Transaction Management: An Overview of
Digital Tools for Managing Complex Transactions

Module 2: Smart Contracts, the Contract Codex and Smart Contract Analytics

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Module 2: Smart Contracts, the Contract Codex and Smart Contract Analytics (90 minutes)

Blockchain Basics Review

- Blockchain is software
- Distributed ledger technology is database
- Stored in unique 'blocks'
- Decentralized storage
- Immutable ledger
- Transparent and secure
- Efficient and scalable

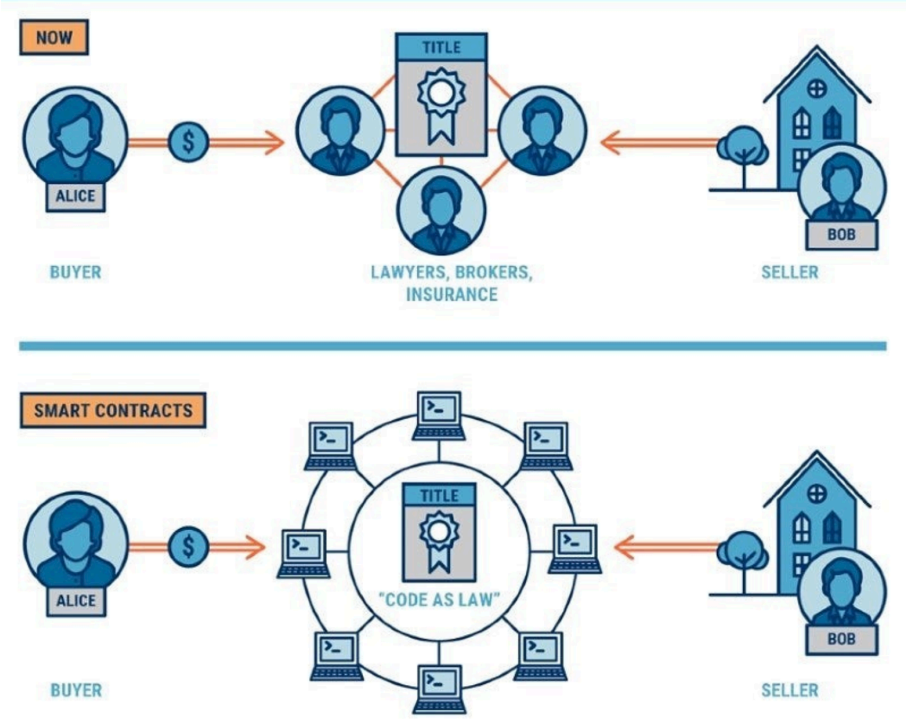
Smart Contracts

Just like Blockchain and Distributed Ledger Technology (DLT) is software, so is a smart contract. And just as DLT has evolved from hand written ledger sheets, to spreadsheets, to relational data bases to DLT; so too are smart contracts the evolution of hand written contracts to typed/printed contracts to "static" digital contracts to "dynamic" smart contracts.

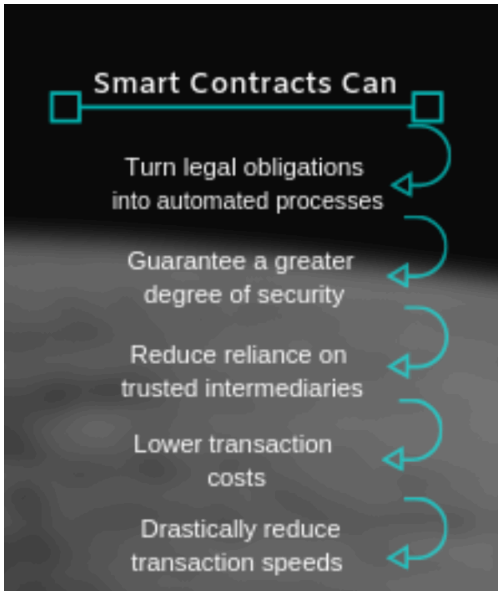
> *A smart contract is a computer code that can be built into the blockchain to facilitate, verify, or negotiate a contract agreement. Smart contracts operate under a set of conditions that all parties agree to. When those conditions are met, the terms of the agreement are automatically carried out.*

Smart contracts can automate various processes and operations, based on trusted, outside data input agreed to by the transaction parties. For example, the release of a letter of credit dependent on whether a transaction party has made payment for their natural gas supply or transport invoice on time. The process and fundamental logic are simply the automation with code of the "if-this-then-that" credit release contract term previously agreed by the transaction parties. This aspect of the transaction is made secure, transparent, efficient and indelible by use of the blockchain and DLT. Blockchain and DLT are the enablers necessary for smart contracts to become commonplace in business transactions.

Smart contracts – by minimizing the need to trust a counter party, rely upon a third party, or have legal system intervention – can reduce counter party risk, expand transaction credit and create other contracting opportunities. The vending machine is the original form of a smart contract. At its core, a vending machine is a security mechanism, as the machinery reflects the nature of the deal: it computes and dispenses change as well as the customer's choice of product.



Smart contracts involve objectively verifiable actions, or actions that can be automated such as cash flows, transfer of commodities, issuance of instructions (such as dispatching and imbalance reconciliation), etc. As a result, financial and supply chain contracts (as you saw in Module 1 with the Maersk case study), present obvious smart contract application opportunities. Smart contracts can reduce the costs of people calculating complicated outcomes, and thereby make possible new kinds of contracts that weren't possible before. "Contracts-for-Difference", are used in financial trading where software very rapidly and continually monitors data from an "Oracle" (a mutually agreed trusted source), adjusts transaction balances and can dispense cash flows based on frequently updated market prices.



In 1996, Nick Szabo described a smart contract as "a set of promises, specified in digital form, including protocols within which the parties perform on these promises."

"A set of promises"	**"Specified in digital form"**
• Depending on the model of smart contract deployed, such promises may be a formal contract or non-contractual rules • In other words, consisting of contractual terms and/or rules-based operations designed to carry out business logic	• A smart contract operates electronically • It consists of contract text and lines of code prescribing conditions for action and outcomes • Contractual clauses and/or functional outcomes are embedded as software code.
"Protocols"	**"Within which the parties perform"**
• A computer protocol in the form of an algorithm constitutes a set of rules agreed by the transaction parties as to how data will be processed and acted upon. • Technology-enabled, rules-based operations enable actions to be performed, such as the release of a letter of credit.	• The idea of automated performance is at the heartof a smart contract • Driven in part by the blockchain technology typically hosting a smart contract, they are regarded as irrevocable • Once initiated, the outcomes for which a smart contract is encoded to perform cannot typically be altered or stopped (unless an outcome depends on an unmet condition)

IMPORTANT – Once transaction parties consummate a smart contract, it will be performed as specified.

A Beginner's Guide to Smart Contracts

Let's view a 4 minute smart contract overview video

- https://www.youtube.com/watch?v=RZXJMdAk5zk

Smart Contracts Variations			
Contract entirely in code	Contract in code with separate natural language version	"Split" natural language contract with encoded performance	Natural language contractwith encoded payment mechanism

There are a variety of conceptual approaches to smart contracts. However, be aware that smart contracts which encode the entirety of the "natural language" of contract (a "code is the contract" model) are challenging from a legal perspective. That model puts into question whether the transaction parties have formed legally binding contract.

Are smart contracts legal? Yes, if structured correctly.

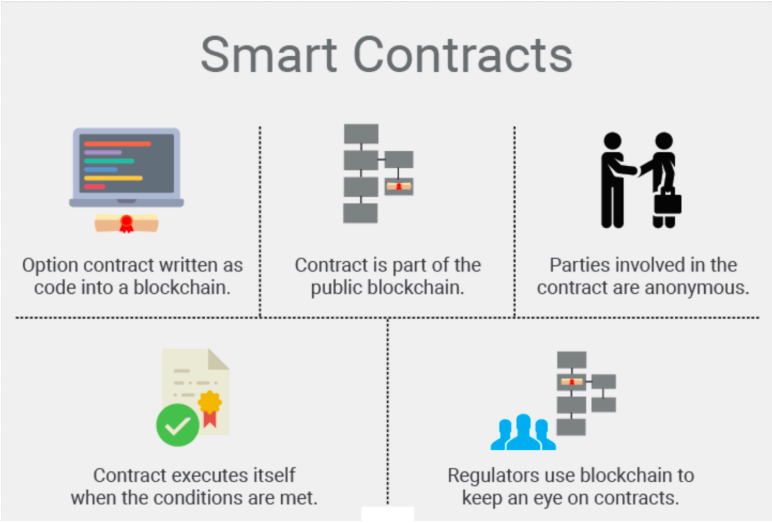
- Is there offer & acceptance, intent, and consideration? An intention to be bound?
- Contract law adapted to digital contracting: E-commerce, shrink-wrap or click-through agreements
- Existing body of electronic signature and records law (e.g., Uniform Electronic Transactions Act)

The Electronic Signatures in Global and National Commerce Act ("E-SIGN Act") and state laws modeled on the Uniform Electronic Transactions Act ("UETA") also provide important support for the concept that smart contracts should be treated as legally enforceable agreements. Many states (AZ, TN, VT, OH, FL, CA, WY, NV, NH, IL, HI, IA) have passed specific bills that a contract that is secured through blockchain technology is considered to be in an electronic form and to be an electronic record. Congress passed the E-SIGN Act last summer as a way to have broad national agreement.

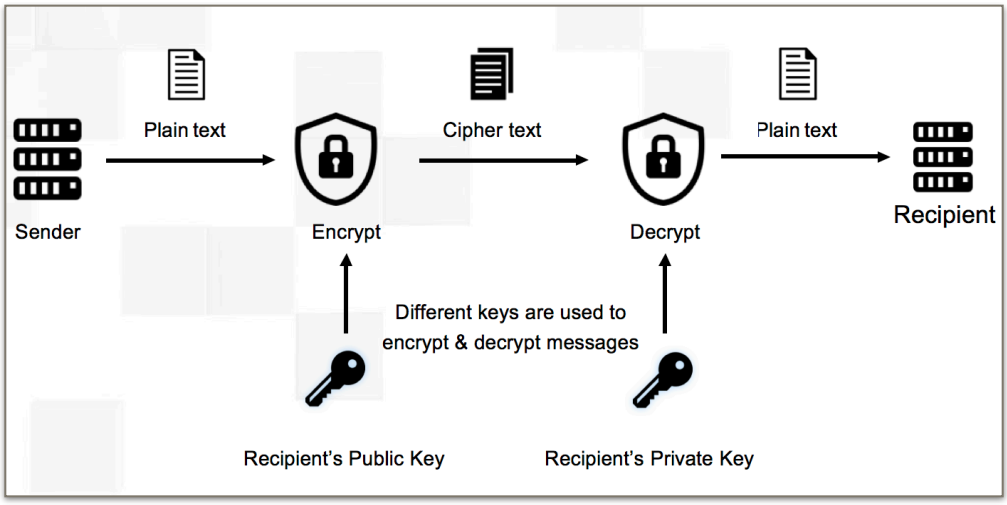
Most smart contracts then are a combination of traditional legal language describing the transaction combined with the code to automate the transaction. In addition to traditional contracts, smart contacts also need to provide to unintended outcome unique to them. Smart contract code can contain bugs. Code may not always perform as the parties had intended. Messages transmitted over the internet can be delayed or interrupted, and data can be corrupted in transmission. Private encryption keys can be obtained by hacking. The liability implications of these kinds of events need to be carefully crafted into the smart contract base model.

Smart contracts are typically deployed on a blockchain with the smart contract program logic residing within a "block." That block is the software-generated container that bundles together the messages relating to a particular smart contract. Those messages may act as inputs or outputs of the smart contract programing logic and may themselves point to other computer code or other blocks.

A private blockchain will use public key encryption common to that blockchain's permitted transaction parties and private key encryption for each permitted party with that private blockchain. In a smart contract transaction initiated on a blockchain, the initiating transaction party selects the pre-designed appropriate smart contract form from a drop-down menu within their private blockchain screen display, selects all the required contract variable to complete the contract, selects their desired counter party(s) and hits "send". This causes their smart contract to be converted into an unreadable 'cipher text' using algorithms or mathematical formulas, to protect and secure the data that is housed in a blockchain block.



The selected counter parties receive a contract offer notification on their screen and from their identical copy of the private blockchain residing on their computer and with their private key may call up a deciphered version of the smart contract. They can accept or counter any variable proposed and send their response to the initiator via the same blockchain process. Once mutually agreed, the smart contract is digitally signed and the final smart contract is stored in a block (as are all previous iterations). Use of the blockchain makes smart contract transactions highly secure and reliable.

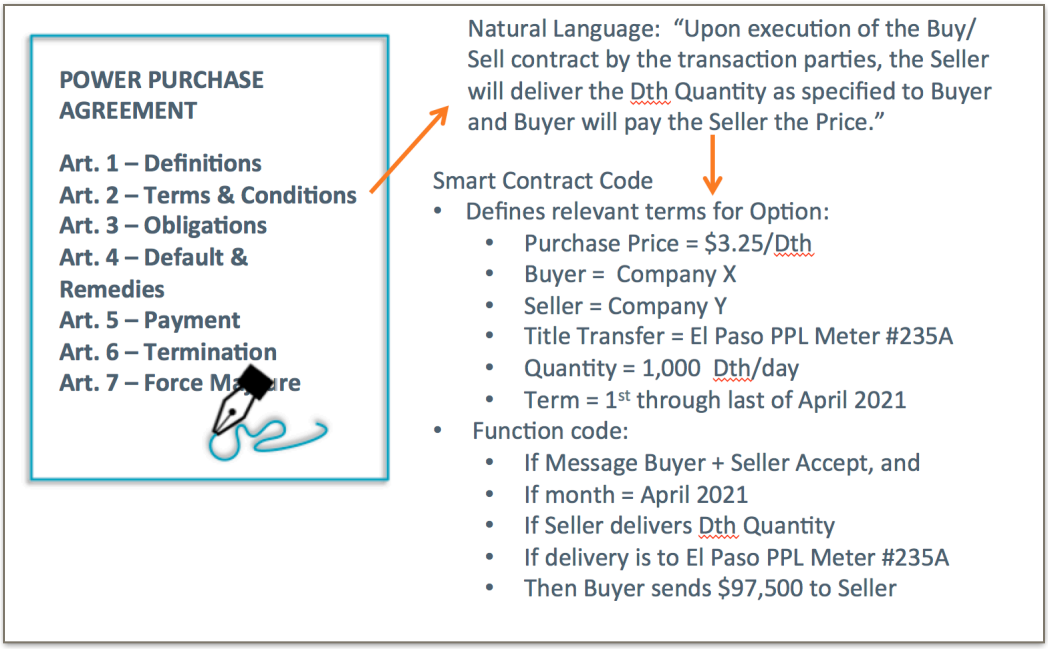


Smart Contract Basics and the Oracle

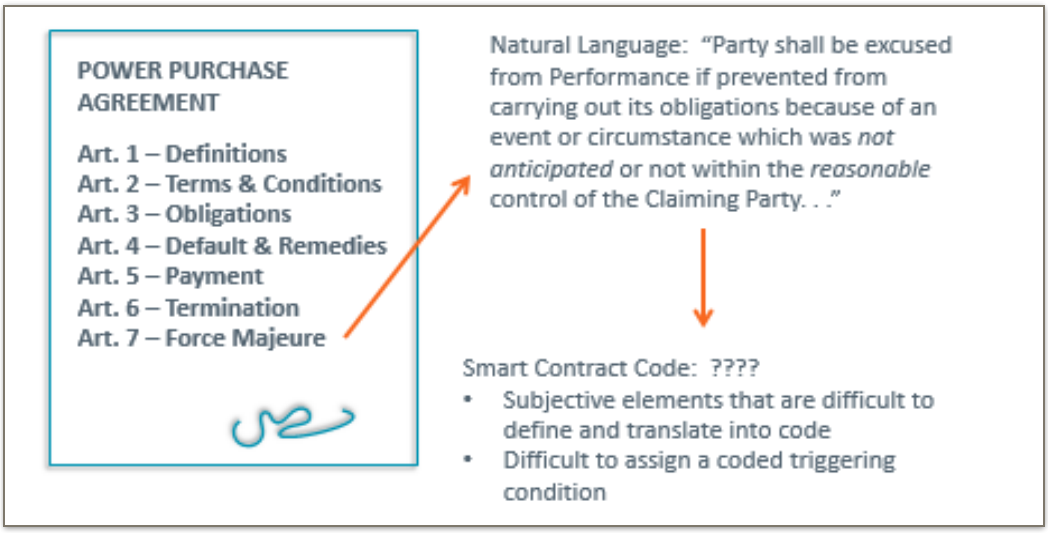
Here's a 6 minute Coursera class to move us further along in our understanding of smart contracts.

- https://www.coursera.org/lecture/new-technologies-business-leaders/what-is-a-smart-contract-MVL9L?isNewUser=true&redirectTo=%252Flearn%252Fnew-technologies-business-leaders%253Faction%253Denroll

Let's examine some examples of how smart contract code or language can be created.



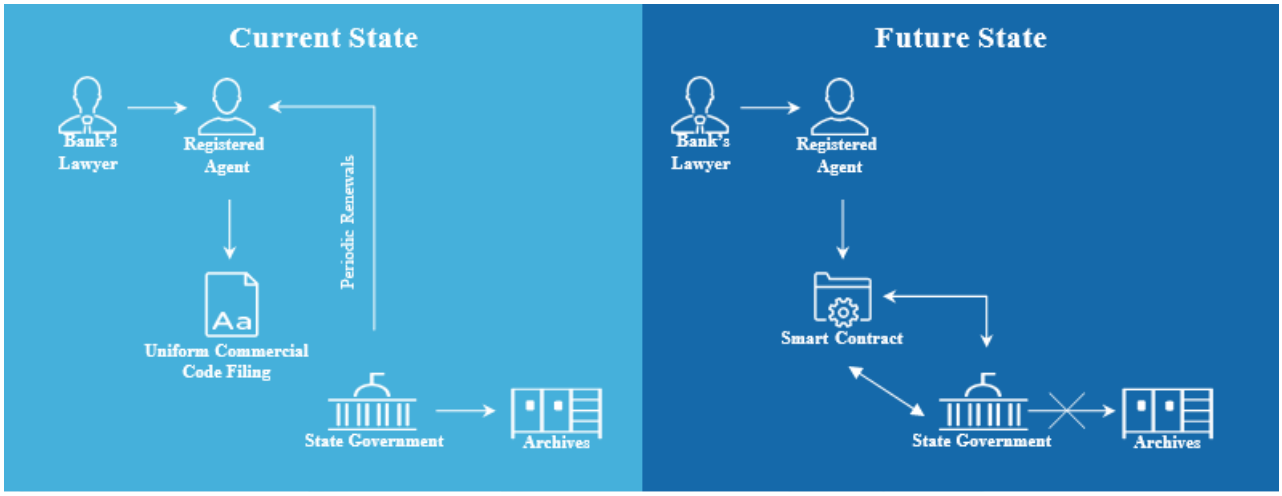
But some contract language will be hard to code, as it requires interpretation.



Let's examine some applications

- Smart Contracts for Records Management
- Contract and Record Retention Management

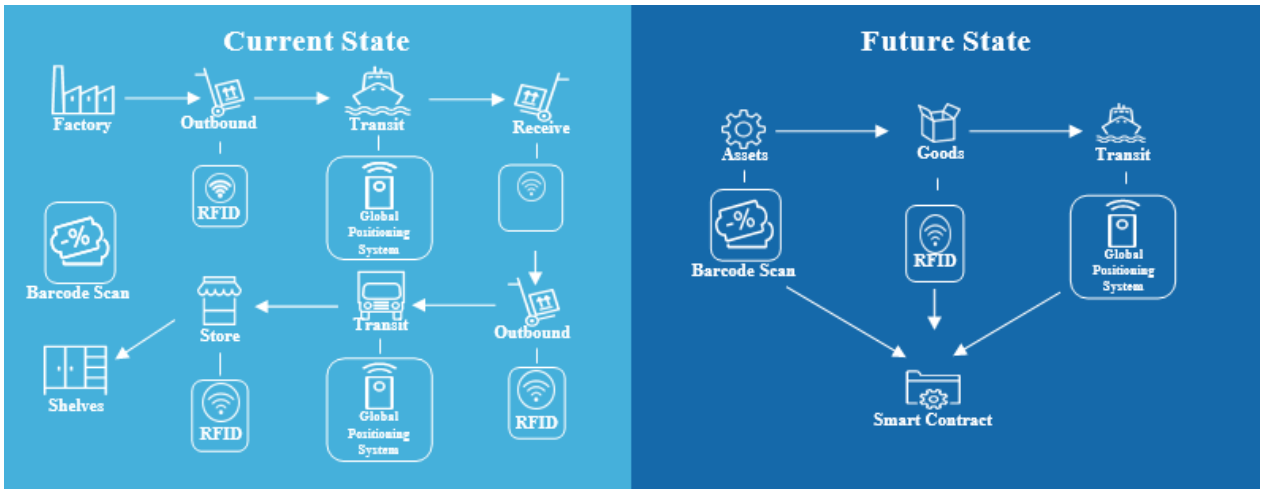
Contract and record retention compliance can be automated to comply with rules requiring destruction or release of records or assets on a future date or upon a specified condition with smart contracts.



"Current Challenges"	"Smart Contract Benefits"
• Paper-based filing for many foundational documents of finance with government • Error-prone, manual process for renewing/releasing Uniform Commercial Code filings results in latency • Expired archival data stored with government occupies warehouses and incurs additional costs	• Reduced legal bills through auto-renewal and auto-release of digitized UCC filings • Automated processes, including calling by lenders for additional collateral and tracking of loan vs. collateral value • Archival data automatically becomes unsearchable/unreplayable after it reaches its sunset date
Smart Contract Considerations	
• Smart contract platform must be capable of storing data on a distributed ledger without slowing performance or compromising data privacy • Active involvement of lenders and registered agents must exist for more complex functions (e.g. auto- release or automated call for additional collateral) • Clarification regarding whether courts would consider a document legally destroyed if it is merely cryptographically unsearchable rather than removed from the ledger	

Supply Chain Management

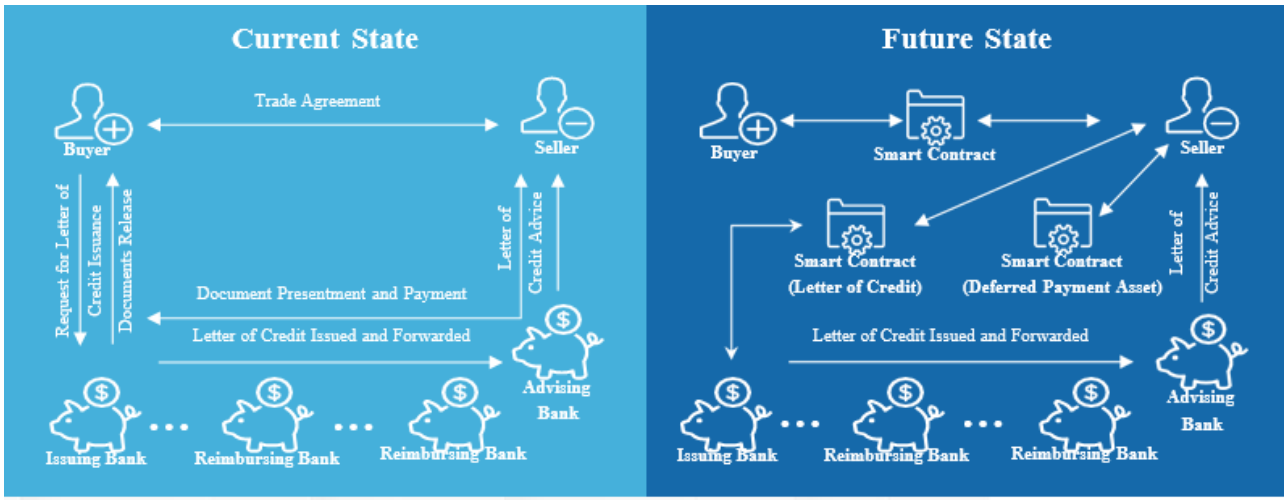
Extended supply chain visibility, enabled by smart contracts, provides stand-up and tear-down of goods tracking across brands, retailers, logistics and contracted counter parties.



"Current Challenges"	"Smart Contract Benefits"
• Limited visibility due to siloed data capture and desire to only share information with relevant parties • Need for captured data to be similarly formatted to extract values • Incompatibilities in data and blind spots in tracking goods due to silos in the supply chain (even source-tagged goods)	• Simplification of complex multi-party systems delivery • Achieve granular-level inventory tracking and delivery assurance, potentially improving supply chain financing, insurance and risk • Enhanced tracing and verification to reduce risk of fraud and theft
Smart Contract Considerations	
• Trusted oracles must be implemented to provide validated registrations of an entity • Identities must be registered and attested over time, including for institutions, individuals, sensors, facilities and goods	

Trade Finance Management

Payment method and instrument automation enabled by smart contracts provides risk mitigation and improved financing and process efficiencies for buyers, suppliers and financial institutions



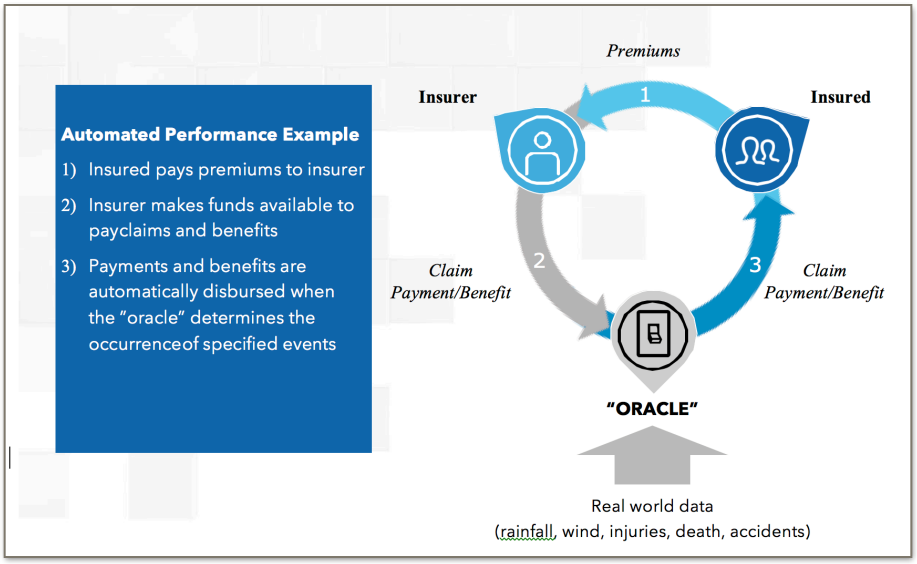
"Current Challenges"	"Smart Contract Benefits"
• Time-consuming and costly Letter of Credit issuance process due to required coordination and paperwork • Physical document management can delay shipment receipt until title document is released • High document fraud/duplicate financing due to de-linked processes	• Faster approval and payment initiation through automated compliance and monitoring of Letter of Credit conditions • Improved efficiency in creating, modifying and validating trade, title and transport-related contract agreements • Increased liquidity of financial assets due to ease of transfer and fraud reduction
Smart Contract Considerations	
• Industry-wide standards for smart contract templates and procedures must be implemented for wider acceptability and adoption • Legal implications for potential smart contract execution fall-out must be determined (in particular for defaults and dispute resolution) • Integration with settlement systems, off-chain ecosystems and technology prerequisites (e.g. Internet of Things) must be successful to achieve full benefits	

Smart Contract Performance and Oracles

Contracts sometimes involve difficult, subjective, judgment which makes automated performance more difficult. For example, smart contracts may be difficult to develop and implement where the situation calls for: (1) reversibility of transactions; (2) subjective analysis (how much flood damage was there on the second floor of a building?); and (3) the programming of excessively complex or nebulous principles into smart contract code (e.g., interpretational standards, such as "reasonableness").

Transaction parties must determine other issues even when smart contracts call for objective "outside data." An example of the "outside data" aspect of a blockchain would be in the context of natural gas deliveries: who decides when supply source "froze off"? Transaction parties will have to agree in advance to make the determination. For example, the parties may agree to use temperature data compiled by the National Weather Service. Parties will also need to agree to sufficient "fallback" providers if the primary data source is no longer available and the extent to which they can challenge the outside data.

The transaction parties will also need to agree on how the information will make its way to a blockchain. Algorithmic platforms, known as "oracles," whose sole task is to feed information from the outside world into the ledger to facilitate smart contract enforcement, will perform the data-input function. The outside oracle must be a trusted third party and must preserve the integrity of the smart contract by transmitting accurate and trustworthy data in a secure manner.

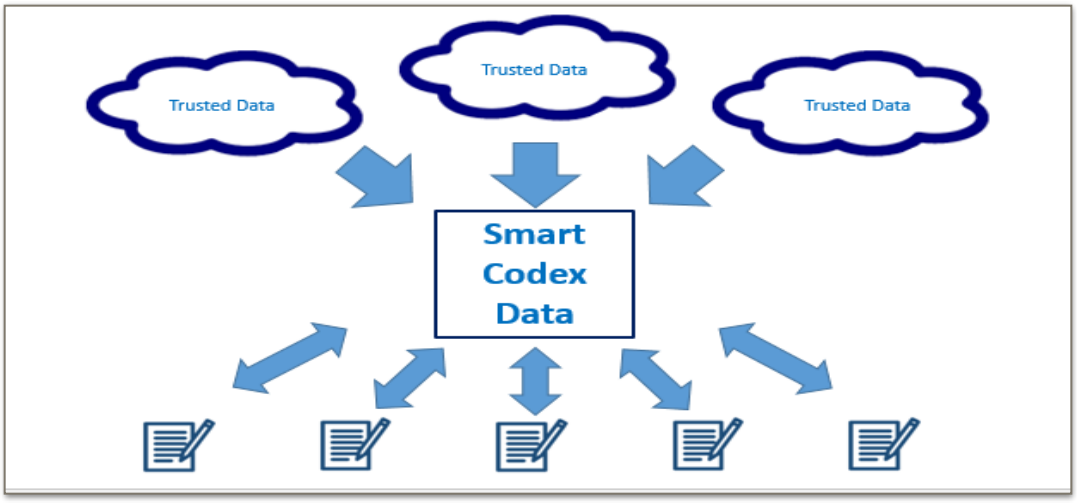


In the reverse situation, the parties to a ledger-hosted smart contract may intend for an event on the hosting ledger to affect the outside world. Without involvement from a trusted third party, however, enforcement is limited to the particular blockchain. Complex smart contract proposals may call for off-ledger assets to be moved, such as physical goods or funds held in a bank, upon the occurrence of some event on a blockchain. In such a situation, the parties would enlist a trusted third party (potentially a financial institution) to monitor the blockchain and respond to events as required.

Smart Contracts, the Smart Contract Codex and Smart Contract Analytics

The Smart Contract Codex monitors federal, state, local and industry regulations, rules, standards and specifications (Codex Data) affecting the transaction and either advises the transaction parties automatically of the need to amend their buy/sell or transportation Interactive smart contract or automatically updates their contract and appropriately modifies the transaction.

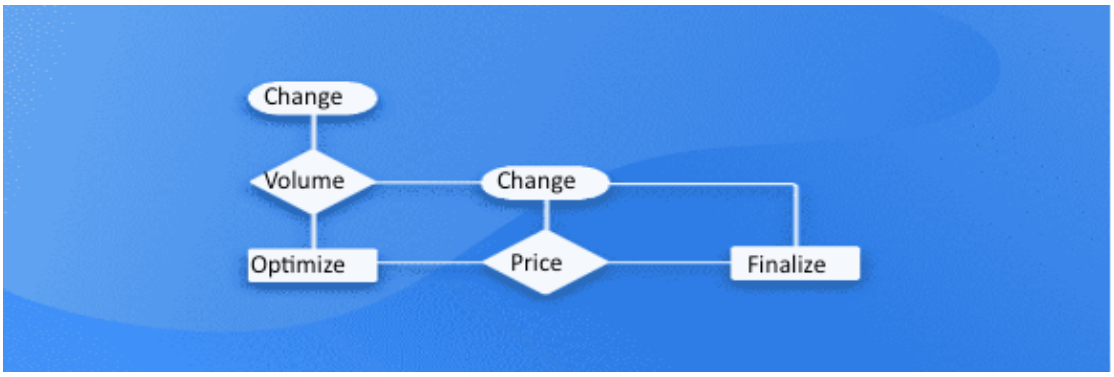
The Smart Contract Codex may be a central directory of Codex Data which govern the interactive smart contracts of all transaction parties to a particular private blockchain and to which all interactive smart contracts refer. As transaction parties select a smart contract template and begin to input variable information (such as state, delivery pipeline, volume, price receipt point, etc.) to describe the transaction desired, the Smart Contract Codex is prompted to add appropriate information to the template to create a contract unique, for example, to the state, delivery pipeline and receiving distributor selected by the transaction parties. This information added by the Smart Contract Codex in part governs the transaction's operation once the Interactive smart contract is digitally signed.



When transaction parties agree to employ the Smart Contract Codex to automatically amend their interactive smart contract, such changes when subsequently incorporated in an interactive smart contract henceforth govern the ongoing operation of the transaction and may prompt automatic orders by the interactive smart contract to change any of the actions previously initiated by the interactive smart contract.

Regulations, rules, standards and specifications which may be reduced to metrics digitally quantifying transaction performance are embodied in the Smart Contract Codex. This information before input to the Smart Contract Codex is certified by an appropriate official such that thereafter the information may be relied upon as current and correct by Transaction Parties. These regulations, rules, standards and specifications may be dimensions, weights, volumes, concentrations, times, durations, distances, areas, locations and any other measure by which an aspect of a transaction may

be compared to the Smart Contract Codex without human intervention to determine whether that transaction conforms to current regulations, rules, standards and specifications.



In an example of the operation of the interactive smart contract and the Smart Contract Codex, on the first day of a month a regulation by a federal regulatory body becomes effective, causing a change in an operating specification of a transporter used by the Transaction Parties and affecting their transaction being managed by an interactive smart contract. The interactive smart contract queries the Smart Contract Codex at 3:00 am each day to confirm regulation, rule, standard and specification compliance of the transaction. The interactive smart contract queries the Smart Contract Codex for compliance with regulations, rules, standards or specifications pertaining to transactions in the county, state and with their transporter during the subject month. The interactive smart contract through calculation determines transaction non-compliance on the date of the federal regulation change. The transporter's operating specification change requires a reduction of the Transaction Parties' transportation volume to regain regulation rule, standard and specification conformance. The interactive smart contract calculates the volume change needed to attain conformance, optimizes the transaction value among its various volume change choices, initiates the change and informs the Transaction Parties of the change and its cause.

Discussion - Q&A Day 2

Useful blockchain links

Chamber of Digital Commerce

- https://digitalchamber.org/

Coursera class

- https://www.coursera.org/lecture/new-technologies-business-leaders/what-is-a-smart-contract-MVL9L?isNewUser=true&redirectTo=%252Flearn%252Fnew-technologies-business-leaders%253Faction%253Denroll

Bybit Learn

- https://learn.bybit.com/blockchain/what-are-smart-contracts-in-blockchain-how-do-they-work/

Blockgeeks

- https://blockgeeks.com/guides/smart-contracts/