ELYSIUMPRO
INSPIRING THE LEADING EDGE TECHNOLOGIES

ELYSIUMPRO

—INSPIRING THE LEADING EDGE TECHNOLOGIES —

FINAL YEAR PROJECTS

MOBILE COMPUTING 2018 - 2019

TITLES WITH ABSTRACTS

CALL US @

(+91) 9944 7933 98

(+91) 452-439 0702, 439 2702

19 Years of Experience | Automated Services | 24/7 Help Desk Support

Advanced Technologies and tools | Legitimate Members of all Journals

ELYSIUM GROUPS

ELYSIUMPRO

INSPIRING THE LEADING EDGE TECHNOLOGIES

www.elysiumpro.in

#227, Elysium Campus, Church Road, Anna Nagar,
Madurai - 625020, Tamil Nadu, India

CALL US @

+91 9944 7933 98

(+91) 452 439 0702, (+91) 452 439 2702

/ElysiumPro Project Center / ElysiumPro / ElysiumPro

ELYSIUM GROUPS

EPRO MC - 001	A Two-Tier Distributed Fuzzy Logic Based Protocol for Efficient Data Aggregation in Multi-Hop Wireless Sensor Networks

This study proposes a two-tier distributed fuzzy logic based protocol in order to improve efficiency of data aggregation operations in multi-hop wireless sensor networks (WSNs). Clustering is utilized for efficient aggregation requirements in terms of consumed energy. In a clustered network, member (leaf) nodes transmit obtained data to cluster-heads (CH) and CHs relay received packets to the base station. In multi-hop wireless networks, this CH-generated transmission occurs over other CHs. Due to the adoption of a multi-hop topology, hotspots and/or energy-hole problems may arise. In this paper, we propose a Two-Tier Distributed Fuzzy Logic Based Protocol (TTDFP) to extend the lifespan of multi-hop WSNs by taking the efficiency of clustering and routing phases jointly into account. The proposed protocol, TTDFP, is a distribution-adaptive protocol that runs and scales efficiently for sensor network applications. Additionally, along with the two-tier fuzzy logic based protocol, we utilize an optimization framework to tune the parameters used in the fuzzy clustering tier in order to optimize the performance of a given WSN. This paper also includes performance comparisons and experimental evaluations with the selected state-of-the-art algorithms. The experimental results reveal that TTDFP performs better than any of the other protocols under the same network setup considering metrics used for comparing energy-efficiency and network lifespan of the protocols.

EPRO MC - 002	Mobile Data Gathering with Bounded Relay in Wireless Sensor Networks

Sensing data gathering is an important and fundamental issue in the Internet of Things (IoT). However, for battery-powered sensors, energy depletion is unavoidable. Using mobile sinks to collect sensing data by one-hop transmission is an effective way to prolong the lifetime of wireless sensor networks but will inevitably cause an excessive long delay time of data gathering. In order to reduce the delay time of mobile data gathering, it is necessary to incorporate multi-hop transmission into mobile data gathering. In this paper, a new mobile data gathering algorithm with multi-hop transmission is proposed to reduce the delay time of data gathering. The proposed algorithm is called the Bounded Relay Combine-TSP-Reduce (BR-CTR). The BR-CTR algorithm visits the convergence area of sensors' communication ranges to reduce the number of visiting points. The BR-CTR algorithm is integrated with a path adjustment mechanism, which can further shorten the planned traveling path effectively. In performance evaluation, we compare the BR-CTR algorithm not only with the existing mobile data gathering algorithms with one-hop transmission but also with the existing mobile data gathering algorithms with multi-hop transmission in terms of the length of traveling path, delay time, network lifetime and buffer size requirement. Experimental results indicate that the proposed algorithm has high performance on all the above-mentioned indices.

EPRO MC - 003	Zone Probabilistic Routing for Wireless Sensor Networks

This article modeled the data routing problem in Wireless Sensor Networks as an in-zone random process. The data packets are randomly routed from the source to the sink within the defined Routing Zone via any-path. The proposed "Zone Probabilistic Routing (ZPR)" is a distributed probabilistic and randomized anycast routing protocol. In ZPR, The forwarding probability distribution is defined by multiplying the Four Probability Distributions (4PD) namely: direction, transmission distance, perpendicular distance and residual energy. In order to meet different performance requirements for different applications, these probability distributions are completely controllable via a set of exponential control-parameters (direction control, transmission distance control, perpendicular distance control and residual energy control). This set of parameters is user-oriented and can be modified prior to nodes deployment to achieve different performances. Through extensive simulations and experimental results, the optimal values for these exponential control-parameters have been obtained to meet different performance requirements in terms of energy consumption, energy balancing, network lifetime and delay. Furthermore, through an extensive performance evaluation study and simulation of large-scale scenarios, the results showed that our proposed ZPR protocol achieved better performance compared to the state-of-the-art solutions in terms of network lifetime, energy consumption and data routing efficiency.

EPRO MC - 004	Charging Utility Maximization in Wireless Rechargeable Sensor Networks by Charging Multiple Sensors Simultaneously

Wireless energy charging has been regarded as a promising technology for prolonging sensor lifetime in wireless rechargeable sensor networks (WRSNs). Most existing studies focused on one-to-one charging between a mobile charger and a sensor that suffers charging scalability and efficiency issues. A new charging technique - one-to-many charging scheme that allows multiple sensors to be charged simultaneously by a single charger can well address the issues. In this paper, we investigate the use of a mobile charger to charge multiple sensors simultaneously in WRSNs under the energy capacity constraint on the mobile charger. We aim to minimize the sensor energy expiration time by formulating a novel charging utility maximization problem, where the amount of utility gain by charging a sensor is proportional to the amount of energy received by the sensor. We also consider the charging tour length minimization problem of minimizing the travel distance of the mobile charger if all requested sensors must be charged, assuming that the mobile charger has sufficient energy to support all requested sensor charging and itself travelling. Specifically, in this paper, we first devise an approximation algorithm with a constant approximation ratio for the charging utility maximization problem if the energy consumption of the mobile charger on its charging tour is negligible. Otherwise, we develop an efficient heuristic for it through a non-trivial reduction from a length-constrained utility maximization problem.

EPRO MC - 005	Distributed Node Coordination for Real-Time Energy-Constrained Control in Wireless Sensor and Actuator Networks

Wireless Sensor and Actuator Networks (WSANs) are emerging as a new generation of Wireless Sensor Networks (WSNs). Due to the coupling between the sensing areas of the sensors and the action areas of the actuators, the efficient coordination among the nodes is a great challenge. In this paper, we address the problem of distributed node coordination in WSANs aiming at meeting the user's requirements on the states of the Points of Interest (POIs) in a real-time and energy-efficient manner. The node coordination problem is formulated as a non-linear program. To solve it efficiently, the problem is divided into two correlated subproblems: the Sensor-Actuator (S-A) coordination and the Actuator-Actuator (A-A) coordination. In the S-A coordination, a distributed federated Kalman filter-based estimation approach is applied for the actuators to collaborate with their ambient sensors to estimate the states of the POIs. In the A-A coordination, a distributed Lagrange-based control method is designed for the actuators to optimally adjust their outputs, based on the estimated results from the S-A coordination. The convergence of the proposed method is proved rigorously. As the proposed node coordination scheme is distributed, we find the optimal solution while avoiding high computational complexity. The simulation results also show that the proposed distributed approach is an efficient and practically applicable method with reasonable complexity.

EPRO MC - 006	Index Modulation for Cluster-based Wireless Sensor Networks

Index Modulation is applied to cluster-based wireless sensor networks (WSNs) in this study. The aim is to design an efficient decision gathering scheme for target-detection cluster-based WSNs. The proposed scheme implies that only a single node reports all the local decisions from cluster-members toward the central entity. Unlike conventional clustering, the reporting node is not fixed as it varies based on the obtained local decisions. Consequently, the local decisions of all cluster members are divided into two groups. The first one is modulated and the other one determines the index of the reporting node. The decision error rate of the proposed scheme is analyzed and an upper bound is derived. The derived bound is shown to precisely matches simulation results at pragmatic signal to noise ratio values. Furthermore, the detection threshold for the global decision is optimized for minimizing the decision error rate, and formulated in a closed-form expression.

EPRO MC - 007	A Novel Hierarchical Two-tier Node Deployment Strategy for Sustainable Wireless Sensor Networks

Wireless sensor networks (WSNs) have been widely adopted to fulfil the imperative requirement of real-time monitoring and/or long-term surveillance of the field-of-interest. However, due to the limited battery capacity, energy is the most critical constraint for improving the sustainability of a WSN. Hence, conserving energy and extending battery life are important in designing a sustainable WSN. Fortunately, the emerging energy harvest techniques provide us with a semi-permanent energy resource to power WSNs. In this article, we introduce a novel energy-aware hierarchical two-tier (HTT) energy harvesting-aided WSNs deployment scenario. More precisely, we consider two types of nodes in the system: one is the regular battery-powered sensor node (RSN), and the other is the energy harvesting-aided data relaying node (EHN). The objective is to use only RSNs to monitor FoI, while EHNs focus on collecting the sensed data from RSNs and forwarding the gathered data to the data sink. The minimum number of EHNs is deployed based on a newly designed probability density function to minimize the energy consumption of RSNs. This, in turn, extends the lifetime of the deployed WSN. The simulation results indicate that the proposed scheme outperforms some well-known techniques in the network lifetime, while enhancing the total throughput.

EPRO MC - 008	Maximizing Sensor Lifetime with the Minimal Service Cost of a Mobile Charger in Wireless Sensor Networks

The wireless energy transfer technology based on magnetic resonant coupling has emerged as a promising technology for wireless sensor networks, by providing controllable yet perpetual energy to sensors. In this paper we study the use of a mobile charger to wirelessly charge sensors in a rechargeable sensor network so that the sum of sensor lifetimes is maximized while the travel distance of the mobile charger is minimized. Unlike existing studies that assumed a mobile charger must charge a sensor to its full energy capacity before moving to charge the next sensor, in this paper we assume that each sensor can be partially charged so that more sensors can be charged by the mobile charger before their energy depletions. Under this new charging model, we first formulate two novel optimization problems of scheduling a mobile charger to charge a set of sensors, with the objectives to maximize the sum of sensor lifetimes and to minimize the travel distance of the mobile charger while achieving the maximum sum of sensor lifetimes, respectively. We then propose efficient algorithms for the problems. We finally evaluate the performance of the proposed algorithms through experimental simulations. Simulation results demonstrate that the proposed algorithms are very promising.

EPRO MC - 009	Secure Distributed Estimation over Wireless Sensor Networks under Attacks

The problem of distributed estimation over wireless sensor networks in an adversarial environment with the presence of attacks on sensed and communicated information is considered. To tackle with this problem, a secure diffusion leastmean squares (S-dLMS) algorithm is proposed. The proposed SdLMS can be considered as a hybrid system, which consists of a non-cooperative LMS (nc-LMS) subsystem and a diffusion LMS (dLMS) subsystem. The nc-LMS subsystem is used to provide a reliable reference estimate, which is further used for constructing the threshold test to detect the trust neighbors of each node. Then, based on the detected secure network topology, the dLMS subsystem is performed by combining the received information from the trust neighbors. The performance of the proposed SdLMS algorithm in the mean and mean-square senses is analyzed, and then an adaptive rule is suggested to select the threshold for detection. Finally, some simulations are performed to show the effectiveness of the proposed S-dLMS algorithm under fixed and time-varying attacks, respectively.

EPRO MC - 010	A Decentralized Optimization Framework for Energy Harvesting Devices

Designing decentralized policies for wireless communication networks is a crucial problem, which has only been partially solved in the literature so far. In this paper, we propose a Decentralized Markov Decision Process (Dec-MDP) framework to analyze a wireless sensor network with multiple users which access a common wireless channel. We consider devices with energy harvesting capabilities that aim at balancing the energy arrivals with the data departures and with the probability of colliding with other nodes. Over time, an access point triggers a SYNC slot, wherein it recomputes the optimal transmission parameters of the whole network, and distributes this information. Every node receives its own policy, which specifies how it should access the channel in the future, and, thereafter, proceeds in a fully decentralized fashion, with no interactions with other entities in the network. We propose a multi-layer Markov model, where an external MDP manages the jumps between SYNC slots, and an internal Dec-MDP computes the optimal policy in the short term. We numerically show that, because of the harvesting, stationary policies are suboptimal in energy harvesting scenarios, and the optimal trade-off lies between an orthogonal and a random access system.

EPRO MC - 011	Optimal Packet Aggregation Scheduling in Wireless Networks

to-machine communication. Wireless sensor networks are deployed every day, resulting in a more distributed infrastructure, where the communication and processing are handled by energy, bandwidth, and processing constrained devices. Aggregation of multiple packets flowing over the same path increases spectral efficiency, energy efficiency, and resource utilization. We address the problem of determining the optimal waiting time to maximize the utility within the network. We provide a general framework, where the utility function is user-defined for each individual application stream and packet. This allows the user to optimize for energy, delay or expiration rate in the resolution of individual streams. Our algorithm calculates the optimal time for any given condition on-the-fly and can adapt to changing conditions with low computational complexity. We provide an optimal multi-hop distributed and scalable under congestion versions of our algorithm. Our simulations in ns3 show that we outperform state-of-the-art policies by 1.55x in terms of information freshness. Our solution reduces average power consumption by more than 60%. Our congestion-aware solution shows constant performance with increasing congestion levels, whereas state-of-the-art solutions degrade by up to 70% under the same conditions.

EPRO MC - 012	Sustainable and Efficient Data collection in Cognitive Radio Sensor Networks

Cognitive Radio is a promising technology to maximize spectrum efficiency that can apply to Wireless Sensor Networks. This paper proposes a protocol for Cognitive Radio Sensor Network for efficient power management, spectrum sharing that meets QoS requirements for data rates and interference management among Cognitive Radio Sensor Network Clusters. The large Wireless Sensors Network is cloud-assisted by an SDN-controller and multiple sinks to help with the data collection and allow sensors operate at a lower power. The protocol encompasses an reinforcement learning scheme for efficient spectrum utilization that reduces energy consuming spectrum hand-offs. Software Defined Wireless Sensor Network dynamically adapts to the spectrum and interference requirements on per active flow basis and learns Primary Users' traffic to totally avoid collision with the licensed users. The Cognitive Radio Sensor Network is considered as large organized on a local basis to extend networks lifetime and resource reuse.

EPRO MC - 013	Fast Deployment of UAV Networks for Optimal Wireless Coverage

Unmanned Aerial Vehicle (UAV) networks have emerged as a promising technique to rapidly provide wireless coverage to a geographical area, where a flying UAV can be fast deployed to serve as cell site. Existing work on UAV-enabled wireless networks overlook the fast UAV deployment for wireless coverage, and such problems have only been studied recently in sensor networks. By considering such UAV heterogeneity to cover the whole target area, this paper studies two fast UAV deployment problems: one is to minimize the maximum deployment delay among all UAVs (min-max) for fairness consideration, and the other is to minimize the total deployment delay (min-sum) for efficiency consideration. We prove both min-max and min-sum problems are NP-complete in general. When dispatching UAVs from the same location, we give an optimal algorithm of low computational complexity $O(n2)$ for the min-max problem. When UAVs are dispatched from different locations, we preserve their location order during deployment and successfully design a fully polynomial time approximation scheme (FPTAS) of computation complexity $O(n2\log 1\epsilon)$ to arbitrarily approach the global optimum with relative error ϵ. When UAVs are dispatched from the same initial location, we present an approximation algorithm of linear time. As for the general case, we propose a pseudo polynomial-time algorithm to solve it optimally

EPRO MC - 014	Throughput-Optimal Broadcast in Wireless Networks with Dynamic Topology

We consider the problem of throughput-optimal broadcastingin time-varying wireless network with an underlying Directed Acyclic (DAG) topology. Known broadcast algorithms route packets along pre-computed spanning trees. In large wireless networks with time-varying connectivities, the optimal trees are difficult to compute and maintain. In this paper we propose a new online throughput-optimal broadcast algorithm, which takes packet-by-packet scheduling and routing decisions, obviating the need for any global topological structures, such as spanning-trees. Our algorithm utilizes certain queue-like system-state information for making transmission decisions and hence, may be thought of as a generalization of the well-known back-pressure algorithm, which makes point-to-point unicast transmission decisions based on local queue-length information. Technically, the back-pressure algorithm is derived by greedily stabilizing the packet-queues. However, because of packet-duplications, the work-conservation principle is violated and appropriate queuing processes are difficult to define in the broadcast setting. To address this fundamental issue, we identify certain state-variables which evolve like virtual queues. By stochastically stabilizing these virtual queues, we devise a throughput-optimal broadcast policy. We also derive new characterizations of the broadcast-capacity of time-varying wireless DAGs and propose efficient algorithms to compute the capacity either exactly or approximately under various assumptions.

EPRO MC - 015	A Data Parasitizing Scheme for Effective Health Monitoring in Wireless Body Area Networks

Wireless body area networks (WBANs) have emerged recently to provide health monitoring for chronic patients. In a WBAN, the patient's smartphone is deemed an appropriate sink to help forward the sensing data to back-end servers. Through a real-world case study, we observe that temporary disconnection between sensors and the associated smartphone can happen frequently due to postural changes, causing a significant amount of data to be lost forever. In this paper, we propose a scheme to parasitize the data in surrounding Wi-Fi networks whenever temporary disconnection occurs. Specifically, we model data parasitizing as an optimization problem, with the objective of maximizing the system lifetime without any data loss. Then, we propose an optimal offline algorithm to solve the problem, as well as an online algorithm that allows practical implementations. We have also implemented a prototype system, where the online algorithm serves as the underlying technique, based on Arduino. To evaluate our scheme, we conduct a series of experiments with the prototype system in controlled and real-world environments. The results show that the lifetime is prolonged by 100 times, and it could be further doubled if the health monitoring application permits a few packet losses.

EPRO MC - 016	SenseVault: A Three-tier Framework for Securing Mobile Underwater Sensor Networks

The unique characteristics of underwater channels, such as the mobility of sensor nodes, require robust and efficient security mechanisms for secure and efficient data collection in mobile underwater sensor networks (UWSNs). In this paper, we propose a novel three-tier framework for securing data collections in mobile UWSNs, called SenseVault. First, to support both the authentication of intra-cluster nodes and the authentication of inter-cluster nodes, we propose a cubic cluster formation approach to adapt to dynamic environments with flexible split and merge operations, and use cryptographic hash functions to derive secret keys for the authentication of nodes moving among the clusters. Second, we design a lightweight node revocation and authentication key update mechanism based on higher-order polynomial. To provide strong resilience against misbehavior of the compromised cluster head, we further introduce a Tripartite Cooperation Update (TCU) scheme by leveraging the cooperation among surface stations, safe neighboring cluster heads and safe intra-cluster members. Third, we propose a deterministic quantization approach, called Virtual Phase Shift (VPS) for the secure generation of secret keys at the physical layer. Extensive experimental results demonstrate the effectiveness of the proposed framework under different scenarios.

EPRO MC - 017	Traffic-Aware Sensor Grouping for IEEE 802.11ah Networks: Regression Based Analysis and Design

Traditional IEEE 802.11 network is designed for the use of small scale local wireless networks. However, the emergence of the Internet of Things (IoT) has changed the scene of wireless communications. Thus, recently, the IEEE task group ah (TGah) has been dedicated to the standardization of a new protocol, called IEEE 802.11ah, which is customized for this type of large-scale networks. IEEE 802.11ah adopts a grouping- based MAC protocol to reduce the contention overhead for each group of devices. However, most existing designs simply randomly partition devices into groups, and less attention has been paid to the problem of forming efficient groups. Therefore, in this paper, we argue that the performance of grouping is closely related to heterogeneity in traffic demands of devices, and propose a traffic- aware grouping algorithm to improve channel utilization. Since channel utilization of a group closely depends on the collision probability, we further derive a regression-based analytical model to estimate the contention success probability with consideration of sensors' heterogeneous traffic demands. The evaluation via NS-3 simulations shows that the proposed regression-based model is quite accurate even when clients have diverse traffic demands, and our traffic-aware grouping outperforms other baseline approaches, especially when the network is nearly saturated.

EPRO MC - 018	Sensor-based Proximity Detection in the Face of Active Adversaries

Context-centric proximity detection is a promising approach to defend against relay attacks in many mobile authentication systems. Prior work demonstrated the effectiveness of a variety of contextual sensor modalities for this purpose, including audio-radio environment (ambient audio, WiFi, Bluetooth and GPS) and physical environment (temperature, humidity, gas and altitude). We present a systematic assessment of co-presence detection in the presence of a strong, context-manipulating attacker against unattended terminals. First, we show that it is feasible to manipulate, consistently control and stabilize the readings of different acoustic and physical environment sensors using low-cost, off-the-shelf equipment. Second, based on these capabilities and the strengthened threat model, we show that an attacker who can manipulate the context gains a significant advantage in defeating context-based co-presence detection. For systems that use multiple sensors, we investigate two approaches based on machine learning techniques - features-fusion and decisions-fusion, and show that both are vulnerable to contextual attacks but the latter approach can be more resistant in some cases. We further consider other defensive approaches that may be used to reduce the impact of even such a strong context-manipulating attacker. Our work represents the first concrete step towards analyzing, extending and systematizing prior work on contextual co-presence detection under a stronger, but realistic adversarial model.

EPRO MC - 019	Optimal Packet Aggregation Scheduling in Wireless Networks

One of the most critical emerging problems for 5G and Internet of Things is the handling of machine-to-machine communication. Wireless sensor networks are deployed every day, resulting in a more distributed infrastructure, where the communication and processing are handled by energy, bandwidth, and processing constrained devices. Aggregation of multiple packets flowing over the same path increases spectral efficiency, energy efficiency, and resource utilization. We address the problem of determining the optimal waiting time to maximize the utility within the network. We provide a general framework, where the utility function is user-defined for each individual application stream and packet. This allows the user to optimize for energy, delay or expiration rate in the resolution of individual streams. Our algorithm calculates the optimal time for any given condition on-the-fly and can adapt to changing conditions with low computational complexity. We provide an optimal multi-hop distributed and scalable under congestion versions of our algorithm. Our simulations in ns3 show that we outperform state-of-the-art policies by 1.55x in terms of information freshness. Our solution reduces average power consumption by more than 60%. Our congestion-aware solution shows constant performance with increasing congestion levels, whereas state-of-the-art solutions degrade by up to 70% under the same conditions.

EPRO MC - 020	Selfish Decentralized Computation Offloading for Mobile Cloud Computing in Dense Wireless Networks

Offloading computation to a mobile cloud is a promising solution to augment the computation capabilities of mobile devices. In this paper we consider selfish mobile devices in a dense wireless network, in which individual mobile devices can offload computations through multiple access points or through the base station to a mobile cloud so as to minimize their computation costs. We provide a game theoretical analysis of the problem, prove the existence of pure strategy Nash equilibria, and provide an efficient decentralized algorithm for computing an equilibrium. For the case when the cloud computing resources scale with the number of mobile devices we show that all improvement paths are finite. Furthermore, we provide an upper bound on the price of anarchy of the game, which serves as an upper bound on the approximation ratio of the proposed decentralized algorithms. We use simulations to evaluate the time complexity of computing Nash equilibria and to provide insights into the price of anarchy of the game under realistic scenarios. Our results show that the equilibrium cost may be close to optimal, and the convergence time is almost linear in the number of mobile devices.

EPRO MC - 021	Primary User-aware Optimal Discovery Routing for Cognitive Radio Networks

Routing protocols in multi-hop cognitive radio networks (CRNs) can be classified into two main categories: local and global routing. Local routing protocols aim at decreasing the overhead of the routing process while exploring the route by choosing, in a greedy manner, one of the direct neighbors. On the contrary, global routing protocols choose the optimal route by exploring the whole network to the destination paying the flooding overhead cost. In this paper, we propose a primary user-aware k-hop routing scheme where k is the discovery radius. This scheme can be plugged into any CRN routing protocol to adapt, in real time, to network dynamics like the number and activity of primary users. The aim of this scheme is to cover the gap between local and global routing protocols for CRNs. It is based on balancing the routing overhead and the route optimality, in terms of primary users avoidance, according to a user-defined utility function. We analytically derive the optimal discovery radius (k) that achieves this target. Evaluations on NS2 with a side-by-side comparison with traditional CRNs protocols show that our scheme can achieve the user-defined balance between the route optimality, which in turn reflected on throughput and packet delivery ratio, and the routing overhead in real time.

EPRO MC - 022	Multipath Cooperative Routing with Efficient Acknowledgement for LEO Satellite Networks

Multipath routing can significantly improve the network throughput and end-to-end (e2e) delay. Network coding based multipath routing removes the complicated coordination among multiple paths so that it further enhances data transmission efficiency. Traditional network coding based multipath routing protocols, however, are inefficient for Low Earth Orbit (LEO) satellite networks with the long link delay and regular network topology. Considering these two characteristics, in this paper, we firstly formulate the multipath cooperative routing problem, then propose a Network Coding based Multipath Cooperative Routing (NCMCR) protocol for LEO satellite networks to improve the throughput. We propose source-based and destination-based multipath cooperative routing algorithms, which deliver different parts of a data flow along multiple link-disjoint paths dynamically and cooperatively. Furthermore, we design an efficient No-Stop-Wait ACK mechanism for our NCMCR protocol to accelerate the data transmission, where a source node continuously sends subsequent batches before it receives ACK messages for the batches sent previously. Under the proposed acknowledgement mechanism, we theoretically analyze the number of coded packets that should be sent and the transmission times of each batch for successfully decoding a batch. NS2-based simulation results demonstrate that our NCMCR outperforms the most related protocols.

EPRO MC - 023	Reliability analysis of condition monitoring network of wind turbine blade based on wireless sensor networks

This paper proposes a reliability analysis method for the condition monitoring network of wind turbine blade based on wireless sensor networks. Two critical factors which play significant roles in the reliability evaluation of the monitoring network are focused on, that is, the reliability of communication links and the reliability of sensor nodes. Firstly, with the established reliability models for sensor nodes and communication links the method of establishing reliability simulation model of monitoring network is presented based on Monte Carlo method. Secondly, according to the analysis of the intra-cluster reliabilities of the tree topology and the mesh topology, the topology selection principle of the sensor network for a single blade is proposed. Finally, the influence of maintenance cycle and communication interference on the overall reliability of the monitoring network is illustrated and the proper maintenance cycle is achieved. The solution to communication interference is put forward with the data retransmission measure. The overall reliability of the network is improved effectively by adopting the one-time data retransmission measure. Our work is expected to provide the guidance in theory and technology for constructing the high-performance condition monitoring and control system for wind turbine blades.

EPRO MC - 024	A Data Parasitizing Scheme for Effective Health Monitoring in Wireless Body Area Networks

Wireless body area networks (WBANs) have emerged recently to provide health monitoring for chronic patients. In a WBAN, the patient's smartphone is deemed an appropriate sink to help forward the sensing data to back-end servers. Through a real-world case study, we observe that temporary disconnection between sensors and the associated smartphone can happen frequently due to postural changes, causing a significant amount of data to be lost forever. In this paper, we propose a scheme to parasitize the data in surrounding Wi-Fi networks whenever temporary disconnection occurs. Specifically, we model data parasitizing as an optimization problem, with the objective of maximizing the system lifetime without any data loss. Then, we propose an optimal offline algorithm to solve the problem, as well as an online algorithm that allows practical implementations. We have also implemented a prototype system, where the online algorithm serves as the underlying technique, based on Arduino. To evaluate our scheme, we conduct a series of experiments with the prototype system in controlled and real-world environments. The results show that the lifetime is prolonged by 100 times, and it could be further doubled if the health monitoring application permits a few packet losses.

EPRO MC - 025	A Novel Hierarchical Two-tier Node Deployment Strategy for Sustainable Wireless Sensor Networks

Wireless sensor networks (WSNs) have been widely adopted to fulfil the imperative requirement of real-time monitoring and/or long-term surveillance of the field-of-interest. However, due to the limited battery capacity, energy is the most critical constraint for improving the sustainability of a WSN. Hence, conserving energy and extending battery life are important in designing a sustainable WSN. Fortunately, the emerging energy harvest techniques provide us with a semi-permanent energy resource to power WSNs. In this article, we introduce a novel energy-aware hierarchical two-tier (HTT) energy harvesting-aided WSNs deployment scenario. More precisely, we consider two types of nodes in the system: one is the regular battery-powered sensor node (RSN), and the other is the energy harvesting-aided data relaying node (EHN). The objective is to use only RSNs to monitor FoI, while EHNs focus on collecting the sensed data from RSNs and forwarding the gathered data to the data sink. The minimum number of EHNs is deployed based on a newly designed probability density function to minimize the energy consumption of RSNs. This, in turn, extends the lifetime of the deployed WSN. The simulation results indicate that the proposed scheme outperforms some well-known techniques in the network lifetime, while enhancing the total throughput.

EPRO MC - 026	Dynamic Connectivity Establishment and Cooperative Scheduling for QoS-Aware Wireless Body Area Networks

In a hospital environment, the total number of Wireless Body Area Network (WBAN) equipped patients requesting ubiquitous healthcare services in an area increases significantly. Therefore, increased traffic load and group-based mobility of WBANs degrades the performance of each WBAN significantly, concerning service delay and network throughput. In addition, the mobility of WBANs affects connectivity between a WBAN and an Access Point (AP) dynamically, which varies the link quality significantly. To address the connectivity problem and provide Quality of Services (QoS) in the network, we propose a dynamic connectivity establishment and cooperative scheduling scheme, which minimizes the packet delivery delay and maximizes the network throughput. First, to secure the reliable connectivity among WBANs and APs dynamically, we formulate a selection parameter using a price-based approach. Thereafter, we formulate a utility function for the WBANs to offer QoS using a coalition game-theoretic approach. We study the performance of the proposed approach holistically, based on different network parameters. We also compare the performance of the proposed scheme with the existing state-of-the-art.

EPRO MC - 027	Energy Efficiency Maximization in Mobile Wireless Energy Harvesting Sensor Networks

In mobile wireless sensor networks (MWSNs), scavenging energy from ambient radio frequency (RF) signals is a promising solution to prolonging the lifetime of energy-constrained relay nodes. In this paper, we apply the Simultaneous Wireless Information and Power Transfer (SWIPT) technique to a MWSN where the energy harvested by relay nodes can compensate their energy consumption on data forwarding. In such a network, how to maximize system energy efficiency (bits/Joule delivered to relays) bytrading off energy harvesting and data forwarding is a critical issue. To this end, we design a resource allocation (ResAll) algorithm by considering different power splitting abilities of relays undertwo scenarios. In the first scenario, the power received by relays is split into a continuous set of power streams with arbitrary power splitting ratios. In the second scenario, the received power is only split into a discrete set of power streams with fixed power splitting ratios. For each scenario above, we formulate the ResAll problem in a MWSN with SWIPT as a non-convex energy efficiency maximization problem. By exploiting fractional programming and dual decomposition, we further propose a cross-layer ResAll algorithm consisting of subalgorithms for rate control, power allocation, and power splitting to solve the problem efficiently and optimally. Simulation results reveal that the proposed ResAll algorithm converges within a small number of iterations, and achieves optimal system energy efficiency by balancing energy efficiency, data rate, transmit power, and power splitting ratio.

EPRO MC - 028	Distributed Clustering-Task Scheduling for Wireless Sensor Networks Using Dynamic Hyper Round Policy

Prolonging the network life cycle is an essential requirement for many types of Wireless Sensor Network (WSN) applications. Dynamic clustering of sensors into groups is a popular strategy to maximize the network lifetime and increase scalability. In this strategy, to achieve the sensor nodes' load balancing, with the aim of prolonging lifetime, network operations are split into rounds, i.e., fixed time intervals. Clusters are configured for the current round and reconfigured for the next round so that the costly role of the cluster head is rotated among the network nodes, i.e., Round-Based Policy (RBP). This load balancing approach potentially extends the network lifetime. However, the imposed overhead, due to the clustering in every round, wastes network energy resources. This paper proposes a distributed energy-efficient scheme to cluster a WSN, i.e., Dynamic Hyper Round Policy (DHRP), which schedules clustering-task to extend the network lifetime and reduce energy consumption. Although DHRP is applicable to any data gathering protocols that value energy efficiency, a Simple Energy-efficient Data Collecting (SEDC) protocol is also presented to evaluate the usefulness of DHRP and calculate the end-to-end energy consumption. Experimental results demonstrate that SEDC with DHRP is more effective than two well-known clustering protocols, HEED and M-LEACH, for prolonging the network lifetime and achieving energy conservation.

EPRO MC - 029	SaW: Video Analysis in Social Media with Web-Based Mobile Grid Computing

The burgeoning capabilities of Web browsers to exploit full-featured devices can turn the huge pool of social connected users into a powerful network of processing assets. HTML5 and JavaScript stacks support the deployment of social client-side processing infrastructure, while WebGL and WebCL fill the gap to gain full GPU and multi-CPU performance. Mobile Grid and Mobile Cloud Computing solutions leverage smart devices to relieve the processing tasks to be performed by the service infrastructure. Motivated to gain cost-efficiency, a social network service provider can outsource the video analysis to elements of a mobile grid as an infrastructure to complement an elastic cloud service. As long as users access to videos, batch image analysis tasks are dispatched from the server, executed in the background of the client-side hardware, and finally, results are consolidated by the server. This paper presents SaW (Social at Work) to provide a pure Web-based solution as a mobile grid to complement a cloud media service for image analysis on videos.

EPRO MC - 030	An Adaptive Emergency Broadcast Strategy for Vehicular Ad Hoc Networks

In recent years, since the adoption of the IEEE 802.11p and IEEE 1609 standards, Vehicular Ad hoc Networks (VANETs) have received a significant amount of attention in Ad hoc Network studies. Vehicular safety applications have thus played an important role in VANETs, and many emergency broadcast systems have been proposed. However, some of these broadcast mechanisms might result in the broadcast storm problem. The emergency broadcast strategy proposed in this paper is that when a car accident occurs, the vehicle's sensors detect impacts and immediately send emergency messages to inform other vehicles nearby. In addition, we propose a way to eliminate redundant broadcasts and to ensure that emergency messages can be transmitted properly. We propose a stability function to estimate the reliability of the transponder. The backoff procedure of this proposed method assigns appropriate waiting times to different forwarders. The proposed scheme is implemented with NS2 simulator based on WAVE/DSRC standards. Simulation results show that the proposed protocol exhibits outstanding performance in terms of forwarding counts, packet loss rate, and delay time in different environments. In addition, our protocol maintains stability in different vehicle density scenarios so that each vehicle receives emergency messages and holds a low latency to ensure that the driver has adequate safety response time to enhance traffic safety.

EPRO MC - 031	Joint Topology Control and Stable Routing Based on PU Prediction for Multihop Mobile Cognitive Networks

Link stability significantly suffers from dynamical primary user activities and random node movement in mobile cognitive networks (MCNs). In multihop MCNs, it will become even worse due to potential interference among multiple links so that stable routing will become more important and also more challenging than that in traditional wireless networks. In this paper, we first formulate the joint topology control and stable routing (JTCSR) problem based on primary user (PU) activity prediction. Then, we propose a PU prediction model to reveal channel utilization patterns of PUs. Next, we propose a novel routing metric PU prediction-based stability metric (PPSM), which quantitatively measures PU activities and node mobility, and design a min-max PPSM matrix construction algorithm. Finally, we propose and develop a PU prediction-based (PP) JTCSR algorithm for maximizing network throughput, which can find out the most stable and the shortest path. Theoretical analysis validates the effectiveness and efficiency of our approach. NS2-based simulation results further demonstrate that our PP-JTCSR can generate stable and efficient topology through predicting PU activities quantitatively, and outperforms related proposals in terms of path stability, average throughput, and packet loss rate.

EPRO MC - 032	A Data Parasitizing Scheme for Effective Health Monitoring in Wireless Body Area Networks

Wireless body area networks (WBANs) have emerged recently to provide health monitoring for chronic patients. In a WBAN, the patient's smartphone is deemed an appropriate sink to help forward the sensing data to back-end servers. Through a real-world case study, we observe that temporary disconnection between sensors and the associated smartphone can happen frequently due to postural changes, causing a significant amount of data to be lost forever. In this paper, we propose a scheme to parasitize the data in surrounding Wi-Fi networks whenever temporary disconnection occurs. Specifically, we model data parasitizing as an optimization problem, with the objective of maximizing the system lifetime without any data loss. Then, we propose an optimal offline algorithm to solve the problem, as well as an online algorithm that allows practical implementations. We have also implemented a prototype system, where the online algorithm serves as the underlying technique, based on Arduino. To evaluate our scheme, we conduct a series of experiments with the prototype system in controlled and real-world environments. The results show that the lifetime is prolonged by 100 times, and it could be further doubled if the health monitoring application permits a few packet losses.

EPRO MC - 033	Unlicensed LTE Pricing for Tiered Content Delivery and Heterogeneous User Access

It has been a significant issue to satisfy the rapidly growing data traffic with the limited wireless radio resources. Licensed-assisted access to unlicensed spectrum (e.g., LAA) brings hope for the service provider (SP) to mitigate the deficiency of radio resources. This work contributes on designing a pricing model in a licensed and unlicensed coexisting network, modelled as a two-sided market with content providers (CPs) and end users (EUs) at the SP's two sides. A premium content delivery deal is further designed via the optimal auction in order to efficiently allocate the scarce radio resources for the CPs with higher traffic load and QoS requirement. Thus, the SP and CPs form a prioritized spectrum game, and the SP and EUs form a radio access subscription game. By backward induction, we derive the basic delivery price and the premium delivery price to CPs, the reservation price, and the LTE-only and LAA subscription prices to EUs. Analysis shows that all players benefit from the premium delivery deal and co-existence of unlicensed LTE. When the unlicensed spectrum becomes reliable, all players' payoffs and the subscription ratio increase. In addition, the impact of the subsidies and technology heterogeneity are also addressed in this article.

EPRO MC - 034	An Evolutionary Self-Cooperative Trust Scheme against Routing Disruptions in MANETs

How to achieve reliable routing has always been a major issue in the design of communication networks, among which mobile ad hoc networks (MANETs) possess the most adversarial networking environment due to the absence of fixed infrastructure, the nature of open transmission media and the dynamic network topology. These characteristics also make the design of routing protocols in MANETs become even more challenging. In this paper, we propose an evolutionary self-cooperative trust (ESCT) scheme that imitates human cognitive process and relies on trust-level information to prevent various routing disruption attacks. In this scheme, mobile nodes will exchange trust information and analyze received trust information based on their own cognitive judgment. Eventually, each node dynamically evolves its cognition to exclude malicious entities. The most attractive feature of ESCT is that even the internal attackers know how the security mechanism works, they cannot compromise the system. In this paper, we evaluate the performance of ESCT scheme under various routing disruption attack situations. Simulation results affirm that ESCT scheme promotes network scalability and ensures the routing effectiveness in the presence of routing disruption attackers in MANETs.

EPRO MC - 035	Dynamic Connectivity Establishment and Cooperative Scheduling for QoS-Aware Wireless Body Area Networks

In a hospital environment, the total number of Wireless Body Area Network (WBAN) equipped patients requesting ubiquitous healthcare services in an area increases significantly. Therefore, increased traffic load and group-based mobility of WBANs degrades the performance of each WBAN significantly, concerning service delay and network throughput. In addition, the mobility of WBANs affects connectivity between a WBAN and an Access Point (AP) dynamically, which varies the link quality significantly. To address the connectivity problem and provide Quality of Services (QoS) in the network, we propose a dynamic connectivity establishment and cooperative scheduling scheme, which minimizes the packet delivery delay and maximizes the network throughput. First, to secure the reliable connectivity among WBANs and APs dynamically, we formulate a selection parameter using a price-based approach. Thereafter, we formulate a utility function for the WBANs to offer QoS using a coalition game-theoretic approach. We study the performance of the proposed approach holistically, based on different network parameters. We also compare the performance of the proposed scheme with the existing state-of-the-art.

EPRO MC - 036	Cost Minimization for Cooperative Traffic Relaying between Primary and Secondary Networks

Cooperation between primary and secondary networks offers significant benefits in data forwarding. But cost implication in such cooperation is not well understood. In this paper, we explore cost incurred in both primary and secondary networks when they are allowed to relay each other's traffic in a cooperative manner. We model costs in both networks and formulate a multiobjective optimization problem. For this problem, we present a novel algorithm to construct an ε-approximation curve and prove its error bounds. Based on this curve, we develop three important applications. The first application is to show the minimum cost value for any one single objective or the relationship between the two objectives over the entire range of possible values. The second application is to address different cost parameters in the primary and secondary networks. We show how to obtain a new approximation curve by scaling the original ε-approximation curve with appropriate factors and quantify its error bounds. The third application is to use this curve to study a single objective optimization problem with guaranteed error bound. The results in this paper offer some deep theoretical insights on potential costs incurred in both networks when they are allowed to relay each other's traffic cooperatively.

EPRO MC - 037	Evaluating and Enhancing Information Dissemination in Urban Areas of Interest using Opportunistic Networks

Opportunistic networks can provide an alternative way to support the diffusion of information in special locations within a city, particularly in crowded spaces, where current wireless technologies can exhibit congestion issues. The efficiency of this diffusion relies mainly on user mobility. In fact, mobility creates the opportunities for contacts and, therefore, for data forwarding. This paper is, therefore, mainly focused on evaluating the dissemination of information in urban scenarios with different crowd densities and renewal rates. Through observation, we obtained real data from a local subway station and a plaza. These data were used, in combination with a pedestrian mobility simulator, to generate people mobility traces. We evaluated the diffusion of messages in these scenarios using the direct and the epidemic protocols. Experimental results show that content diffusion is mainly affected by two factors: degree of mobility and message size. Although it is well known that increasing the node density increases the diffusion rate, we show that, when keeping node density fixed, higher renewal rates cause the delivery ratio to drop. Moreover, we found that the relation between message size and contact duration is also a key factor, demonstrating that large messages can lead to a very low overall performance. Finally, with the aim of increasing the diffusion effectiveness of large messages, we propose an improvement over the Epidemic protocol, namedEpidemicX2, based on the fragmentation of the data to be sent. The results show that the delivery ratio is increased, and the average delivery time is reduced, with no substantial increase in terms of overhead.

EPRO MC - 038	A Novel Light-weight Subjective Trust Inference Framework in MANETs

There is an inherent reliance on collaboration among the participants of mobile ad hoc networks in order to achieve the fixed functionalities. However, they are susceptible to the destruction of the malicious attacks or denial of cooperation. Therefore, it becomes obvious that the security issue is urgently needed to be addressed. Over the last few years, many trust-considered countermeasures have been proposed. The design of trust quantification methods is the key of these countermeasures. In this study, we abstract a novel light-weight subjective trust inference framework, which is divided into trust assessment and trust prediction. The process of node trust assessment is based on node's historical behaviours. Then utilizing the obtained trust data sequence, we introduce the SCGM(1,1)-weighted Markov stochastic chain measure to predict node's trust for future decision making. Experimental results have been conducted to evaluate the effectiveness of the proposed trust model. As an important security application, based on the standard On-Demand Multicast Routing Protocol (ODMRP), we make four major improvements which take the issue of trust into consideration, and propose a novel trust-based routing protocol called the On-Demand Trust-Based Multicast Routing protocol (ODTMRP). And finally, convincing experimental results are presented using three routing evaluation metrics.

EPRO MC - 039	Finding Decomposable Models for Efficient Distributed Inference over Sensor Networks

Graphical models have been widely applied in distributed network computation problems such as inference in large-scale sensor networks. While belief propagation (BP) based on message passing is a powerful approach to solving such distributed inference problems, one major challenge, in the context of wireless sensor networks, is how to systematically address the trade-off between energy efficiency and inference performance. In this paper, we consider a distributed structure optimization problem and investigate the effects of graphical model structure on energy consumption and inference performance. We first formulate the problem as a multi-objective constrained combinatorial optimization problem and prove its NP-hardness. Then, we propose an efficient distributed heuristic to solve the problem in polynomial time. Through extensive simulations, using both real-world sensor network data and synthetic data, we empirically evaluate our proposed graphical model structure optimization framework. The simulation results demonstrate that the graphical model constructed by the proposed framework can efficiently trades off the performance of the inference algorithm (measured by the mean squared error) with the energy consumed by the inference algorithm (measured by the energy used in communication). In addition, our proposed framework provides valuable insights for network designers on designing efficient model selection algorithms for distributed inference problems.

EPRO MC - 040	ULOOF: a User Level Online Offloading Framework for Mobile Edge Computing

Mobile devices are equipped with limited processing power and battery charge. A mobile computation offloading framework is a software that provides better user experience in terms of computation time and energy consumption, also taking profit from edge computing facilities. This article presents User-Level Online Offloading Framework (ULOOF), a lightweight and efficient framework for mobile computation offloading. ULOOF is equipped with a decision engine that minimizes remote execution overhead, while not requiring any modification in the device's operating system. By means of real experiments with Android systems and simulations using large-scale data from a major cellular network provider, we show that ULOOF can offload up to 73% of computations, and improve the execution time by 50% while at the same time significantly reducing the energy consumption of mobile devices.

ELYSIUMPRO

A UNIT OF ELYSIUM GROUPS

Thank you!

ELYSIUM GROUPS