The Digital Pink Slip: 
A Blockchain Use Case for Automobile Registration

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Indiana State University

Dijo Alexander, PhD
Head of Technology, SAP (Litmos eLearning)
It all began......June 29, 2007

Apple reinvents the phone
“It’s important for today’s auditors to be at the forefront of disruptions, such as blockchain, and to identify ways to innovate to advance audit quality and to align auditing capabilities with the changes occurring in the marketplace.”

Frank Casal, vice chair of audit KPMG
Agenda

- What is Blockchain?
- How Does it work?
- Use Case
- Proof of Concept
- Conclusion
- What’s Next....
What is a Record? Block?? Blockchain???

**Records**
- Can be any information
- All the information about the asset

**Blocks**
- Collection of records
- Blocks are a snapshot of each state
- Track an asset whose state changes

**Blockchain** is the ledger
- Continuously updated record of who holds what
- Representation of the continuous “change of state”
What is Blockchain?

Self-sustaining, peer-to-peer database for managing and recording transactions with no central bank or clearinghouse involvement

“Blockchain” is named after how transactions are stored—blocks of data, encrypted by altering (or hashing) part of the previous block

Blockchain is the representation of the continuous “change of state”
How Does it Work? No Central Authority

Historically, we have had to rely on third party institutions (e.g. government, financial institutions, large corporations) to manage the integrity, trust, and transaction itself. In a way, we have shifted that protocol to the underlying technology of Blockchain.

Bill Briggs, managing director, US and Global Chief Technology Officer, Deliotte Consulting LLP
How Does It Work?

• System is presumed immune to tampering, fraud, or political control
• Handled through algorithms and consensus among multiple computers
• Designed to protect against domination of the network by any single computer
• Every transaction is processed just once, in an electronic ledger
What is Blockchain used for?

Asset, Participant, Transaction

Blockchain is a technology used for managing the exchange of assets.

**Asset**
- An asset can be anything of value.
- Include physical or non-physical asset.
- e.g.) currency, real estate, inventory, EMR

**Participant**
- Organization or people who take part in the digital business network
- who exchange these assets

**Transaction**
- Submitted by a participant to affect the assets
- Exchange itself during which there is a change of state
  (a new block is created)

Wherever there is “change of state”, there is new block
Why do we need Blockchain?

The problem with traditional transactions.....

- The seller doesn’t trust the buyer
- The buyer doesn’t trust the seller
- Buyer and seller must rely on the third party

Can we have a system where trust exists on the transaction and not the central authority?
How can to build Trust

What obstacles inhibit Trust?

• Tampering
• Lack of Transparency
• Confirmation
• Double spending problem
Immutability for “Trust”

Problem: Tampering

Solution: Immutability

Hash is mathematical algorithm
✓ that allows one way encryption
✓ “easy” to compute & “difficult” to reverse.

Immutability → Crypto-technology
How much money would you have if you doubled one cent every day for one month?

$10,737,418.24

\[ 2^{30} = 1,073,741,824 \]

How does that translate to 256 bit electronic signature?

\[ 2^{256} = \text{a very large number} \]
Private Key: Sign (Message, sk) = Signature
Public Key: Verify (Message, 256 bit Signature, pk) = T/F

Private Key (sk): 10010011........
Public Key (pk): 01000111........
Provenance for “Trust”

Problem: Transparency

Solution: Distributed Ledger

The chain is the ledger.

- Clear picture of the history of the chain itself
- Gives you confidence and helps create trust
What are Distributed Ledgers

- Centralized
- Decentralized
- Distributed
Finality for “Trust”

Problem: Double Spending

Solution: Finality (new block)

Block is only added after validation.

- Crypto has network of miners (validators)
- Algorithm to auto-validate the authenticity of prior blocks

Finality $\rightarrow$ Verification e.g.) Proof of Work
Consensus for “Trust”

Problem: No Central Authority

Solution: Verification/Acceptance

\[
\text{e.g.) mining}
\]

We build consensus by:

✓ Validation of each transaction.
✓ Participants in the chain can raise red flags
Build Trust in a “Trustless” System

Immutability → Crypto-technology

Provenance → Distributed Ledger

Finality → Verification e.g.) Proof of Work

Consensus → No Central Authority
Adding Value through Blockchain

✓ Recordation—track ownership of the physical asset
  • e.g.) Stocks, bonds, money, artwork, votes, and digital identity

✓ Value Exchange—transfer of ownership
  • e.g.) Everyone on systems knows when an asset is sold

✓ Smart Contracts—imbedded ledger is immutable
  • e.g.) Buying a car in minutes not days
Build Trust in a “Trustless” System

We can trust the transaction

But.....

Can we add conditions and/or constraints to our transaction??

Smart Contracts
Contracts

A contract is:
- A *promise* or a set of promises for the *breach* of which the law gives a *remedy* or the *performance* of which the law in some way recognizes a *duty*.

Parties of a Contract:
- At least 2 parties
  - Offeror
    - Makes an offer
    - To do or not do something
  - Offeree
    - Person to whom offer is made
    - If accepted, then contract
Contracts

Elements of a Contract:

✓ Agreement
  • Offer and acceptance; mutual assent

✓ Consideration
  • Money, property, services

✓ Contractual Capacity

✓ Lawful Object

Smart Contracts (1996) “a set of promises, specified in digital form, including protocols within which the parties perform on those promises”

“Smart Contracts” were formally proposed in 1996!
Traditional Contracts

**Paper Contract**
Cory agrees to pay $20K for the car. Once Claire gets the deposit, she will transfer the vehicle ownership to Cory by handling him over the car documents and the car.

*Signature*
Smart Contracts

Problem: Adding Conditions/Constraints

Solution: Smart Contracts

Smart contract as a script (rules)

✓ Executed before the new block will be created.
✓ Any failure = lack of finality and new block will not be created.

Add Conditions to transactions → Smart Contracts
Smart Contracts

1. Bill wants to sell a boat. He identifies himself with his public (pk) = 730484 and uses a smart contract to define the terms of the sale with his private key.

   **Smart Contract**
   
   If $20K is sent to account (pk 730484) then automatically transfer boat ID 4920x8 and smart access to the account that transferred the funds.

   **Digital Signature**

2. Bill leaves the boat and a key on the lot with a smart contract controlled lock. That boat has a (pk) = 123456

3. Phyllis wants to buy the boat. She finds the boat on the internet. She signs the contract with her private key transferring $20K from her blockchain address (sk) to Bill’s blockchain address 730484.

4. The smart contract is verified by each node on the network if Bill is the owner of the boat and if Phyllis have enough money to pay.

5. Network agrees, all conditions are true. Phyllis automatically gets access to the smart garage lock. Money exchanges and a new block is created.

6. Phyllis can unlock smart contract with (pk) and pick up boat
No court cases in US providing direct guidance on the enforceability of smart contracts.

Smart Contracts are:

- Not “Smart” or a “Contract”
- Self-governing contracts
- Simplify and automate lengthy and inefficient business processes.
- Terms and conditions are recorded in the contract’s code.
- Shared network automatically executes the contract and monitors compliance.
- Outcomes are validated instantly without a third party.
- Self-executing

Examples of Smart Contracts:

- Only used in North America
- Cannot ship to California
- Validate age
  - e.g.) selling tobacco/liquor to minor
- Only physicians can validate EMR (HIPPA)
- Cannot sell prior to Jan 1, 2020 at 12:00pm
- If sold, then must pay royalty
- Interstate Commerce (Sherman Act)

Electronic Signatures in Global and National Commerce Act (E-Sign Act) of 2000 gives the legal effect to electronic signatures e.g.) DocuSign
Blockchain: Adding Trust to the Change of State

**Blocks**
A block of data is simply a snapshot of the state of an asset.

**Blockchain**
A mechanism that registers the “change of state” adding trust to the transaction.

**Trust** is added through:

1. **Immutability.** The “Hash” is a one way encryption to verify the transaction is authentic.
2. **Provenance.** The distributed ledger is a historical record of who holds what.
3. **Finality.** A block is only added after validation.
4. **Consensus.** Participants in the blockchain network have the ability to raise red flags.

**Smart Contracts**
A smart contract is a computer script with a predefined set of rules. This script runs on the blockchain and sets the conditions required to complete a contract. It auto-executes if and when all the conditions are met before the new block will be created. Otherwise the transaction will fail.

“Like a cryptographic box that contains value & only unlocks if certain conditions are met”

Indiana State University
What are the possibilities?

Gartner research predicts there will be over 26 billion connected devices by 2020.
Blockchain technology is moving into the financial mainstream with IBM and seven European banks:

- IBM is building a blockchain for seven of Europe’s biggest banks in the area of trade finance.
- Deutsche Bank, HSBC, KBC, Natixis, Rabobank, Societe Generale and Unicredit are the banks that are part of the consortium.
Non-Financial Blockchain Uses

- Blockchain-as-a-Service (BaaS)
  - Company: Ethereum Blockchain as a Service by Microsoft Azure, Rubix by Deloitte, IBM Blockchain on Bluemix
- Compliance and security
  - Company: Chainalysis, Third Key Solutions, Tradle, Vegoogo, Elliptic, Coinalytics, Sig3, BlockSee, CryptoCorp, Blockverify
- Traceability of food products and supply chain audit
  - Company: Provenance
- Job market
  - Company: Verbatim, Appi, Satoshi Talent, Coinality
- Real estate recording
  - Company: Ubiquity, Silvertown
- Gaming and gambling
- Digital identity, identification and authentication
  - Company: Keychain, 2WAY.IO, ShoCard, Guardtime, Blockverify, HYPR, Onename, Civic, UniqID Wallet, Identity, Evenym, BanQu, AID:Tech, SolidX
- Licensing
  - Company: license.rocks
- Open organization/business-related collaboration
  - Company: Colony
- Ride-share
  - Company: Arcade City, La 202
- Esports
  - Company: FirstBlood
- Enterprise-grade solutions and development platforms (infrastructure)
  - Company: XNotes Alliance, Tymelx, Symbiont, Softicle, Pragmatic Coders, OTCOX, Openchain, Nuco, Monax, Libra Enterprise, Interbit, Credits, Colu, Ciphers, ChromaWay, ChainThat, Chain Reactor, Chain, Blob, BlockCypher, Blockchain Foundry, BigchainDB, Avalanche, Applied Blockchain, AlphaPoint Distributed Ledger Platform
- Network infrastructure
  - Company: Ethereum, ChromaWay
- Mining
  - Company: Waves
- Diamonds
  - Company: Everledger
- Media
  - Company: Pubilq
- Data management
  - Company: PeerNova, Guardtime
- Government and organizational governance
  - Company: BITNATION, Advocate, Borderless, Otonomo, BoardRoom, Colony
- Land registry
  - Company: The Dubai Land Department (DLD)
- Internet of Things (IoT)
  - Company: Databroker DAO, Chronicled, filament, Chimera, Filament, Stock.it
- Supply chain management
  - Company: Skuchain, Factom
- Operating system
  - Company: BloxEnterprise by Blox, BOLOS by Ledger, EOS by Blok.One, DeOS by Razar mind, GemOS by Gem, Vault OS by ThoughtMachine
- Data integrity and security
  - Company: PeerNova, Guardtime
- Authorship and ownership
  - Company: Bitproof, Blocki, Stampetry, Verisart, Monegraph, OriginalMy, Crypto-Copyright, Proof of Existence, Ascribe, Pa.et
- Energy
  - Company: Energy Blockchain Labs, Grid Singularity, TransActive Grid by LO3 Energy
- Reputation verification and ranking
  - Company: The World Table (Open Reputation), ThanksCoin
- Decentralized social network
  - Company: Datt, DECENT, Diaspora*, Akasha, Synergeo
- E-voting
  - Company: Follow My Vote, Estonia’s e-Residency platform
- Content management/distribution
  - Company: Brave, Bittunes, PeerTracks, JAAK, Paperchain
- Birth and death certificates
  - Company: Khanelections, LLC
- Internet of Things (IoT)
Blockchain Technology on the rise

Capital market spending on blockchain technology in $ billions

- Actual
- Estimated

Source: Aite Group
How to do you build Blockchain?

• Need to depend on Blockchain database
• What are the BlockChain databases that are out there?
  • Microsoft--Azure Blockchain Workbench
  • Oracle Autonomous Blockchain Cloud Service
  • Intel’s Sawtooth
  • SAP HANA Blockchain
  • IBM Hyperledger Fabric
  • Apache Hyperledger (open source)

Apache Software Foundation founder to lead blockchain Hyperledger Project

Well-known open-source developer and leader Brian Behlendorf is now the executive director of Hyperledger, a project for advancing enterprise open-source blockchain technology.
Application Architecture

(API) Application Programming Interface

Blockchain
Database

User Interface

Relational
Database

User Interface
Data Exchange Built on Blockchain

Reference: Fujitsu.com
Proof of Concept

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- Assets = cars
- Transactions = buying and selling of cars
- Participants =
Use Case: Block 101

Blockchain Transaction:

Dijo’s Autohaus buys a car from the OEM Manufacturer.

- A new block (101) is created
- Title changes from Tesla (OEM) to Dijo

---

**Block 101**

Previous Hash: fec04740-d898-43ac-b45v-69b8304c917a

Hash: 01ea7ld5-52ec-4c34-b853-1b315aa4052a

Time stamp: September 1, 2018 11:49am UTC

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<tr>
<td>Make</td>
<td>Tesla</td>
</tr>
<tr>
<td>Model</td>
<td>Model X</td>
</tr>
<tr>
<td>Color</td>
<td>Blue</td>
</tr>
<tr>
<td>Titleholder</td>
<td>Dijo’s Autohaus</td>
</tr>
<tr>
<td>Insurance Coverage</td>
<td>[...]</td>
</tr>
<tr>
<td>Registration</td>
<td>[...]</td>
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<tr>
<td>Status</td>
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</tr>
<tr>
<td>Smart Contract</td>
<td>[...]</td>
</tr>
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</table>

The chain originates with the OEM manufacturer.
Use Case: Block 102

Blockchain Transaction:

Dijo’s Autohaus sells the car to Cory Campbell.

- A new block (102) is created
- Title changes from Dijo’s Autohaus to Cory

<table>
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<tr>
<th>Block 102</th>
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<tbody>
<tr>
<td>Previous Hash: 01ea7ld5-52ec-4c34-b853-1b315aa4052a</td>
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<tr>
<td>Hash: jKla781d-4358-cjao5848a3-89jxlejb8s0ak</td>
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<tr>
<td>Time stamp: September 2, 2018 7:32 pm UTC</td>
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<tr>
<td>VIN: 1L81SJX26SA003608</td>
</tr>
<tr>
<td>Year: 2018</td>
</tr>
<tr>
<td>Make: Tesla</td>
</tr>
<tr>
<td>Model: Model X</td>
</tr>
<tr>
<td>Color: Blue</td>
</tr>
<tr>
<td>Titleholder: Cory Campbell</td>
</tr>
<tr>
<td>Insurance Coverage: [...]</td>
</tr>
<tr>
<td>Registration: [...]</td>
</tr>
<tr>
<td>Status: Complete</td>
</tr>
<tr>
<td>Smart Contract: [...]</td>
</tr>
</tbody>
</table>
Use Case: Block 103

Block 103

Previous Hash: jKla781d-4358-cjao5848a3-89jlxlejb8s0ak
Hash: a8akdidb-a8d9-a98ldkac99-jas8jalwpqzod

Time stamp: September 4, 2018 9:15am UTC

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<td>Make</td>
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</tr>
<tr>
<td>Titleholder</td>
<td>Kim Herb</td>
</tr>
<tr>
<td>Insurance Coverage</td>
<td>[...]</td>
</tr>
<tr>
<td>Registration</td>
<td>[...]</td>
</tr>
<tr>
<td>Status</td>
<td>Complete</td>
</tr>
<tr>
<td>Smart Contract</td>
<td>[...]</td>
</tr>
</tbody>
</table>

Blockchain Transaction:

Cory sells the car to Kim.

✓ A new block (103) is created
✓ Title changes from Cory to Kim
Use Case: Can we sell to two people?

Double spending is trying to sell the same assets twice, to two different people.

Blockchain Transaction:

Cory sells the car to Claire

Cory owns Block 102—not the latest block in the chain

- Transaction **FAIL**
- Why?
  - Algorithm designed to ensure prior block is the longest
  - Yes, no new Block Created
Use Case: What if a Block is altered?

Cory alters Block 103 by changing the Title holder to back to himself.

Blockchain Transaction:
- Title changes from Kim Herb back to Cory Campbell.
- Cory tries to sell the car to Steve Lamb.
- Transaction FAIL Why?

Change in Record changes the HASH. Hash no longer links to the previous hash

- No new Block Created

Cannot change a block--Immutability
Use Case: Addition of Smart Contracts

**Smart Contracts**
A smart contract is a computer script with a predefined set of rules. This script runs on the blockchain and sets the conditions required to complete a contract. It auto-executes if and when all the conditions are met before the new block will be created. Otherwise the transaction will fail.

“A smart contract is added by ___ to require registration with the Department of Motor Vehicles before any sale is complete.”
Use Case: Addition of Smart Contracts

Blockchain Transaction:
Kim sells the car to Chloe, but the transaction fails.

✔️ Transaction 🔄 Why?

Kim did not register with the DMV

This Block Fail….Block 104 is NOT created
**Use Case: Addition of Smart Contracts**

**Blockchain Transaction:**
Kim sells the car to Chloe, but the transaction fails.

- Kim registers with DMV
- Smart contract executes
- Block 104 created

<table>
<thead>
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<td>Model</td>
<td>Model X</td>
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<tr>
<td>Titleholder</td>
<td>Chloe</td>
</tr>
<tr>
<td>Insurance Coverage</td>
<td>[...]</td>
</tr>
<tr>
<td>Registration</td>
<td>[YES]</td>
</tr>
<tr>
<td>Status</td>
<td>Complete</td>
</tr>
<tr>
<td>Smart Contract</td>
<td>[DMV Registration]</td>
</tr>
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</table>

Previous Hash: a8akidb-a8d9-a98ldkac99-jas8jalwpqzod
Hash: a89d02k-kald9-bjao89e0d-z938akdh93jd
Time stamp: September 5, 2018 3:47pm CST
Use Case: Addition of Smart Contracts

**Smart Contracts**
A smart contract is a computer script with a predefined set of rules. This script runs on the blockchain and sets the conditions required to complete a contract. It auto-executes if and when all the conditions are met before the new block will be created. Otherwise, the transaction will fail.

A smart contract is added by ___ to require insurance with ____ before any sale is complete.
Use Case: Addition of Smart Contracts

Blockchain Transaction:

Regulatory body requires proof of insurance must be on file with the DMV.

- Chloe submits her proof of insurance to the DMV
- Smart contract executes
- Block 105 created
- Chloe retains Title
Review: What happened?

Recent Transactions:

<table>
<thead>
<tr>
<th>Block</th>
<th>Time Stamp</th>
<th>Transaction ID</th>
<th>Transaction Submitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>September 1, 2018 11:49am UTC</td>
<td>01ea7ld5-52ec-4c34-b853-1b315aa4052a</td>
<td>Dijo’s Autohaus</td>
</tr>
<tr>
<td>102</td>
<td>September 2, 2018 7:32 pm UTC</td>
<td>jKla781d-4358-cjao5848a3-89jlxlejb8s0ak</td>
<td>Cory Campbell</td>
</tr>
<tr>
<td>103</td>
<td>September 4, 2018 9:15am UTC</td>
<td>a8akdidb-a8d9-a98ldkac99-jas8jalwpqzod</td>
<td>Kim Herb</td>
</tr>
<tr>
<td>104</td>
<td>September 5, 2018 3:47pm UTC</td>
<td>8a9d02k-kald9-bjao89e0d-z938akdho3jd</td>
<td>Chloe Eleanor</td>
</tr>
<tr>
<td>105</td>
<td>September 6, 2018 1:23pm UTC</td>
<td>9adkaigh-d8ad-mazpd8dd3-1k90ziah89a4</td>
<td>Chloe Eleanor</td>
</tr>
</tbody>
</table>
“Trusting” the Transactions

Immutability → Altering block (e.g. changing titleholder) changed the hash

Provenance → participants can see where block originated as well as ownership

Finality → Single, trusted source of ownership and transaction history

Consensus → All the blocks in a chain must agree on the transactions validity
What’s Next?

Regulation
- Emissions
- Insurance
- Registration

Innovation
- Certified mechanics
- Certified parts

Safety
- Valid licenses
- Proof of Insurance
- Registration

Disruptive Innovation
- Future for CarFax and Kelley Blue Book?
What’s Next?

FUTURE

BLOCK CHAIN
SAP has conducted a survey among its SAP Blockchain Community members. Our members are customers and partners, each sharing an interest and need to learn more about blockchain and its adoption as a technology to improve our lives. The highlights of the survey are shared in the infographic below, based on more than 200 responses, primarily from senior business leaders, supply chain managers, innovation & strategy officers and business analysts.

**MOST PROMISING BLOCKCHAIN USE CASES**

- Supply chain and IoT: 92%
- Legal and regulatory: 19%
- Cryptocurrency: 8%
- Sustainability: 3%

**MOST IMPORTANT BLOCKCHAIN ATTRIBUTES**

- Transparency in the value chain: 42%
- Trustworthy shared data: 39%
- Industry standardization: 13%

- 76% of survey respondents view that operational supply chain will be replaced by Smart Contracts in 5 - 10 years.
- 83% of survey respondents assume that blockchain will become the system of trust.
- 96% of survey respondents think that blockchain will improve the compliance of companies.

**SAP IMPORTANCE IN DRIVING BLOCKCHAIN**

- 91% of survey responders view SAP’s involvement with blockchain as positively impacting their company’s adoption of blockchain.
- 92% of survey responders would join an SAP led blockchain consortium.
- 92% of survey responders consider SAP’s support of blockchain in standard products will accelerate adoption in the supply chain, manufacturing and IoT markets.

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Implications for the Accounting Profession

“A world where all transactions for a company occur on the blockchain would enable auditors to verify large amounts of routine data automatically, allowing them to focus instead on more complex transactions and controls.”

Kimberly Ellison-Taylor, chairman of the AICPA ~ December 5, 2017

“The accounting profession is built on confirmation and verification, and that’s what blockchain is all about.”

Barry Melancon, AICPA president and CEO ~ October 23, 2017

“Blockchain is one of the technologies that are ‘shaping’ the accounting industry.”

Erik Asgeirsson, president and CEO of CPA.com ~ October 23, 2017
Potential uses for blockchain in accounting and audit:

- Immutable records
- Traceable audit trails
- Automated audit processes
- Authentication of transactions
- Tracking ownership of assets
- Development of “smart contracts”
- Registry and inventory system for any asset, ranging from raw materials to intellectual property
What Does it Mean for Accountants?

Impact on audit practices:

- Blockchain in accounting & audit greatly reduces potential for errors when reconciling complex & disparate information from multiple sources.
- Accounting records are not alterable once committed even by the owners of the accounting system.
- Every transaction is recorded & verified—the integrity of financial records is guaranteed.
- Potential to greatly reduce or even eliminate the need for auditing resources.
- Increased need to audit controls and transaction anomalies.
- Potentially disrupting accounting profession as a whole.
Conclusion:

- A “Block” is a snapshot of the “change of state” to the asset
- Blockchain has the potential to shift the nature of Accounting
- Blockchain has the potential to vastly automate the accounting process in compliance with regulatory requirements
- Blockchain will have a useful impact in every business
- The Accounting profession has a unique opportunity to define the blockchain agenda
- The future of Blockchains lies in smart contracts and supply chain
- Embrace the hype and before it’s forced upon you!

Lead with technology, rather than follow it.
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Questions?

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