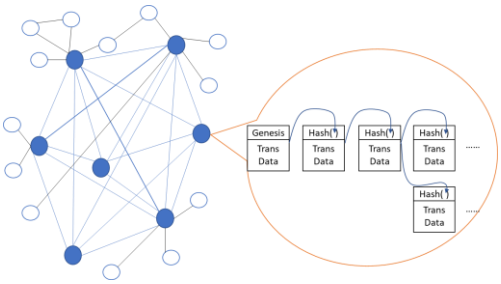

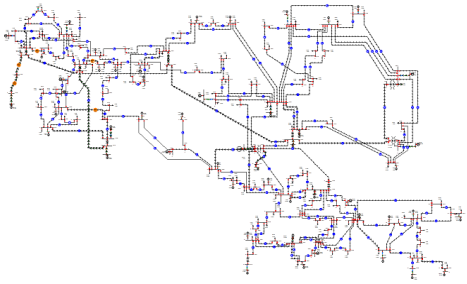

Blockchain & Energy SysTems (BEST2019) Conference
January 18th – 19th, 2019
Orlando, Florida, USA

Conference Program

General Chairs
Qipeng Phil Zheng, University of Central Florida

Panos Pardalos, University of Florida

In Part Sponsored by Better & Upper Inc.

Blockchain & Energy Systems Conference
1/18 – 1/19/2019 in Orlando, FL, USA

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Welcome Letter from the Organizers

Dear Colleagues,

The miracle of bitcoin and digital currency has made blockchain one of the most popular and promising technologies in a digital world. Blockchain technology has a great potential to change our daily life in the same way internet had impacted our society. At the same time, our society is running on energy systems because almost all of our activities are powered by non-human forces in some sense. There are two major ways that blockchain systems are interacting with energy systems. Firstly, the blockchain systems are reliant on the computing systems powered by electricity. Cryptocurrency mining has already caused troubles in electricity consumption as more and more computing powers have joined. Secondly, energy systems are expecting more distributed renewable resources and leaning toward higher transparency and fairness. Blockchain technology undoubtedly will help resolve these related issues. This conference brings together the experts in both blockchain technology and energy systems. It is aiming for smart integrations of blockchain and energy systems. The impacts are both ways. It is interesting to notice and study the interrelationship and interdependence between blockchain networks and electrical power networks. We are very grateful to have a group of researcher, practitioners coming from different countries and places to discuss this integration of blockchain technology and energy systems, and its future.

We wish you all enjoy this BEST2019 conference.

Sincerely,

BEST2019 Conference Organizers
Qipeng Phil Zheng, University of Central Florida
Panos Pardalos, University of Florida

Conference Schedule Summary

1/18/2019, Friday

9:15am **Welcome Speech**

9:20am **Opening Remarks**

9:30am – 10:15am **Plenary Presentation**

10:15am – 10:30am Coffee Break

10:30am – 12:00 **Session FA**

12:00pm – 1:30pm **Welcome Luncheon** in the Lobby area (provided by BEST2019)

1:30pm – 2:30pm **Session FB**

2:30pm – 2:45pm Coffee Break

2:45pm – 4:15pm **Session FC**

6:00pm – 7:00pm **General Reception Dinner** in the Lobby area (provided by BEST2019)

1/19/2019, Saturday

9:30am – 10:15am **Plenary Presentation**

10:15am – 10:30am Coffee Break

10:30am – 12:00 **Session SA**

12:00pm – 1:30pm **Saturday Luncheon** in the Lobby area (provided by BEST2019)

1:30pm – 3:00pm **Session SB**

3:00pm – 3:30pm Coffee Break and Adjourning the Conference

Friday 1/18/2019 Schedule including presentation abstracts

➔ 9:15am **Welcome Speech**

Qipeng Phil Zheng, University of Central Florida, USA

qipeng.zheng@gmail.com

➔ 9:20am **Opening Remarks**

Panos Pardalos, University of Florida, USA

pardalos@ufl.edu

➔ 9:30am – 10:15am **Plenary Presentation**

Blockchain for Energy, IoT and Other Emerging Technologies: A Survey of Business, Technology and Innovation Drivers

David Metcalf, University of Central Florida, USA

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Abstract: Blockchain is fundamentally changing energy and resource management in a variety of ways. Beyond supply chain and utilities alone, this session will take a broad view of technical and business implications in current research and industry trends. The early protocols and token offerings dealing with energy and utilities will be surveyed. Next, an understanding of the influence of utility tokens and technology and policy shifts that are reshaping how startups and established businesses can leverage blockchain-enabled applications will be explored. Based on these new trends, novel and expanded examples from energy management and other areas of resource management will be described. These include cybersecurity and identity, GIS, healthcare as an industry segment example, and shifts in real-world mining between open and private chains. Two special guests will describe their real-world findings in these areas. The session will conclude with additional insights into the future of blockchain for enabling complex transactions in the energy segment and beyond.

➔ 10:15am – 10:30am Coffee Break

➔ 10:30am – 12:00 **Session FA**

Analysis of transactions of energy-related ERC20 tokens

Alexander Semenov, University of Jyvaskyla, Finland

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Henri Heinonen, University of Jyvaskyla, Finland

Ville Yli-Pelkonen, University of Jyvaskyla, Finland

Timo Hämäläinen, University of Jyvaskyla, Finland

Veikko Hara, University of Jyvaskyla, Finland

Abstract: Ethereum is the second largest cryptocurrency by market capitalization. In addition to that, Ethereum is a platform that enables development of smart contracts that run on Ethereum blockchain. ERC20 is one of the standards for smart contracts; ERC20 contracts have common methods for transfer of their value, and can be traded on ERC20 exchanges. There are different ERC20 tokens, and many of them focus on energy related areas. We collected list of energy-related ERC20 tokens, and developed the software that extracted transactions of those tokens from Ethereum blockchain. We analyze transaction volume and value, and study network formed by these transactions.

Distributed Demand Response under Real Time Electricity Pricing

Andrew L. Liu, Purdue University, USA

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Abstract: The situation where price-responsive consumers determine what to do in the near future (such as when to charge their PEVs) forms a dynamic and incomplete-information game, in which the consumers' collective actions will impact electricity prices, which in turn affect their payoffs. We propose a multiarmed bandit (MAB) game framework in which each consumer plays an MAB problem to minimize the cumulative regret, as opposed to naively responding to day-ahead prices. Numerical results show very fast convergence to a steady-state of the MAB game with much reduced price volatility than the naïve-response case. Such a framework can also be used in a blockchain-based, peer-to-peer market to help agents decide on bidding strategies to buy/sell electricity.

Residential Energy Transaction with Blockchain Technology

Guanxiang Yun, University of Central Florida, USA

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Qipeng Phil Zheng, University of Central Florida, USA

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Abstract: This presentation proposes a model to simulate the behavior of prosumers in electrical power system and studies the system performance of the local power grid. With the advancement of household size renewable generator, some prosumers can generate enough energy for their self-use and will also have redundant amount. In the current energy system, they only can sell it back to the grid. But by using the blockchain technology, the prosumers can sell electricity directly to other users. The blockchain technology can also guarantee the transaction happens in a decentralization system even though the two users making the transaction do not know each other. We establish a two-level optimization model. The first level models the pricing strategies of the prosumers in this local power grid. The second level models the power generation and electricity consumption behaviors of the prosumers. By using the system we propose, we can have better utilization of the renewable energy and the average price for the electricity can be reduced.

➔ 12:00pm – 1:30pm **Welcome Luncheon** in the Lobby area (provided by BEST2019)

➔ 1:30pm – 2:30pm **Session FB**

To mine or not to mine: An investigation of Cryptocurrency Mining Dynamics

Vipul Aggarwal, University of Washington, USA

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Abstract: In this paper, we analyze the effects of the introduction of Emergency Difficulty Adjustment (EDA) algorithm to the Bitcoin-Cash (BCH) blockchain. EDA was introduced to incentivize the miners to participate in BCH mining. EDA would periodically lower the difficulty of mining on BCH blockchain, thereby, making it more profitable in terms of difficulty adjusted returns index (DARI) than BTC. This led miners to switch chains actively as well as wait on the BCH chain to lower in difficulty before participating. Since mining is competition-driven, we analyze this economic phenomenon using dynamic game estimation methodology of [Patrick et al., 2007]. We find that transaction fees convinced miners to mine BTC even though it wasn't profitable to do so. The ensuing competition led to higher rate of mining which raised future costs due to difficulty adjustments. Moreover, we also find that the switching chains behavior during EDA period was detrimental to the profits of the miners. EDA ensured longevity of the BCH chain immediately after the fork, however, it wasn't profitable for the miners overall.

Mining Pool of Cryptocurrency Network Impact on Energy Consumption

Mengnan Chen, University of Central Florida, USA

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Qipeng Phil Zheng, University of Central Florida, USA

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Abstract: With increasing difficulty of cryptocurrency network, mining with lower-performance devices can take a very long time before block generation. Single miner with lower hashing power may not get enough reward to cover the cost of electricity and hardware. Mining pools are a way for miners to pool their resources together and share their hashing power while splitting the reward equally according to the amount of shares they contributed to solving a block. As we know the electricity usage of cryptocurrency mining is enormous, and the entire cryptocurrency network now consumes more electricity power than a number of countries, how does the power consumption affect the network of mining pool become a problem in power systems. In this project, we study the cooperation and competition between the different mining pools in Bitcoin network, and find the relationship between the electricity price, power efficiency of mining hardware and the topology of the mining pool network.

➔ 2:30pm – 2:45pm Coffee Break

➔ 2:45pm – 4:15pm **Session FC**

Robustness and Vulnerability of Interdependent Infrastructure Networks: Mathematical Modeling and Optimization Aspects

Vladimir Boginski, University of Central Florida

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Abstract: Interdependent networks arise in many application domains associated with infrastructure systems, such as electric power, telecommunication, and transportation networks. In a real-world setup, these systems interact with each other, so that disruptions/failures of components in one of the systems may affect the performance of other systems that depend on those components. Thus, failures can propagate through interdependent networked systems in a cascading fashion, where a failure of a component in one system may cause a failure of multiple components in another system, and so on. Important research issues that need to be addressed in studying such interdependent networks include developing mathematical models of cascading failures, as well as assessing robustness/vulnerability of these networks via appropriate quantitative metrics. Furthermore, these mathematical representations may allow one to formulate and solve optimization problems that can potentially reveal interesting properties of the underlying systems and optimal strategies for enhancing their resilience. In this presentation, we will discuss some of our recent results and identify challenges and potential future research directions in this area.

Blockchain based decentralized microgrid energy distribution system

Henri Heinonen, University of Jyvaskyla, Finland

Ville Yli-Pelkonen, University of Jyvaskyla, Finland

Alexander Semenov, University of Jyvaskyla, Finland

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Veikko Hara, University of Jyvaskyla, Finland

Timo Hämäläinen, University of Jyvaskyla, Finland

Abstract: Electric grid is a fully connected network, where even small villages need to be connected to the main provider; maintenance costs of such a network are very high. Due to that, around 70% of electricity bill consist of taxes and transfer costs. The remaining part (~30%) is the cost of the electricity itself. For example, one electricity provider has 230 meters of overhead power cabling per customer. In big cities there could be dozens of meters of ground power cabling per customer. A small village with 50 households could have its own microgrid disconnected from main power grid. Combining blockchain technology with renewables and small nuclear power plants could provide cheaper electricity for microgrid users. In this presentation we describe novel blockchain based energy distribution system; it allows regular individuals to participate in energy generation and distribution. We describe architecture of the

system and provide economic justification of its usage. In addition to that, we compare electricity costs in such a system versus traditional distribution system in Finland.

Peer-to-peer Energy Trading among Strategic Prosumers Using Blockchain

Arnob Ghosh, Purdue University, USA

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Abstract: We consider users which may have renewable energy harvesting devices, or distributed generators. Such users can behave as consumer or producer (hence, we denote them as prosumers) at different time instances. We consider a tiered market where the grid selects a price function which reveals price in the real time based on the total demand to the grid. In the real time, a prosumer can buy from another prosumer in a peer-to-peer market knowing the price from the grid using the blockchain. We use the 'proof of stake' concept for the blockchain. The exchange price is set by a platform, and can be different for different sellers. A prosumer is a selfish entity which selects the amount of energy it wants to buy either from the grid or from other prosumers, or the amount of excess energy it wants to sell to other prosumers by maximizing its own payoff. The platform also consumes energy to validate a transaction. The strategy, and the payoff of a prosumer inherently depend on the strategy of other prosumers as a prosumer can only buy if the other prosumers are willing to sell. We formulate the problem as a coupled constrained game, and seek to obtain the generalized Nash equilibrium. We show that the game is a concave potential game and show that there exists a unique generalized Nash equilibrium. We propose a distributed algorithm which converges to the exchange price which clears the market and achieves the generalized Nash equilibrium. We, finally, show how the grid should select price function in a day-ahead scenario by computing the estimated demand from the history. Our numerical result shows that the tiered market can reduce the peak load, and increase the prosumers' total payoffs.

➔ 6:00pm – 7:00pm **General Reception Dinner** in the Lobby area (provided by BEST2019)

Saturday 1/19/2019 Schedule including presentation abstracts

➔ 9:30am – 10:15am **Plenary Presentation**

Blockchain-Integrated and Peer-to-Peer Energy Trading in Smart Power Grids

Jianhui Wang, Southern Methodist University, USA

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Ahmad Taha, The University of Texas at San Antonio, USA

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Abstract: The power grid is rapidly transforming, and while recent grid innovations increased the utilization of advanced control methods, the next-generation grid demands technologies that enable the integration of distributed energy resources (DER) -- and consumers that both seamlessly buy and sell electricity. This work develops an optimization model and blockchain-based architecture to manage the operation in smart power grids with peer-to-peer (P2P) energy trading transactions. An operational model in distribution networks is presented considering various types of energy trading transactions. The proposed framework is prototyped through an efficient blockchain implementation, namely the IBM Hyperledger Fabric. This implementation allows the system operator to manage the network users to seamlessly trade energy. Case studies and prototype illustration are provided.

➔ 10:15am – 10:30am Coffee Break

➔ 10:30am – 12:00 **Session SA**

Title: Cache Attacks on Blockchain Based Information Centric Networks: An Experimental Evaluation

Swapnoneel Roy, University of North Florida, USA

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Abstract: Protecting and securing data that reside at various hosts in the Internet has become more important than ever before because of the growing number of cyber attacks. Though there have been several studies related to denial of service and cache attacks, those studies are primarily based on simulations and investigations of attacks on real networks are still lacking. In this paper, we experimentally investigated the effects of cache attacks on blockchain based information-centric networks. We used the hyperledger fabric to implement the blockchains for small and medium-sized networks. We implemented cache attacks where the attacker targets the cache with unpopular content, forcing the user to fetch the data from the web servers. We experimented with two different topologies (linear and mesh) and also considered two cache sizes at the nodes.

Three cache replacement policies were used: Least Recently Used, Random, and First In First Out. The cache hit, time taken to get the data, and the number of hops to serve the request were obtained with real network traffic. On the hyperledger fabric framework, we implemented two types of requests and showed how the query delay, invoke delay, and update delay vary with time. Based on our results, we find that most of the information centric networks, including the ones based on blockchains, are vulnerable to cache attacks.

Blockchain-based renewable energy certificates program

Fangyuan Zhao, Tsinghua-Berkeley Shenzhen Institute, China

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Abstract: Distributed renewable energy generation offers an exciting opportunity in green energy transition for mitigating climate change and other environmental concerns, while it is overlooked in most of the conventional renewable energy certificates programs. Blockchain shows an advantage of incorporating a galaxy of distributed prosumers in a transparent and low cost manner. This paper proposes a blockchain-based renewable energy certificates system with an incentive scheme, for tracing renewable power and stimulating the adoption as well. The simulation of the concept model is implemented on Ethereum blockchain for performance and cost analysis.

Blockchain technology performance - state of the art and new trends

Viacheslav Zhygulin, Bitfury, Ukraine

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Abstract: This is overview presentation about the current state of the blockchain technology from point of view of performance and scalability. The main obstacle to scale blockchains is outlined: current blockchain protocols require every transaction to be confirmed by every validating node in the network. Consequently, with the number of validating nodes growth, the performance of the blockchain is decreasing due to an increase of security overhead. As an example to support this idea, comparison of permissioned and permissionless blockchains is made. Further, the presentation is describing the main directions of ongoing research devoted to solving the scalability problem. Mostly it is focused on developing confirmation mechanisms which require only some part of the network to validate transactions, preserving a level of security compared to existing blockchains. Two main research directions are on-chain and off-chain solutions. The on-chain group's most prominent technologies are sharding, Proof-of-Stake consensus algorithm and DAGs, whereas the off-chain solutions are based on concepts of payment channels and state channels. Every research direction developed with overview details and project examples: Lightning Network, Plasma, IOTA, Ethereum 2.0, etc.

➔ 12:00pm – 1:30pm **Saturday Luncheon** in the Lobby area (provided by BEST2019)

➔ 1:30pm – 3:00pm **Session SB**

Title: TBA

Robin Phelps, University of Central Florida, USA

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Abstract: TBA

Title: A Hands-on Introduction to Deep Learning with Keras

Muthukumaran Ramasubramanian, University of Alabama in Huntsville, USA

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Tathagata Mukherjee, University of Alabama in Huntsville, USA

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Abstract: Deep learning is a relatively newer branch of machine learning that is based on learning representations (features) from data. It uses the idea of Artificial Neural Networks (ANN) for learning deep feature representations. With the wide application of Deep Learning for solving problems across different domains it has become imperative to use deep learning frameworks for fast prototyping, testing as well as for production. In this talk we first cover the the basics of neural networks followed by a dive into the mathematics behind how neural networks work. Then we introduce variations to the ANN architecture that has been extensively used in the literature (Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN)). Finally, we show demos of systems that have been built using Keras (A Python Based API for Neural Networks using Tensorflow as backend) at The National Space Science Technology Center at The University of Alabama in Huntsville.

Title: Blockchain & Energy Systems – Past, Present and Future

Qipeng Phil Zheng, University of Central Florida, USA

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Abstract: The ups and downs of cryptocurrency has caught a great amount of attention around the world in the past couple of years. After the hype of cryptocurrency, people started exploring the real potentials of blockchain technology. It very likely will change our daily life in the same way the Internet had impacted our society. Its own development will also be dependent on our needs. Among the many things in our life, energy systems is deeply interrelated to blockchain implementations. This presentation will bring up and discuss those challenges facing us to make blockchain more efficient from energy systems' perspective and potentials that blockchain

technology will reform and fundamentally change the operations in energy systems. Specifically, this presentation will discuss potential research questions around the interdependence between blockchain networks and energy/power networks, how the advanced properties of blockchain can be utilized in energy systems to increase efficiency, the current investment trends in blockchain application in energy systems with example projects, among many others.

➔ 3:00pm – 3:30pm **Coffee Break and Adjourning BEST2019**

Conference Venue and Amenity

➔ Conference Venue Location

This conference will be held in Hampton Inn & Suites Orlando Airport @ Gateway Village, 5460 Gateway Village Circle, Orlando, Florida, 32812, USA.

Hotel Telephone is 407.434.8306.

➔ Shuttle Bus to and from the MCO airport

There is shuttle bus between MCO airport and the conference venue. You can call 407-857-2830 to schedule a pick up once you have arrived and collected their bags. For leaving the hotel to the airport, you can schedule with the front desk. The shuttle leaves every 30 minutes on the hour and half hour.

➔ Parking

Parking is complimentary during the event and for registered staying guests.

➔ WiFi

The Hampton Inn will provide complimentary WiFi for participants. Log-in information will be provided onsite.

➔ Conference Room

The conference room is also on the first floor with noticeable signs at the door. Please ask the front desk (right at the hotel gate) for the room if you do not find it.