Investment Thesis: Blockchain in Healthcare

Alexander Tsado

12/8/2016

Deck Roadmap

1 In-depth Intro to Blockchain

- Evolution of Information Transfer
- What is Blockchain?
- How Blockchain works
- Benefits & Complaints of Blockchain
- Levels Companies Operate in

Slides 3-13

2 FinTech Investments

- Facts on bitcoin investments
- Venture Capital Deal Flow

Slides 14-16

3 Blockchain in Healthcare

- Blockchain status in healthcare
- Blockchain Value Props for healthcare
- Notable companies and Value Verticals
- Niche considerations when evaluating healthcare Blockchain opportunities

Slides 17-26

Evolution of Information Transfer

Where would you go to learn about cardiovascular disease?

1994

Encyclopedia

You would look for an Encyclopedia, either at home if you are lucky to have one, or take a trip to the library and search for the page that would enlighten you.

This would have cost you some considerable amount of time, transportation money, fee to access the library or money you pay for the Book.

2004

The Internet, Wikipedia

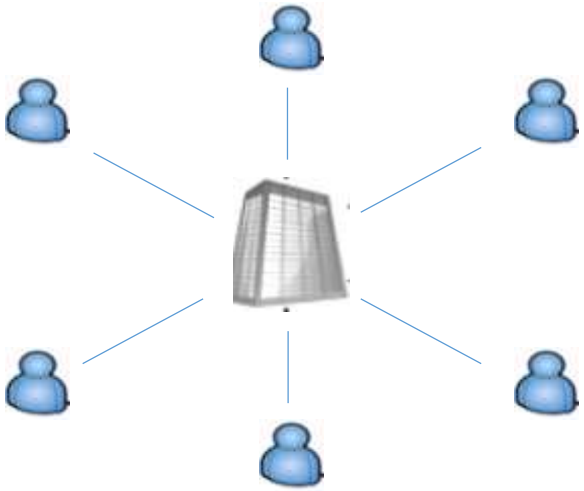
He would pull out his phone or any other web-enabled device and search for this piece of information. One of the easiest places he would find his answer is on a website called Wikipedia.

This probably took him 5 minutes and didn't cost much money if any.

What has changed in relation to information flow over these 10 years?

Trend behind Transformational Improvements in Transfer

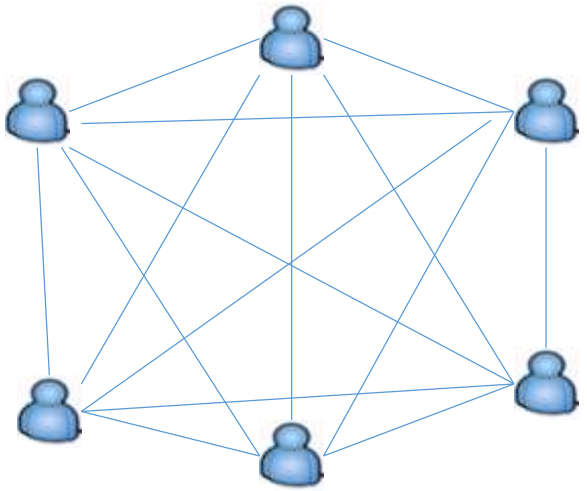
Encyclopedia



Centralized Content

- Thousands of exclusive content generators who were expensive to pay
- Books either available for purchase, or in Libraries
- Access limited to a handful of people

Wikipedia

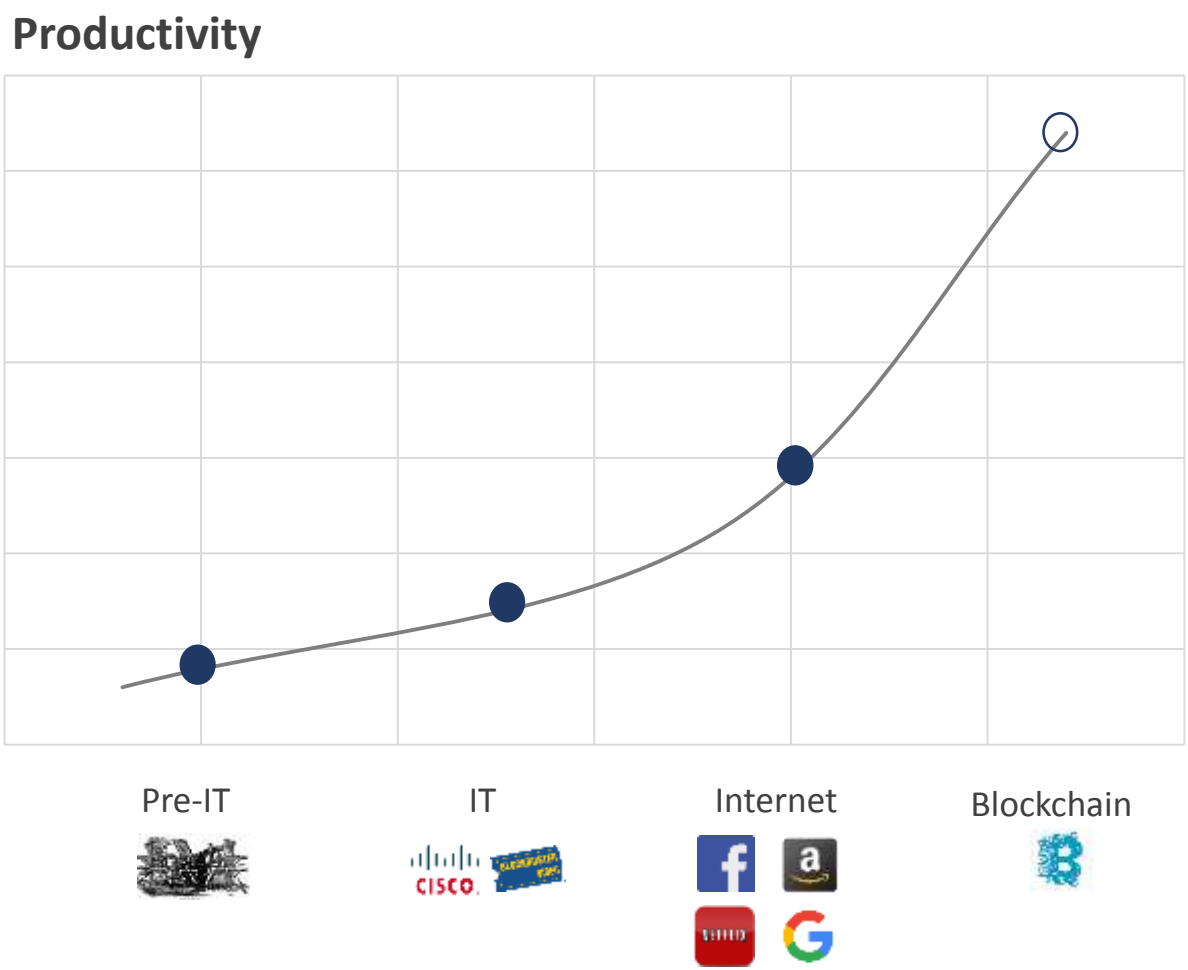


Decentralized Content

- Millions of content generators
- **Much lower Cost** of generating content
- Internet available to a hundred times **more people** than the Books
- **Much faster** generation of content

Move towards Decentralized Information Creation & Distribution

Next Level of Information Transfer Evolution: Blockchain



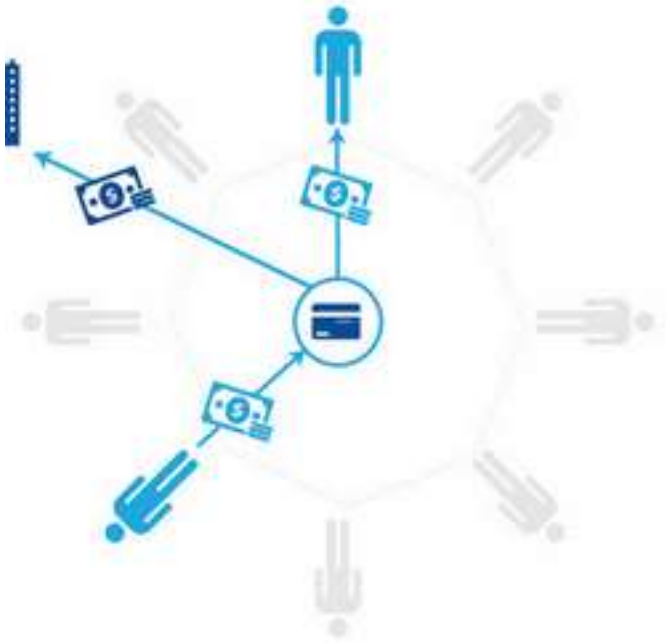
- Firms who adopted IT became **more efficient** at accomplishing normal business tasks, leading to **linear** improvement on productivity.
- Firms that fully embraced the internet era drove down distribution cost, and **fundamentally changed** the way business was conducted, allowing them reach **exponential** scale and drive out other competition. The FANG – Facebook, Amazon, Netflix, Google – companies are examples of successful firms here.
- In this deck, we explore the growth potentials for companies that build on the Blockchain.

What is Blockchain?

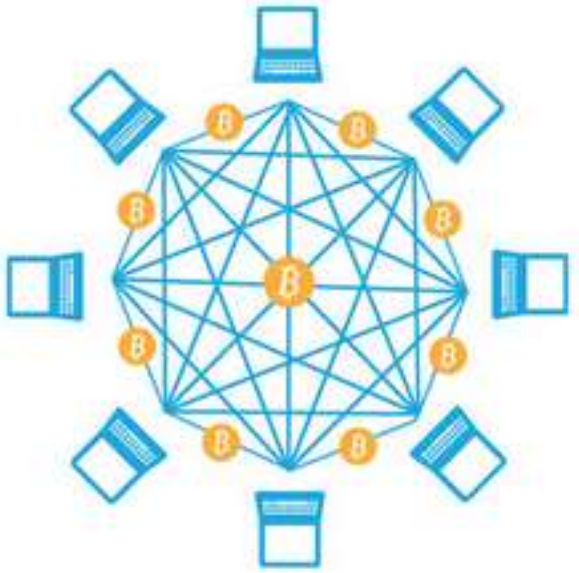
It’s an immutable record of digital events shared peer to peer between different parties. It can only be updated by consensus of a majority of the participants in the system and, once entered, information is very hard to erased. It revolutionizes the concept of data storage.

How it got discovered

Right after the Global Financial Crisis when people lost faith in the banks, **Satoshi Nakamoto** solved a very complex Game Theory conundrum called the Byzantine General Problem, which ensured that at a particular time, a block of asset could be transferred to only one other person, **without the need for a third-party check.**



Current payment systems require third-party intermediaries that often charge high processing fees.



Machine-to-machine payment using Blockchain could allow for direct payment between individuals, as well as support micropayments.

How Blockchain Works: Closer Look At A Transaction

User A sends funds to User B

There needs to be an application or platform where the users create their own entity, and initiate their asset. For example with bitcoins, a user can join a mobile or web app called Coinbase where they create an account, convert currency like US Dollars to Bitcoin and then send out those funds.

The transaction is configured into a block

The app compiles relevant data for the transfer into a transaction. The transaction contains the owner address, the sender address, a private key or password to verify rightful ownership, and the hash of the previous block. Each block has several transactions.

The transaction is broadcast across the entire network which validates it

There's a requirement to solve the block's hash function or simply or guess the inputs of the block before the block gets added to the chain. This check keeps the system secure. Several computers around the world spend their processing power trying to solve the hash for a reward, mostly monetary. This is called Mining.

The block is then added to the chain which records the entire non-reversible history of transactions in a public ledger

After one computer solves the hash, it broadcasts its solution to thousands of other computers to validate the result. Validation is a much simpler problem. Once validated by greater than 50% of the network, the block gets added to the chain.

User B receives funds from User A

The universal chain is updated so user B's account is credited with the fund, which he/ she can do whatever she pleases with.

Why Blockchain: 7 Driving Key Principles

- **Transparency & Visibility** - No one should be able to cover their tracks.
- **Accountability** - Every action should be attributable to it's owner.
- **Privacy** - Security should be afforded without giving up confidential information.
- **Scalability** - Must be able to scale to trillions of digital assets.
- **Portability** - Security must move with the data, wherever the data goes.
- **Permanence** - Security must not be ephemeral – it must exist as long as the data exists, and ideally longer.
- **Open** - It must not rely on traditional closed trust anchors.

Blockchain Benefits to Industries

TECHNICAL

- Secure Transaction Ledger Database
- Eliminates Error Handling and Reconciliation

MARKET/BUSINESS

- Automation of Execution and Settlement
- Cost Reduction in Infrastructure and Transaction

LEGAL/ REGULATORY

- Smart Controls i.e. Self Enforcing Contracts
- Trusted Third Party Elimination

Common Complaints about Blockchain

TECHNICAL

- Underdeveloped ecosystem infrastructure
- Lack of mature applications
- Immature middleware and tools
- Scalability of transactions
- Legacy system migration
- Tradeoffs with databases
- Privacy of public data
- New security threat
- Lack of Standards

MARKET/BUSINESS

- Moving assets to the Blockchain
- Quality of project ideas
- Critical mass of users
- Volatility of cryptocurrency
- Onboarding new users
- Few poster companies
- Not enough qualified individuals
- Infrastructure Cost issues
- Innovator's dilemma

BEHAVIORAL/ EDUCATIONAL

- Lack of understanding of potential value
- Limited executive vision
- Change management
- Trusting a network
- Few best practices
- Low usability factor

LEGAL/ REGULATORY

- Unclear regulations
- Government interferences
- Compliance requirements
- Hype
- Taxation and reporting

Levels Companies Operate in: Value Chain

Applications

Applications designed for the end user to solve particular use-cases

- Brokerage services
- Cryptocurrency exchanges
- Software wallets
- Hardware wallets
- Merchant and retail services
- Financial data providers
- Compliance and identity
- Payments integrations
- Trading platforms
- Brokerage services
- Payroll
- Insurance
- Investments & Loans
- Global/ Local money services
- Capital markets solutions

Middleware

Entry point APIs for developers who want to build applications and innovate on top of the underlying protocols

- Technology services providers
- Blockchain platforms
- Software development environments
- General purpose APIs
- Special purpose API
- Smart contracts tools

Base Protocols

For core developers well versed into cryptology-based software technologies

- Public consensus blockchains
- Private consensus blockchains
- Microtransactions infrastructure
- Miners

Notable Companies at Each Level

Applications

coinbase — Brokerage mobile and web app where supported cryptocurrencies can be traded

BTCpeint — World's largest Bitcoin Bank ATM network

paybits — Receive part of your paycheck in bitcoin with this paycheck processing company

Middleware

BitGo — Integrate multi-sig, HD security into your bitcoin application

MultiChain — Rapidly build applications on blockchains and shared ledgers

CONSENSUS — Venture production studio building end-user tools for Blockchain ecosystems

Base Protocols

bitcoin — Most popular and successful cryptocurrency

ripple — Send real-time Int'l payments across networks

BTCC — Longest-running bitcoin exchanges worldwide

Deck Roadmap

1 In-depth Intro to Blockchain

- Evolution of Information Transfer
- What is Blockchain?
- How Blockchain works
- Benefits & Complaints of Blockchain
- Levels Companies Operate in

Slides 3-13

2 FinTech Investments

- Facts on bitcoin
- Venture Capital Deal Flow

Slides 14-16

3 Blockchain in Healthcare

- Blockchain status in healthcare
- Blockchain Value Props for healthcare
- Notable companies and Value Verticals
- Niche considerations when evaluating healthcare Blockchain opportunities

Slides 17-26

Facts on Bitcoin

- Bitcoin was the first implementation of Blockchain, is the most dominant cryptocurrency and our focus in this section.
- As medium of storing and transacting value, it can be viewed as cash. However Commodities Futures Trading Commission classifies it as commodity but unlike other commodities it doesn't have any other real-world applications.
- It's viewed as an emerging technology with risk/return profile similar to a late-stage venture.

Advantages

1. Anyone can add bitcoin to their portfolio, not just qualified investors.
2. Investors can invest without paying hefty fees typically charged by VCs.
3. Bitcoin is highly liquid vs VC investments.
4. Ultimately the fact that it's cap will be reached by 2140 suggests that it has deflationary tendencies, which will lead to higher value as supply reduces.

Disadvantages

1. At $10B, Market cap is very small and so difficult for institutional investors to take meaningful positions.
2. With the absence of any sovereign Government backing, Bitcoin's value is backed by public's confidence in its security and value, making it highly volatile.
3. State-by-state licensing regime makes investing in Bitcoin extremely costly.
4. Risk of another currency becoming more popular, for example Ethereum

Venture Capital Deal Flow

Investor interest has heightened since Bitcoin value exceeded $200 in 4Q 2013. The investments have come from general VCs, corporate VC arms, sector-specific VCs, individual angels and banks. Cumulatively about $1.8B has gone into 550 deals in the space. Some notable rounds were led by Union Square Ventures, a16z, Pantera Capital and Khosla Ventures

Bitcoin & Blockchain VC Deal Flow By Quarter

Top Investors by Deal Count

Top Investors	Deal Count
Digital Currency Group	64
Blockchain Capital	42
Boost VC	33
500 Startups	26
Pantera Capital	18
Plug and Play	17
Coinsilium Group	14
RRE Ventures	13
Barry Silbert	13
Roger Ver	12
Sean Percival	12
FundersClub	12
Timothy Draper	11
Techstars	10
Ribbit Capital	8
Future Perfect Ventures	8
Firestartr	8
Ben Davenport	8
Sv Angel	7
Paul Veraditttakit	7

Deck Roadmap

1 Understand Blockchain

- Evolution of Information Transfer
- What is Blockchain?
- How Blockchain works
- Benefits & Complaints of Blockchain
- Levels Companies Operate in

Slides 3-13

2 FinTech Investments

- Facts on bitcoin investments
- Deal Flow and Capital Markets

Slides 14-16

3 Blockchain in Healthcare

- Status of Blockchain in healthcare
- Blockchain Value Props for healthcare
- Notable companies and Value Verticals
- Niche considerations for evaluating healthcare Blockchain opportunities

Slides 17-26

Status of Blockchain in Healthcare

- **There is a growing trend towards personalized medicine**, with people tracking and gaining more information about their health than ever before. Federal legislation (*Medicare Access and CHIP Reauthorization Act*) has also dramatically sped up digitization of medical records. However issues arise when all this data need to be stored securely and transferred across healthcare practitioners to foster collaboration. Blockchain can help with these.
- **Blockchain in healthcare is still very early stage requiring education around use-cases that can benefit from it**, unlike in finance where it is a worldwide phenomenon. However it has moved past the theoretical stages and has spurred activity from major companies and venture capitalists.
- According to Founder of Factom, a healthcare startup that has received over $1B in funding, Blockchain can enable for the first time the long sought longitudinal health record that contains every episode of care from childhood to old age in every location healthcare was delivered. This capability would **radically reduce medical errors and improve care quality** as well as empower individuals to have full control over their own health records
- An initial adoption barrier was that Healthcare providers – historically locked in competition and often resistant to sharing health data within their systems – would need to agree to use Blockchain. With recent developments in the United States, **Federal Legislation is incentivizing data sharing with new pay-for-value payment models**.
- The United Kingdom, Australia and Estonia have seen considerable government adoption of the technology, with **Estonia for example signing a deal with GuardTime to secure 1 million patient records on the Blockchain in 2016**

Blockchain Value Propositions for Healthcare

"One of the pretty obvious use cases for Blockchain is its ability to identify when there's been data manipulation and when there's been a disruption in that flow" – Peter Nichol, former IT chief of the Connecticut state health insurance exchange

	Health Information Exchange (HIE) Pain Points	Blockchain Opportunities
	**Establishing a Trust Network** depends on the HIE as an intermediary to establish point-to-point sharing and "book-keeping" of what data was exchanged.	**Disintermediation of Trust** likely would not require an HIE operator because all participants would have access to the distributed ledger to maintain a secure exchange without complex brokered trust.
	**Cost Per Transaction,** given low transaction volumes, reduces the business case for central systems or new edge networks for participating groups.	**Reduced Transaction Costs** due to disintermediation, as well as near-real time processing, would make the system more efficient.
	**Master Patient Index (MPI)** challenges arise from the need to synchronize multiple patient identifiers between systems while securing patient privacy.	**Distributed framework for patient digital identities,** which uses private and public identifiers secured through cryptography, creates a singular, more secure method of protecting patient identity.
	**Varying Data Standards** reduce interoperability because records are not compatible between systems.	**Shared data** enables near real-time updates across the network to all parties.
	**Limited Access to Population Health Data**, as HIE is one of the few sources of integrated records.	**Distributed, secure access** to patient longitudinal health data across the distributed ledger.
	**Inconsistent Rules and Permissions** inhibit the right health organization from accessing the right patient data at the right time.	**Smart Contracts** create a consistent, rule-based method for accessing patient data that can be permissioned to selected health organizations.

10 Notable Healthcare Companies Built on Blockchain

	**Gem**	Blockchain application platform for enterprises. For example, its first partner is Philips Blockchain Lab, a research center on Blockchain who is exploring the uses of Blockchain technology in clinical trials.
	**Guardtime**	Blockchain security company, seeking to register every update and access to healthcare records in the Blockchain. They signed a deal with the Estonian e-Health Authority to secure the country's health records, and created a network that can be used by patients, providers, private companies or the government to access information in a safe way.
	**Brontech**	Australian Blockchain company that built a platform CyphMD's to improve and facilitate data sharing using smart contracts on the Ethereum Blockchain. Improved data sharing will influence the accuracy of the diagnosis and reduce the potential for common clinical errors.
	**MedRec**	Platform that helps manage medical records using Ethereum Blockchain. It was created by MIT graduates with the goal to give patients the control over their health data. Their prototype gives patients one-stop-shop access to their medical history across multiple providers.
	**Blockchain Health Co.**	Blockchain application company operating out of San Francisco seeking to revolutionize the relationship between medical researchers and users, so users can share their medical data while maintaining control.

10 Notable Healthcare Companies Built on Blockchain

	**Pokitdok**	Platform company offering 5 types of solutions: clearinghouse (X12), private label marketplace, scheduling, identity management and payment optimization to improve communication among the medical community and reduce the inefficiency of the healthcare system.
	**Factom**	Help insurance companies use the Blockchain for their record keeping, so that all parties involved are able to easily verify the accuracy of the claims and further increase efficiency in medical billing processes. They signed a deal with US health data software provider to imprint their documents on the Blockchain to guarantee authenticity of sequence of events.
	**Stratumn**	French startup looking to improve the major issue of lack of transparency and trust panning from data falsification in pharmaceutical clinical trials. For example of 137 clinical trials it investigated during a study, 67 found outcomes they weren't expecting, and only 9 reported their results properly.
	**Tierion**	Global Blockchain platform company looking to solve problems in several industries. The startup partnered with Philips Healthcare to work on the possible applications of Blockchain technology to improve the healthcare industry.
	**Blockpharma**	French startup using blockchain-based technologies to fight drug counterfeiting. Blockchain can improve drug traceability, allow participants in the supply chain interact easily and alert the labs of fake drugs.

Classifying Companies by Value

Companies	Description	Value Proposition	Supporting Trends	
Brontech **MedRec** **Guardtime**	**Patient Data Management** These companies perform a service similar to putting healthcare data on the cloud, except that they put it on the Blockchain and unlock the additional benefits that come with the system.	- Foster interoperability to reduce - Secure health records for patients and care providers. - Foster ancestral analysis over time - Enable automation that can come	*The typical primary care physician has to coordinate care with* ***229 other physicians*** *working in 117 practices*	Lack of interoperability costs ***150,000 lives and $18.6 billion*** per year
Gem **Stratumn** **Blockchain Health Co.**	**Research and Clinical Trials** These companies protect the identity of people involved in trials, reduce falsification of results, and manages the thousands of micro-processes and documentation involved.	- Reduce falsification of results - Scale number of people who can and are willing to contribute to studies - Speed up the process - Secure identity of participants	In 2015, publisher Springer had to ***retract 64 articles*** from its journals for fraudulent findings	.
Stratumn **Blockpharma**	**Drug Provenance** These companies prevent patients from consuming counterfeit drugs, by increasing visibility and transparency thus reducing probability of misinformation and data inaccuracy in the supply chain.	- Track drug integrity all the way to the final patient - Reduce complexity of the supply chain - Automate processes using smart contracts	***800,000 deaths*** *due to consumption of falsified medicines in the world every year*	***$100s of billions*** are spent tackling counterfeit drugs in developing nations annually
Factom **Pokitdok** **Tierion**	**Payments, Claims & Other Services** These companies provide other value-added services like payment optimization, scheduling, document management and insurance claims to improve efficiencies in managing operations at hospitals.	- Reduce inefficiencies in hospital operations - Reduce complexity around processing payments to and from different insurance agencies - Provide immutable storage/ history of transactions	*Highmark for example, the biggest health insurer in Pennsylvania* ***lost $222 Million*** *selling coverage under the Affordable care Act in 2015*	.

Business Models

Software as a Service - Companies charge a fee for using their API and infrastructure. Example: Tierion

Professional Services - Some companies build custom projects for enterprise clients. Many existing firms have Blockchain practice areas. Examples: Gem.

Flat Fees & Transaction Fees - Some companies build and maintain networks between a consortium of partners. They make money by charging a subscription fee or a transaction fee on activity in the network. Often times, they are a part owner of the network. Examples: Chain, R3Cev

Service Level Agreements - Some businesses build platforms and host infrastructure for enterprise customers. They offer a SLA for uptime and maintenance. Examples: Bloq, Microsoft

Cryptocurrency Speculation - Some Blockchain companies either issue their own token or the management holds large amounts of a cryptocurrency such as Ethereum. These companies do work that makes the market value of their token increase. They then sell the token to speculators. Examples: Factom

Niche Considerations for Evaluating Healthcare Blockchain Opportunities

Feasibility of use-case/ Partnership with healthcare professionals – Few notable healthcare professionals have cautioned that many proposed Blockchain use-cases are not operationally practical for industry, or overlook that hospitals can get bankrupted by fines relating to careless exposure of patient data. This mandates that startups in this space work very closely with existing healthcare partners to develop feasible solutions.

Ecosystem – Although now is not the time to worry about which Blockchain technologies or standards will dominate, solutions should include abstractions around protocols and platform features to allow portability should it eventually become necessary to switch to a different standard.

Compute resources –The computational requirements to run the blockchain's consensus algorithms consume time and resources. The very features that protect Blockchain against theft and fraud could also drive overhead if not correctly implemented.

Incentive for Miners –With bitcoin, miners earn bitcoins for carrying out mining tasks. Be clear on the economic incentives in place to entice miners to perform the mining and recording tasks. For example with MedRec, the miners are medical researchers who are rewarded with access to census-level data of the medical records.

Governance and Standards – There is an eventual need for governance and standards to prevent recklessness, chaos and calamity. For example there is a huge debate about what the block-size should be, and how this will affect volume of transactions. W3C Consortium does this for the web, while Internet Engineering Task Force does this for the net.

References

Primary Contacts

William Mougayar, *Author The Business Blockchain*
Jacques Kpodonu, *Cardiac Surgeon Harvard Medical School, Health Care Visionary*
Sergio Rebelo, *Professor International Finance at Kellogg*

Ted Talks

The Future will be Decentralized, Charles Hoskinson link
Blockchain Demystified, Daniel Gasteiger link
The Four Pillars of a Decentralized Society, Johann Gevers link

Databases

PitchBook, Statista, CB Insights

Events

The Business Blockchain by Westloop Ventures Chicago

Appendix

coinbase

Location: **San Francisco, CA**

Year Founded: **2012**

Capital Raised to Date: **$142.5M**

First Funding Date: **September 2012**

First Funding Amount: **$600,000**

Latest Funding Date: **September 2012**

Latest Funding Amount: **$10.5M**

Latest Funding Post-Valuation: **$500.5M**

Description: Coinbase operates a digital currency wallet and exchange platform to facilitate merchant and consumer bitcoin and Ethereum payments. Founded in 2012, the company has now expanded to 33 countries. The company debuted the first US bitcoin debit card in 2015 in a partnership with Dwolla and Visa

BitPesa BITPESA

Location: **Karen, Nairobi, Kenya**

Year Founded: **2013**

Capital Raised to Date: **$1.8M**

First Funding Date: **May 2014**

First Funding Amount: **$700,000**

Latest Funding Date: **February 2016**

Latest Funding Amount: **N/A**

Latest Funding Post-Valuation: **N/A**

Description: BitPesa provides an exchange for bitcoin conversions into and between African currencies, including the Nigerian naira and the shillings of Kenya, Tanzania and Uganda. In addition, it facilitates the sale or withdrawal of bitcoin for mobile money payments and bank transfers

21

Location: **San Francisco, CA**

Year Founded: **2013**

Capital Raised to Date: **$116.05M**

First Funding Date: **June 2013**

First Funding Amount: **$5.05M**

Latest Funding Date: **February 2015**

Latest Funding Amount: **$52M**

Latest Funding Post-Valuation: **$362M**

Description: 21 Provides tools for developers to add bitcoin functionality to online services. The company developed to 21 Computer, software which can turn any desktop into a fully functional bitcoin computer that can send and receive payments. Also develops hardware to allow developers create bitcoin-payable apps.

Location: **San Francisco, CA**

Year Founded: **2012**

Capital Raised to Date: **$100M**

First Funding Date: **November 2013**

First Funding Amount: **$6.5M**

Latest Funding Date: **September 2016**

Latest Funding Amount: **$55M**

Latest Funding Post-Valuation: **$410M**

Description: BitPesa provides an exchange for bitcoin conversions into and between African currencies, including the Nigerian naira and the shillings of Kenya, Tanzania and Uganda. In addition, it facilitates the sale or withdrawal of bitcoin for mobile money payments and bank transfers