EMERGING TECHNOLOGY AND ITS APPLICATIONS REQUIRE NEW STANDARDS

BY YATIN TRIVEDI

Let's put aside the question whether Blockchain is a real technology or a passing fad - a hype. The ups and downs of your fortunes in Bitcoin and similar cryptocurrencies in the last couple of years may have clouded your views. Short-term or long-term success, or failure, of cryptocurrencies may depend on the success, or failure, of Blockchain, but it is important to recognize that Blockchain and the Distributed Ledger Technology (DLT) have far greater uses in wide-ranging applications.

One such use of Blockchain is as a key enabling technology of 5G applications. Prof. Chaudhry and Dr. Asad present their research to propose a Blockchain-based Network Slice and Resource Brokerage system to build an open, transparent, and fair 5G ecosystem. They explain the challenges of addressing the massive cooperation required among 5G devices and potential solutions using Blockchain.

Another application of Blockchain is in creating and maintaining decentralized electric grid (Smart Grid). In his article, Dr. Claudio Lima explains the emergence of, and the importance of, DLT Blockchain for the electric utility industry. He uses Open Blockchain Energy (OBE) Architecture Framework, an emerging standard, and associated reference model to classify and categorize application segments in the energy industry and shows that the concept extends well beyond the Smart Grid to the entire energy sector.

As the world becomes more connected, consumers and industries - and their respective application ecosystems - will inherently require interaction. As these applications create their own DLT blockchains, they will need interoperable solutions. Dr. Claudio Lima, an authority in DLT and Blockchain technology, brings us interesting challenges and the need for global interoperable standards.

Mr. Meloni from University of Cagliari, Italy uses Blockchain and Internet of Things (IoT) to demonstrate the need for consensus algorithms and different ways of achieving the consensus. He then goes on to present the work on the Real-time Onsite Operations Facilitation (ROOF) standard for technical and functional interoperability of federated IoT systems.

Clearly, the need for standards and interoperability in an emerging technology is even greater at this time to ensure smoother deployment and wider adoption in critical applications. Are you working on building Blockchain applications? What standards do you use? What challenges do you have? Can they be solved by new standards? Would you like to discuss these topics with fellow engineers? Let us know if we can facilitate such discussions. We are all ears!

Happy Reading.

Enjoy!

BIography

Yatin Trivedi (ytrivedi@ieee.org) is a member of the IEEE Standards Association Board of Governors (BoG) and Standards Education Committee (SEC), and serves as Vice Chair for the Early Design Services Companies Committee (EDC) under the Computer Society. Since 2012 he has served as the Standards Board representative to the IEEE Education Activities Board (EAB). He also serves as Chairman of the Board of Directors of the IEEE-ESTO. He currently serves as Associate Vice President for hardware services at Aricent Inc. Prior to his current assignment, he served as Director of Strategic Marketing at Synopsys, where he was responsible for corporate-wide technical standards strategy. In 1992, he co-founded Seva Technologies as one of the early Design Services companies in Silicon Valley. He co-authored the first book on Verilog HDL in 1990 and was the Editor of IEEE Std 1364-1995™ and IEEE Std 1364-2001™. He also started, managed and taught courses in the VLSI Design Engineering curriculum at the UC Santa Cruz extension (1990-2001). He started his career at AMD and also worked at Sun Microsystems. He received his B.E. (Hons) EEE from BITS, Pilani and M.S. Computer Engineering from Case Western Reserve University. He is a Senior Member of the IEEE and a member of IEEE-HKN Honor Society.

ABSTRACTS

Blockchain: A Key Enabler for 5G
By Mohammad Asad Rehman Chaudhry and Zakia Asad (Softimizer)

Abstract: Blockchain is predicted to be a key player in reaping real benefits from 5G Networks. Its applications range from providing an autonomous platform for resource sharing, enabling ubiquitous edge computing, to content-based-storage; all of which are significantly different than contemporary scenarios associated with 4G. 5G is all about connecting heterogeneous devices and complex networks with a network of more than 50 billion devices. On one hand, millimeter waves and small cells are a critical building block of 5G, and enable high data rates and low latencies in addition to many other benefits. On the other hand, millimeter waves and small cells give rise to several challenges for example low transmission radius, and interoperability among complex sub-networks. To overcome many of these challenges, 5G devices are expected to perform several collaborative tasks from routing and relaying to computing. For example, 5G can enable holographic communication within short distances without need of any cooperation among devices, but when this distance is large (or network is not homogeneous) the data transfer speed as well as the viability of the service drops significantly.

THE IEEE STANDARDS UNIVERSITY E-MAGAZINE

Promoting the importance of standards in meeting technical, economic, environmental, and societal challenges;

Disseminating learning materials on the application of standards in the design and development aspects of educational programs;

Actively promoting the integration of standards into academic programs;

Providing short courses about standards needed in the design and development phases of professional practice.

This issue of the IEEE Standards Education eMagazine explores the work that has been done and is currently taking place around the “Blockchain Standards”. Certain articles are included here, and the abstracts are shown for the rest.

STANDARDS EDUCATION
PROBLEMS

The educational, cultural, and knowledge system as a whole has always faced risks and problems with difficult solutions. First of all, most academic and professional institutions issue certificates and credentials that are difficult to verify. For employers and third parties to verify a single resume, they are often required to use inefficient and expensive procedures to test the authenticity of all aspects of the applicant’s experience. As expected, companies rarely have the time and resources to dedicate to those procedures. In addition, many diplomas are not digitally verifiable. It seems that only a few institutions release free and online certifications. In the case of qualifications obtained in the past, the situation is more complicated.

Secondly, in recent years there has been a surge in the number of unverified degrees issued by legitimate-sounding institutions. These organizations often advertise themselves as official institutions with names that closely resemble those of famous academies, such that the distinction between them is not immediately apparent. This problem is aggravated by increased counterfeiting of diplomas and certificates. The proliferation of institutions raises an important question as to the quality of educational systems and universities, which is difficult to evaluate in a quantitative way. Institutions often issue diplomas or certificates with scant or absent details as to the course of study pursued and the student’s achievements. Employers, evaluators, and recruiters thus find themselves in the difficult position of having to consider documents of doubtful provenance, which are not standardized, and are often displayed in poor quality. Each of these problems might find solutions in blockchain technology.

Blockchain

Initially introduced as a technology to support the functioning of a decentralized payments system outside the brokering circuit of central banks, distributed-ledger technologies have evolved from both a quantitative and a qualitative perspective. In addition to the Bitcoin network, many other distinct blockchain systems have been developed that go beyond the simple transfers of funds by implementing different and/or supplementary functions (Tasca & Widmann 2018). Despite the passage of time, the underlying philosophy of blockchain remains substantially unchanged. It constitutes a distributed database based on two core cryptographic technologies that ensure the validity and authenticity of transactions: (i) public-private key infrastructure used to store and spend money; and (ii) cryptographic validation of transactions (Böhme et al., 2015). The data of past transactions are ordered in a series of ‘blocks’, such as in a public register, and cannot be altered except by the agreement of more than 50% of blockchain participants (nodes). Cryptographic technologies can thus create a “trustless” infrastructure to enable transactions—the trust is directly guaranteed by the blockchain system without the need of third parties (De Filippi and Wright, 2018).

Until recently, high schools and universities have not thought to use blockchain technologies to solve or mitigate the problems set out above. Old-fashioned organizational paradigms and a conservative attitude toward innovation have prevent-
ed the widespread institutional adoption of new technologies in general. This is partly due to the fact that the benefits of new technology are typically undermined by the high costs of training people in its use. With blockchain, however, the benefits of this trade-off weigh decisively in favor of technological adoption. In fact, the fundamental characteristics of blockchain address each of the key administrative challenges facing high schools and universities: data transparency, auditability, availability, immutability, and efficiency. In other words, it makes all the internal processes more efficient.

The benefits of blockchain apply primarily to data collection, processing, and sharing. The main beneficiaries are as follows:

**Students:** Blockchain could provide higher security and robustness of their data: the use of high-security cryptographic techniques ensure that personal information will never be manipulated or subject to malicious data leaks. Students could also use self-sovereign identity solutions to certify their identity without needing to share the underlying data that makes up that identity.

**Universities and other institutes of education:** Fully automated data processing benefits high school and university registrars who handle (typically, manually) sensitive and confidential student records. These records include, but are not limited to, attendance records, immunization records, grades, transfer information, transcript requests, etc. University registrars could be removed from the verification process altogether. As a result, considerably fewer resources are devoted to qualification verifications and more time can be spent on higher priority tasks, such as verifying the school qualifications of prospective students.

**Employment agencies and job seekers:** Employers might, in fact, avoid the expensive, complicated and lengthy processes involved in background checks and evaluations of job applicants; the agencies might speed up the job seeking process by easily proving the authenticity of applicants’ academic qualifications.

In terms of areas, blockchain can be applied to the following:

**Transcripts:** Academic credentials must be universally recognized and verifiable. At the moment, verifying academic credentials remains largely a manual process (heavy on paper documentation and case-by-case checking). Blockchain solutions could streamline verification procedures and reduce fraud claims to unearned credentials.

**Students records and certificates:** Students records and any other type of accreditation can be stored in a blockchain. Digital records and certificates hold many advantages over paper records and certificates: they require far fewer resources to issue, maintain and use. The veracity of any record can be checked against the registry automatically, without human intervention. The security of the records derives from the security of cryptographic protocols, which ensure that any extract or certificate is cheap to produce but extremely expensive to reproduce by anyone except the issuer. Finally, any issuer-fraud, such as changing the timestamp or changing a certificate serial number, is not possible in the blockchain environment.

**Libraries:** Blockchain could help libraries expand their services by building an enhanced metadata archive, developing protocols to support community-based collections, and facilitating more effective management of digital rights.

**Publishing:** Blockchain could have multiple applications in the publishing industry, from securing new talent, to rights management, and anti-piracy efforts. New platforms are emerging to level the playing field for writers and encourage collaboration among authors, editors, translators, and publishers.

**IP rights:** Currently, tracking intellectual property is a costly endeavor run by specialized organizations, usually when there is a significant business case to do so. Time-stamping scientific discoveries allows to protect intellectual property from being misused. Blockchain could also enable a model for open innovation and open educational resources whereby we could eliminate intermediaries such as fee-based journals, thus allowing anyone to publish openly, and accurately keeping track of reuse without putting limitations on the source material. Thus, teachers would be directly rewarded based on the level of actual use and reuse of their educational materials, similar to how researchers would be rewarded based on citations to their papers.

**P2P reviews:** Thanks to blockchain, the review process could be open to any peer in a given community in a transparent way.

**Scoring:** Authors could be scored/rated automatically by the nodes in the blockchain network as opposed to by a handful of peer reviewers.

**CV:** Blockchain can enhance fraud detection and prevention. This would free up administrative resources by reducing the amount of work needed to process credential verification requests. In addition, blockchain is useful in this way not only for academic institutions but also for employers and third parties, such as job seekers. The former might avoid the expensive, complicated, and lengthy processes involved in background checks and evaluations of job applicants; the latter might speed up the job seeking process by more easily proving the authenticity of their academic qualifications.

However, all that glitters is not gold. A problem that is worth highlighting is the complex relationship between blockchain and well-established regulations, which include the particularly challenging data protection. With the recent enactment of the General Data Protection Regulation, data need to be exchanged in accordance with definitive standards, and subject to certain essential rights. Some of these (the right to be forgotten and data redaction, for instance) are not easily enforceable when it comes to blockchain and DLT. Blockchain architectures will, for instance, need either to store raw personal data on-chain or provide some mechanism for the deletion of private keys where these give access to an individual’s data. Whether regulators would find such implementations compliant with GDPR remains to be seen. Thus, the path to widespread adoption of the technology in the education sector is still long, and many challenges remain.

**REFERENCES:**


**BIOGRAPHY**

**PAOLO TASCIA** is a Digital economist specializing in P2P financial systems. An advisor on blockchain technologies for different international organizations including the EU Parliament and the United Nations. Paolo is founder and Executive Director of the Centre for Blockchain Technologies (UCL CBT) at University College London. Prior to this, he was Lead Economist on digital currencies and P2P financial systems at Deutsche Bundesbank, Frankfurt working on digital currencies and P2P lending. Paolo is also the co-author of the books FINTECH Book and the co-editor of the book Banking Beyond Banks and Money. In addition, he is author of various scientific papers about blockchain, which have been published by prestigious international scientific journals, such as the Harvard Business Review. Paolo is also director of the UCL CBT and the BARAC Project (Blockchain Technology for Algorithmic Regulation and Compliance) supported by LPRC, and the P2P-Net Project (The
TOWARDS AN OPEN DLT BLOCKCHAIN ENERGY STANDARDS FOR DECENTRALIZED GRID APPLICATIONS

By Claudio Lima (Blockchain Engineering Council)

Introduction

Blockchain is defined as a distributed ledger technology (DLT) that is becoming the underlying layer of the future of the Internet of Things (IoT). It is creating a new wave of decentralized services applications, called “DApps,” that will be introduced to replace most of today’s centralized, cloud-based Internet applications. Permissioned, enterprise, and consortium-based DLT Blockchain has been considered as a new enabling technology layer of information technology (IT) enterprise systems and processes, used in industry verticals to improve IT operations, security, and process efficiency [1,2].

DLT Blockchain is being introduced in the energy vertical, particularly in the utility grid sector, to reduce costs, improve security, disintermediate processes, speed transactions, register all smart grid operations [3]. On the other hand, new Blockchain-enabled transactive energy models have been defined and introduced at the consumer and edge side of the grid, which may reshape traditional grid business models, enabling a new wave of decentralized services. Utilities will experience a new level of digital transformation by adopting DLT Blockchain technologies, which can be considered as an evolution towards grid modernization.

Open Blockchain Energy (OBE) Framework

Before DLT Blockchain is considered in the energy sector, it is important to understand, classify, and categorize all its applications segments, and define key concepts and frameworks. For this reason, a new Open Blockchain Energy (OBE) Architecture Framework is proposed and under consideration by the IEEE Standards Association, to create the first concepts on how to segment the DLT Blockchain processes, functionalities, applications, and use cases in the energy grid, which can be harmonized to enhance existing smart grid standards [4].

The distributed ledger OBE BUS contains two main segments. One related to mission critical, secure, and scalable grid operations (Blockchain core and edge); the other on the prosumer (producer and consumer of energy) or customer-facing side (Blockchain prosumer). Both will have DLT Blockchain segment-specific open application programming interfaces (APIs) to support multiple Blockchain grid applications segmentation. The operations segment can support high performance, high security, and mission-critical industrial grid Blockchain operations, where distribution system operators (DSOs) and regional transmission organizations (RTOs) work as participants in the process, as well as wholesaler energy providers, such as independent power producers (IPPs). On the consumer-facing side of the grid, a multitude of new Blockchain applications can be developed, where retailer energy providers, residential and microgrid prosumers can be connected to OBE open APIs. For each grid segment, a set of distinguished Blockchain decentralized applications (DApps) can be developed. This framework can be further evolved and detailed to accommodate more specific grid domains and applications in the near future. An Open Blockchain Energy reference model is needed to drive new grid services, improve and optimize the existing ones and eventually introduce new Blockchain-enabled transactive energy regulation in the energy sector.

End-to-End DLT Blockchain Grid Segmentation

In the energy grid industry vertical, there is no one-size-fits-all DLT Blockchain solution. There are distinct processes, type of assets, and functional requirements that distinguish a typical grid electricity end-to-end solution. For instance, from the generation all the way to the distribution substation, there is a need to control and secure mission-critical assets that are isolated from most of the grid-edge and enterprise processes. This core grid segment, particularly at the transmission and distribution (T&D), substation, and grid edge (feeder side) are currently run by synchrophasor network, supervisory control and data acquisition (SCADA), and DNP3 protocols, evolving towards the IEC 61850 object-oriented protocol. The last mile segment is the prosumer customer-facing side, which includes all customer loads, electric vehicle charging stations, residential and commercial roof-top solar and batteries, with lots of renewable energy penetration at the edge and consumer side.

Based on these definitions, the DLT Blockchain energy grid solutions can be further classified into three main segments—Blockchain core, Blockchain edge/feeder, and prosumer. Each segment has its own grid devices and equipment, which are an essential part of the modern grid. From the T&D side, there are bulk renewable and fossil fuel generation, transmission lines, and substations. From the grid edge/distribution feeder-side, there are important grid elements, called remote terminal units (RTUs), such as capacitor banks, reclosers, voltage regulators, volt-var, transformers, etc. From the consumer-generation side (prosumer), there are smart meters, root-top solar with connected electrical vehicle charging stations and energy storage systems. Each grid element can be a source/sink that generates its own “smart contract,” which is a Blockchain “what..if” embedded software logic. The enterprise and mission-critical permissioned Blockchain platforms can connect to existing grid enterprise/SCADA management system, such as energy management systems (EMS), distributed energy resources management systems (DERMS), and also to enterprise advanced metering infrastructure (AMI) solutions, using grid device smart contract logics that can contain important grid events, transactions, and asset identification that need to be registered and authenticated in the DLT Blockchain shared database. This shows the importance of identifying the critical assets and transactions and defining the levels of security and performance for each Blockchain grid segment. It is very important to create these isolated and federated Blockchain segments to improve grid security, scalability and performance, addressed by the 2P2S (performance, privacy, security, scalability) design principles [1].

Key Takeaways

Currently, there is a lot of misconception in understanding that Blockchain technology can be applied beyond bitcoin or cryptocurrency applications and therefore can provide tremendous value to the utility of the future. The vast majority of the energy/utility regulatory commissioners are still trying
to understand how Blockchain can be used in regulated and unregulated energy markets and how it can play in distributed transactive energy services that may disrupt traditional grid-centric generation models. In most cases, however, Blockchain is associated with high energy consumption scenarios due to the bitcoin mining proof-of-work (PoW) consensus algorithm, which is creating a new and unexpected distributed load to be managed by utilities. However, it is just a matter of time before more deployments are validated and the Blockchain value proposition is realized by grid-energy operators and consumers.

In parallel, there is a strong need to create standards in the DLT Blockchain Energy vertical. With this proposition, the IEEE Standards Association (SA) established in September 2018 the IEEE P2418.5 DLT Blockchain in Energy Standards Working Group [5], which is charged with developing the first global standards to address DLT Blockchain reference architecture, end-to-end framework design, interoperability requirements, and use cases to drive technology adoption.

In summary, DLT Blockchain technologies will be a critical enabling technology for grid modernization, introducing new decentralized services, operational, and cybersecurity models for energy/utilities.

References:

Biography
Claudio Lima is a seasoned technology executive and thought leader in Advanced Blockchain, IoT and AI technologies with expertise in energy (utilities, oil and gas), smart city and telecom/IT digital transformation. He has a Ph.D. in Electronic Engineering at the UKC (England). Previously he was the Global Smart Grid CTO of Huawei Technologies in Europe-Asia-Pacific and a Distinguished Member of Technical Staff (DMTS) at Sprint Advanced Technology Labs (Sprint ATL), in Silicon Valley-CA. Dr. Lima currently leads the IEEE Blockchain Standards development as Chair and Vice-Chair of IoT and Energy Working Groups. He also serves as the Blockchain Cybersecurity Industry Advisory Board Member of the Department of Energy (DOE)/PNNL.