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Blockchain 101

*A primer on blockchain and distributed ledger technology
and its application in the energy industry*

PRESENTED BY

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This Article has two goals. First, we offer a brief introduction to blockchain and distributed ledger technology by tying together concepts that the reader may have encountered out of context and providing some structure and background. Secondly, we highlight a handful of applications and issues of particular interest to those in the energy industry. After the basic mechanics of bitcoin, as the first implementation of blockchain technology, we discuss ethereum, smart contracts, and the explosion of new projects related to the development of decentralized applications. We then move on to discuss various ways in which these new technologies have the potential to significantly affect the energy industry.

I. A BRIEF INTRODUCTION TO BLOCKCHAIN

A. What is Blockchain?¹

Blockchain—or distributed ledger technology—is the technology underlying bitcoin and other cryptocurrencies. It uses cryptography to chain together blocks of data in a manner that makes them difficult to tamper with, particularly when the data is stored across a number of computer systems controlled by different actors that have been given an economic incentive to maintain the integrity of the network.

In the context of bitcoin, this means that every bitcoin transaction is recorded in a single ledger file, copies of which are kept on tens of thousands of computers that run the open-source software necessary to process bitcoin transactions. When you send bitcoin to a friend, you are sending a message to all of those computers that says “*Send .5 bitcoin to Bob.*” Those computers—called “miners”—then find a particular number that, when combined with data from your transaction and several hundred other transactions and run through a particular mathematical function, yields a very specific result. The miner that finds the “winning” solution uploads their block to the network, where it becomes part of the permanent record of bitcoin transactions, and is rewarded with a small amount of bitcoin called a “block reward.”

Each block of data contains a digital thumbprint—a “hash”—of the block before it, which in turn contains the hash of the block before *it*, and so on, such that if you change the slightest bit of data in a given block, it alters the thumbprint of every block of data that follows. The blocks of data are chained together by those digital thumbprints. *Blockchain.*

There is, of course, a lot more to it. You can lose days digging into exactly how hash functions work, the basics of public key cryptography that govern access to individual bitcoin

¹ There are a number of more comprehensive primers available to explain the origins and development of bitcoin and blockchain. See, e.g., BANKING ON BITCOIN (Periscope Entertainment, 2016); NATHANIEL POPPER, DIGITAL GOLD (2015); MICHAEL J. CASEY & PAUL VIGNA, THE AGE OF CRYPTOCURRENCY (2016); MICHAEL J. CASEY & PAUL VIGNA, THE TRUTH MACHINE (2018); *A Beginner's Guide to Blockchain Technology*, COINDESK, <https://www.coindesk.com/information/> (last visited September 4, 2018).

addresses, and the complex web of incentives—often described as *cryptoeconomics*—that govern the behavior of all participants in a blockchain-based network like bitcoin. But the important takeaway is that bitcoin is a working example of at least one way in which blockchain technology might allow historically *centralized* activities to become *decentralized*.

B. Ethereum and Smart Contracts

This decentralization becomes even more powerful once you begin looking at the blockchain protocol called ethereum and the various projects that it has inspired. Ethereum was launched in 2014 as a decentralized platform designed to run “smart contracts.” Unlike traditional contracts, which typically contain language subject to interpretation, smart contracts are programs that execute automatically based on a set of predefined conditions.

In the simplest example of a smart contract, if Alice and Bob want to bet on the price of crude oil, they could enter into a smart contract that would (a) record that Bob thinks the price will be at or above \$70 a barrel on December 1st, while Alice thinks it will be below \$70 a barrel on December 1st, (b) escrow a certain amount of cryptocurrency from each of Alice and Bob, (c) query an agreed upon source of information (*e.g.*, the NYMEX price as quoted on Bloomberg’s website) on December 1st, and (d) based on the settled price for the date, send all of the escrowed funds to either Alice or Bob, with no further action required on the part of either party.

Obviously, there are a lot of potential risks that come with relying on smart contracts that automatically execute without human intervention. Errors in the smart contract code, a glitch in the trusted information source, or a failure of either party to perform a “real world” component of the contract could subject one or both parties to significant risk without the benefit of dispute resolution mechanisms commonly set out in traditional contracts. But at least for certain types of transactions for which conditions can be readily defined, smart contracts offer the hope of greater execution speed, reduced credit risk and regulatory costs, and a reduced likelihood of both breach and errors. And because these smart contracts are running on a decentralized platform, no single service provider or government agency can shut down or censor the transaction.

C. dApps and the Ethereum Virtual Machine

Ethereum can do a lot more than simply record bets. If we think of the bitcoin network as a tens of thousands of computers working together to serve as a giant spreadsheet, we can think of ethereum as tens of thousands of computers working together to serve as a giant *operating system*. Whereas the bitcoin network is designed to perform a fairly narrow set of functions focused on moving and tracking bitcoin transactions, ethereum has its own high-level programming language that allows developers to build not just simple smart contracts but entire applications that are then deployed to the blockchain and, rather than being run on servers controlled by a single company,

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