of real environment.
30	Cooperative Internet Access using Helper Nodes and Opportunistic Scheduling		Having ubiquitous access to the Internet is becoming a necessity of life. Furthermore, we are witnessing a rapid increase in the amount of data requested by mobile users. Cooperative Internet access is a promising approach for addressing these demands, which gives the mobile devices the opportunity to receive help from other mobile devices in order to access the Internet. The helpers can download the data requested by the other users, called clients, through their cellular connections. Then, they transmit the downloaded data to the clients using Wi-Fi or Bluetooth connections. In this paper, we consider the problem of how to share the resources of helpers among a set of clients that request their assistance. Opportunistic scheduling is an effective method that uses the dynamic channel conditions to elevate the systems' overall utilities. We propose an opportunistic scheduling algorithm in order to efficiently use the helper nodes and share them among the clients fairly. We propose a rate control and scheduling method in the case of using only Wi-Fi connections. We also propose a solution for the case

			of using Wi-Fi and Bluetooth at the same time. Through simulation results, we show the effectiveness of our cooperative downloading methods.
31	Resiliency of Mobility-as-a-Service Systems to Denial-of-Service Attacks		Mobility-as-a-Service (MaaS) systems such as ride sharing services have expanded very quickly over the past years. However, the popularity of MaaS systems make them increasingly vulnerable to Denial-of-Service (DOS) attacks, in which attackers attempt to disrupt the system to make it unavailable to the customers. Expanding on an established queuing-theoretical model for MaaS systems, attacks are modeled as a malicious control of a fraction of vehicles in the network. We then formulate a stochastic control problem that maximizes the passenger loss in the network in steady state, and solve it as a sequence of linear and quadratic programs. Combined with a Jackson network simulation and an economic model of supply and demand for attacks, we quantify how raising the cost of attacks (via cancellation fees and higher level of security) Removes Economical incentives for DoS attacks. Calibrating the model on 1B taxi rides, we dynamically simulate a system under attack and estimate the passenger loss under different scenarios, such as arbitrarily depleting taxis or maximizing the passenger loss. Cost of attacks of $15 protects the MaaS system against DoS attacks. The contributions are thus a theoretical framework for the analysis of the network, and practical conclusions in terms of financial countermeasures to the attacks.
32	Optimal node allocation in multi-service WSNs based on correlated strategy		A distributed game theoretic framework based on correlated strategies is proposed to maximize the lifetime of dense, homogeneous, multi-service Wireless Sensor Networks (MS-WSNs), that support multiple services continually and ubiquitously over the WSN deployment. The MS-WSN operation is dealt with as a game played by the multi-mode nodes. A correlated strategies approach is proposed to lead the MSWSN close to its theoretical optimal state with respect to the network lifetime. The computationally efficient correlated strategy proposed to implement service selection by the multimode WSN nodes is distributed, based solely on local information exchange. Indicative simulation results concerning the application of the proposed scheme on top of k-hop clustering reveal that the Proposed correlated strategies based framework leads the MSWSN operation close to its theoretical optimal at no significant exchange of overhead messages.
33	Wireless Service Provider Selection and Bandwidth Resource Allocation in Multi-		In this paper, we study the inter-linked problems of wireless service provider (WSP) selection of users and bandwidth allocation of WSPs in multi-tier heterogeneous cellular

	tier HCNs		networks (HCNs) employing the approach combining stochastic geometry and game theory. Particularly, the expected average user achievable rate is calculated by modeling the distributions of users and base stations (BSs) as independent homogeneous Poisson Point Processes (PPPs). Moreover, a hierarchical game framework is presented to model the complicated interactions among users and WSPs. Wherein, the evolutionary game, non-cooperative game and multi-leader multi-follower Stackelberg game models are respectively adopted to formulate the competition among users, competition among WSPs and cyclic dependency between users and WSPs. According to backward induction, the formulated Stackelberg game would be solved after the formulated evolutionary game and non-cooperative game are sequentially studied. For the evolutionary game, both the closed form expression and asymptotically stability of its evolutionary equilibrium (EE) was analyzed. Then, conditioned on the obtained EE, the existence of Nash equilibrium (NE) for the non-cooperative bandwidth allocation game is established and further, a sufficient condition for the uniqueness of the NE is derived. Finally, extensive simulation results verify both the validity of our analysis and effectiveness of the proposed scheme.
34	On resilience and connectivity of secure wireless sensor networks under node capture attacks		Despite much research on probabilistic key pre-distribution schemes for wireless sensor networks over the past decade, few formal analyses exist that define schemes' resilience to node-capture attacks precisely and under realistic conditions. In this paper, we analyze the resilience of the q-composite key pre-distribution scheme, which mitigates the node capture vulnerability of the Eschenauer–Gligor scheme in the neighbor discovery phase. We derive scheme parameters to have a desired level of resiliency, and obtain optimal parameters that defend against different adversaries as much as possible. We also show that this scheme can be easily enhanced to achieve the same "perfect resilience" property as in the random pairwise key pre-distribution for attacks launched *after* neighbor discovery. Despite considerable attention to this scheme, much prior work explicitly or implicitly uses an *incorrect* computation for the probability of link compromise under node-capture attacks and ignores real-world transmission constraints of sensor nodes. Moreover, we derive the critical network parameters to ensure connectivity in both the absence and presence of node-capture attacks. We also investigate node replication attacks by analyzing the adversary's optimal strategy.

35	Node Service Ability Aware Packet Forwarding Mechanism in Intermittently Connected Wireless Networks		Intermittently Connected Wireless Networks (ICWNs) have been studied in recent years to solve the disruption problem in Mobile Ad hoc Networks (MANETs) and improve the utilization of temporary links raised by node movements. In ICWNs, the packet storing-carrying-forwarding principle is adopted through the cooperation between multiple nodes. Therefore, it is critical to include the connection status of nodes in designing efficient packet forwarding mechanism. In this paper, a node service ability aware packet forwarding mechanism is proposed based on the connection status. Firstly, the connection model is established to analyze the transition of connection status; moreover, the service ability can be evaluated according to the connection strength and connection availability. Secondly, packet forwarding levels are determined based on their transmitting status to exploit the limited buffer resources. Consequently, the efficient packet forwarding mechanism can guarantee the flexibility of packet transmission in both complex And dynamic network scenarios. Numerical results show that about 20% delivery ratio increase can be achieved by the proposed mechanism, while the overheads and latency are Reduced.
36	SRA: A Sensing Radius Adaptation Mechanism for Maximizing Network Lifetime in WSNs		Coverage is an important issue that has been widely discussed in wireless sensor networks (WSNs). However, it is still a big challenge to achieve both purposes of full coverage and energy balance. This paper considers the area coverage problem for a WSN where each sensor has variable sensing radius. To prolong the network lifetime, a weighted Voronoi diagram (WVD) is proposed as a tool for determining the responsible sensing region of each sensor according to the remaining energy in a distributed manner. The proposed mechanism, called SRA, Mainly consists of three phases. In the first phase, each sensor and its neighboring nodes cooperatively construct the WVD for identifying the responsible monitoring area. In the second phase, each sensor adjusts its sensing radius to reduce the overlapping sensing region such that the purpose of energy conservation can be achieved. In the last phase, the sensor with the least remaining energy further adjusts its sensing radius with its neighbor for maximizing the network lifetime. Performance evaluation and analysis reveal that the proposed SRA mechanism outperforms the existing studies in terms of the network lifetime and the degree of energy balance.
37	Learning-Based Distributed Detection-Estimation in Sensor Networks with		The problem of distributed estimation of an unknown deterministic scalar parameter (the target signal) in a wireless sensor network (WSN) is considered, where each

	Unknown Sensor Defects		sensor receives a single snapshot of the field. It is assumed that the observation at each node randomly falls into one of two modes: a valid or an invalid observation mode. Specifically, mode one corresponds to the desired signal plus noise observation mode (*valid*), and mode two corresponds to the pure noise mode (*invalid*) due to node defect or damage. With no prior information on such local sensing modes, a learning-based distributed procedure is introduced, called the mixed detection-estimation (MDE) algorithm, based on iterative closed-loop interactions between mode learning (detection) and target estimation. The online learning step re-assesses the validity of the local observations at each iteration, thus refining the ongoing estimation update process. The convergence of the MDE algorithm is established Analytically. Asymptotic analysis shows that, in the high signal-to noise ratio (SNR) regime, the MDE estimation error converges to that of an ideal (centralized) estimator with perfect information about the node sensing modes.
38	An Efficient Anonymous Batch Authentication Scheme Based on HMAC for VANETs		In vehicular ad hoc networks (VANETs), when a Vehicle receives a message, the certificate revocation list (CRL) checking process will operate before certificate and signature verification. However, large communication sources, storage space, and checking time are needed for CRLs that cause the privacy Disclosure issue as well. To address these issues, in this paper, we propose an efficient anonymous batch authentication scheme (ABAH) to replace the CRL checking process by calculating the hash message authentication code (HMAC). In our scheme, we first divide the precinct into several domains, in which road-side units (RSUs) manage vehicles in a localized manner. Then, we adopt pseudonyms to achieve privacy-preserving and realize batch authentication by using an identity-based signature (IBS). Finally, we use HMAC to avoid the time-consuming CRL checking and to ensure the integrity of messages that may get loss in previous batch authentication. The security and performance analysis are carried out to demonstrate that ABAH is more efficient in terms of verification delay than the conventional authentication methods employing CRLs. Meanwhile, our solution can keep conditional privacy in VANETs.
39	Congestion-Aware Embedding of Heterogeneous Bandwidth Virtual Data Centers With Hose Model Abstraction		Predictable network performance is critical for cloud applications and can be achieved by providing tenants a dedicated virtual data center (VDC) with bandwidth guarantee. Recently, the extended Hose model was applied to the VDC abstraction to characterize the tradeoff between

			cost and network performance. The acceptability determination problem of a VDC with heterogeneous bandwidth demand was proved to be NP-complete, even in the simple tree topology. In this paper, we investigate the embedding problem for heterogeneous bandwidth VDC in substrate networks of general topology. The embedding problem involves two coupled sub-problems: virtual machine (VM) placement and multipath route assignment. First, we formulate the route assignment problem with linear programming to minimize the maximum link utilization, and provide *K*-widest path load-balanced routing with controllable splitting paths. Next, we propose a polynomial-time heuristic algorithm, referred to as the perturbation algorithm, for the VM placement. The perturbation algorithm is congestion-aware as it detects the bandwidth bottlenecks in the placement process and then selectively relocates some assigned VMs to eliminate congestion. Simulation results show that our algorithm performs better in comparison with the existing well-known algorithms: first-fit, next-fit, and greedy, and very close to the exponential time Complexity backtracking algorithm in typical data center network architectures. For the tree substrate network, the perturbation algorithm performs better than the allocation-range algorithm. For the homogeneous bandwidth VDC requests, the perturbation algorithm produces a higher success rate than the recently proposed HVC-ACE algorithm. Therefore, it provides a compromised solution between time complexity and network performance
40	Dual-Bound-Constraints in Morphological Model Refinement for Multiple Skin Color Tones Detection		This paper aims to propose a solution to skin color detection problem when existing multiple skin-color target persons in the image. The AdaBoost algorithm is used to detect the position of the face, and the dominant color of every face regions is used as the initial skin color sample. A new type of sample update mechanism is used to increase the skin color detection accuracy rate, with a constraint mechanism controlling the number of iterations, allowing the proposed system to find out a more complete and smooth skin color regions. In comparison to other methods with fixed samples, the skin color samples in this study varies with each execution, and the resistance to the skin color shift caused by light and shade is improved.