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# Blockchain: A Fundamental Shift for Financial Services Institutions

## What You Need to Know About Blockchain and How to Assess the Opportunity

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# 1. Introduction

In today's world of electronic and mobile banking, money is transforming from something we hold in our hand to numbers we move around the Internet. Electronic or digital forms of money are fast replacing traditional paper and coin. As the Economist noted in 2007, "…cash, after millennia as one of mankind's most versatile and enduring technologies, looks set over the next 15 years or so finally to melt away into an electronic stream of ones and zeros."[1] In this environment, it is natural for new forms of currency to emerge that exist only as strings of digital code. The best-known example of these new cryptocurrencies is the Bitcoin.

Perhaps even more revolutionary than the rise of Bitcoin is the underlying blockchain technology that makes it possible. Blockchain is a distributed database that maintains a continuously growing list of encrypted data records secure from tampering and revision. This distributed model is completely aligned to the structures of the Internet and the concepts that drive digital transformation. It is a new technology paradigm that could create fundamentally new ways of financial interaction and transaction exchange.

Blockchain has the potential to provide unprecedented transaction security through cryptography that avoids costly mainframes and data centers. It completely changes the financial transaction-processing cost model. Beginning from a "standing start" 7 years ago, we are now witnessing the first tentative steps of blockchain technology adoption quicken as interest widens and investment accelerates. Organizations ranging in size from small start-ups to major corporations and governments agencies are now investing in the technology, making it clear that blockchain will cause disruption to current business models in the financial services (FS) sector and beyond.

No financial services firm can afford to ignore blockchain technology any longer. In just a few years, a number if blockchain startups have entered the field for financial services and different blockchain platforms are providing competing solutions. As with all important emerging technologies, the sooner you start to plan for its implementation the better. But before plunging into the blockchain, take a step back. This technology deserves a deep level of analysis. Blockchain solutions are still very new. Some have not yet cleared the testing phase. Capgemini is a partner that can help financial services companies on their journey of analyzing and evaluating different competing blockchain platforms and solutions. This market has a very fast innovation cycle and new solutions may provide new benefits in the future. What follows is an overview of what you need to know about blockchain technology, the challenges it represents for financial institutions, and a guide to getting your blockchain program started.

[1] The Economist, "The end of the cash era", February 15, 2007

# 2. What You Need to Know About Blockchains

***Blockchain is a decentralized, consensus-based, tamper-proof data structure that provides a shared public ledger open to all.***

## A Brief History

The Bitcoin payment system—and the underlying blockchain technology—was invented by Satoshi Nakamoto, who published the invention in 2008 and released it as open-source software in 2009.[2] Like any good story, this one is shrouded in mystery. No one knows who Satoshi Nakamoto actually is, something that is still hotly debated today.

Satoshi's idea was to produce a currency that was independent of any central authority and transferable electronically with very low transaction fees. Since then Bitcoin and other cryptocurrency usage has increased significantly worldwide. As of April of 2015, there are 530 cryptocurrencies available for trade in online markets and more than 740 in total.[3]

Perhaps even more significant than the creation of a purely peer-to-peer version of electronic cash was the technology that drives it. In essence, blockchain is a decentralized, consensus-based, tamper-proof data structure that provides a shared public ledger open to all. It soon became clear that the technology that makes Bitcoin transactions remarkably secure and inexpensive could possibly be game-changing for all of financial services—and many other industries as well.

Oliver Bussmann, CIO of UBS, estimates that blockchain technology could pare transaction processing time from days to minutes.[4] Research being done in other industries (such as insurance and back-office processing in capital markets) also predicts revolutionary changes in the way they will do business evolving out of blockchain technology.

## How It Works

The blockchain is a public ledger of digital events that records all transactions and distributes or shares them at the same time on all computers in that network. It can only be updated by consensus of a majority of the participants in the system. And, once entered, information can never be erased. The Bitcoin blockchain, for example, contains a certain and verifiable record of every single Bitcoin transaction ever made.

In order to be accepted by the rest of the network, a new block must contain either a proof-of-work or a proof-of-stake. A proof-of-work consists of a cryptographic puzzle that each contributor to the public ledger must solve. In the Bitcoin network, users are required to find a specific number (nonce), such that when the block content is hashed along with the nonce, the result is numerically smaller than the network's difficulty target. This takes a significant amount of work to compute, but is easily verified. With the

[2] Davis, Joshua. "The Crypto-Currency: Bitcoin and its mysterious inventor," 10 October 2011, The New Yorker

[3] Andrei Bogza, "Bitcoin and the rise of cryptocurrencies", April, 2015, http://www.fintp.org/blog/Bitcoin-rise-cryptocurrencies/

[4] Clint Boulton, "CIO says blockchain 'will heavily impact' financial services," Aug 18, 2015, CIO.com

alternative proof-of-stake, users need to prove that they have ownership in the currency and create distributed consensus.

More to the point, the structure of the blockchain makes it almost impossible to introduce fraud or to tamper with existing blocks. The blockchain architecture removes the need for a middle man to provide the element of trust, upending current data-center-focused models and thereby drastically changing the payment-cost model.

## Ethereum: A New Paradigm for Transaction Processing

To understand how blockchain technology is transforming financial services, it is important to know a little about the emerging technologies in play today. An important player is Ethereum, a new platform that takes the blockchain concept a step further by creating an open model for a secure, decentralized, generalized-transaction ledger; in effect it is a new model for transaction processing. Launched on July 30, 2015 Ethereum is envisioned by its creators as "...a censorship-proof 'world computer' that anyone can program, paying exclusively for what they use and nothing more."[5]

Attempts to create distributed transaction processing systems started in the 1990s but the challenges for distributed databases were too difficult to overcome. As a result centralized processing became the norm, enabled by the subsequent growth in processing power. Blockchain technology enables the distributed processing of financial transactions, and Ethereum extends this concept into a generalized programmable model for processing leveraging the concept of smart contracts. A smart contract (according to Swanson) is often defined as "computer protocols that facilitate, verify, execute and enforce the terms of a commercial agreement." Richard Brown has written a newer and clearer definition: "A smart-contract is an event-driven program, with state, which runs on a replicated, shared ledger and which can take custody over assets on that ledger." In other words, you can think of a smart contract as a programmable calculator that can (1) receive inputs, (2) execute code, then (3) provide an output. Since it resides on a distributed ledger, it is difficult for any one party to modify (i.e. abuse) the program.

Arguably the most ambitious, next-generation cryptographic applications project to date – and the third-largest crowdfunded project of all time – Ethereum is aiming to create a new universe of programmable contracts, powered and secured by its own proof-of-work blockchain.[6] As of today, Ethereum is still undergoing extensive testing and additional capabilities and tools (e.g. messaging and browser) are being added by its core team of developers. Over time, Ethereum will also make the switch from a proof-of-work algorithm to a proof-of-stake algorithm. Ethereum takes blockchain from an interesting financial payment processing opportunity to a new paradigm for financial transaction processing, totally transforming the IT model currently in use by all financial services companies worldwide and beyond.

[5] Tual, Stephan. "Ethereum Launches". blog.ethereum.org. Retrieved 31 July 2015.

[6] Grace Caffyn, "Ethereum Launches Long-Awaited Decentralized App Network", http://www.coindesk.com/ethereum-decentralized-app-network-launch/, July 30, 2015

# Four More Emerging Blockchain Technologies You Should Know About

Counterparty—This free, open-source platform permits the creation of peer-to-peer assets and applications on the Bitcoin blockchain. It provides users with a decentralized digital currency exchange as well as the ability to: create their own virtual assets; issue dividends; create price feeds, bets and contracts for difference.[7] Its current market capitalization is $2.5M.[8]

Factom—A general-purpose, data-layer blockchain, Factom enables developers to create digital assets on top of the Bitcoin blockchain, utilizing its functionalities for assets other than currency. It offers a faster, cheaper way to develop blockchain-based financial applications.[9]

Ripple-- Created and maintained by Ripple Labs, Ripple is an open-source payments protocol for free and instant exchange of any form of money or value. This real-time, gross settlement system (RTGS), currency exchange, and remittance network is built on a distributed open source Internet protocol, consensus ledger, and native currency called XRP (ripples).[10]

BitShares-- A decentralized financial platform, BitShares features price-stable cryptocurrencies, decentralized asset exchange, industrial performance and scalability, collateralized bond market, and recurring and scheduled payments. Its current market capitalization is $10.8M.[11]

[7] Bromden, Stanislas (2014-04-10). "Counterparty to Create First Peer-to-Peer Digital Asset Exchange Platform". CoinTelegraph. Retrieved 2014-04-27

[8] http://coinmarketcap.com/currencies/counterparty/

[9] Paul Snow, et at., "Business Processes Secured by Immutable Audit Trails on the Blockchain", www.Factom.org, November 17, 2014

[10] "Two US banks are ready to embrace the Ripple protocol", Gigaom. September 24, 2014. Retrieved 2015-06-09

[11] http://coinmarketcap.com/currencies/bitshares/. Retrieved 10-8-2015

# 3. The Future Potential of Blockchain

***A new report from Santander InnoVentures claims blockchain technologies could reduce banks' infrastructural costs by $15-20B a year by 2022.[15]***

Blockchain changes the IT paradigm for processing and has the potential to create a very different model for managing transaction-processing contracts. It also enables all processing to be done over a distributed systems network or in the Cloud, avoiding the use of costly datacenters or mainframes.

The key to the growing interest and investment in blockchain technology is its use of complex and immutable cryptology that cannot be hacked, which opens up an exciting new vista of possible applications. For example, in Honduras, Factom is working with the government to build a secure land-title registry. Blockchain technology allows a truly tamper-proof database of land titles. The Isle of Man is currently working on government initiatives to store information and make contracts using blockchain applications.[12]

In the financial services industry, Nasdaq is exploring the potential of blockchain technology for the record-keeping applications that support private-market trades. Nasdaq feels that blockchain technology will provide extensive integrity, audit ability, governance, and transfer of ownership capabilities.[13] Nasdaq has also joined with Visa, Citi and other industry players to invest $30 million in Chain.com, a blockchain developer platform that serves the enterprise applications market. Additional investors include Capital One and Fiserv. American Express recently announced taking an investment in Abra, a mobile-to-mobile payment system that leverages bitcoin's blockchain as an underlying payment mechanism.[14]

A new report from Santander InnoVentures claims blockchain technologies could reduce banks' infrastructural costs by $15-20B a year by 2022.[15] Banks can save money by eliminating central authorities and bypassing slow, expensive payment networks. The Euro Banking Association also thinks that blockchain technology has the potential to reduce costs, improve product offerings and increase speed for banks. They suggest blockchain technologies are a key subject for further study for transaction banking and payment professionals, especially against the background of evolving financial infrastructures.[16] The potential inherent in bringing more transparent, more secure, lower-cost blockchain technology to financial services cannot be ignored. Financial institutions would do best to consider a core tenant of the digital world and start to 'test and learn.'

[12] Sarah Jen , "The Future for Blockchain Technology", http://www.newsbtc.com/2015/05/20/the-future-for-blockchain-technology/, Posted on May 20, 2015

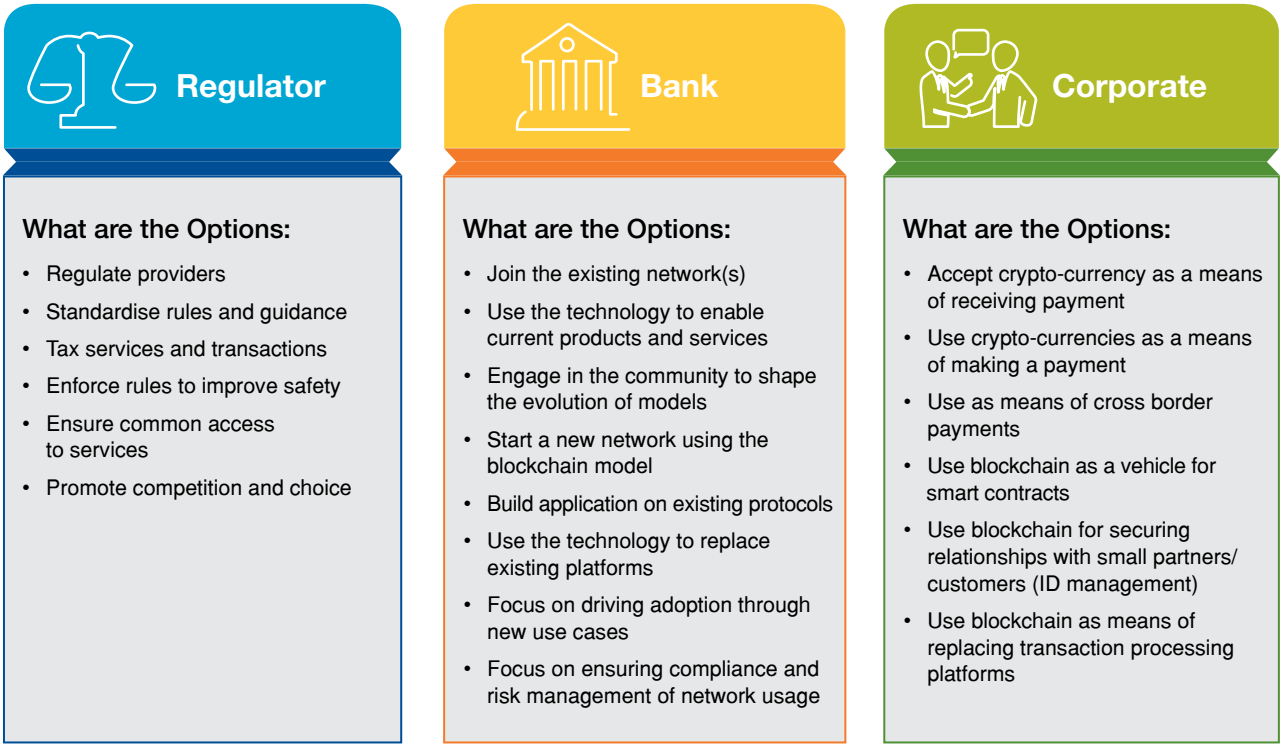
[13] Bradley Cooper, "The blockchain's future opportunities", http://www.mobilepaymentstoday.com/articles/the-blockchains-future-opportunities/, Sept. 10, 2015

[14] http://www.forbes.com/sites/laurashin/2015/10/22/american-express-invests-in-bitcoin-venture-abra-which-announces-u-s-philippines-launch/

[15] The Fintech 2.0 Paper: rebooting financial services. Santander InnoVentures, Oliver Wyman and Anthemis Group. http://www.finextra.com/finextra-downloads/newsdocs/The%20Fintech%202%200%20Paper.PDF

[16] Cryptotechnologies as major IT innovation and technical change agent. EBA Working Group on Electronic and Alternative Payments May, 2015

## Exhibit 1: Implications of Cryptocurrencies for the FS Industry



# 4. Opportunities for Financial Services Institutions

*"The financial industry isn't interested in alternative money and digital currencies. It's interested in the distributed ledger…"*[17]

Distributed-ledger technology has the potential to be a major disruption in financial services. The disruption will likely begin as this new technology makes existing processes more efficient, secure, transparent, and inexpensive, and then later as the technology inspires the creation of new products. Since distributed-ledger processing can easily be transferred to the cloud, it could also have a significant impact on the use of mainframes and private datacenters. This is an exciting time of change and innovation that presents major opportunities for financial services institutions today.

## Blockchain and the Distributed Ledger

According to Robert Sams, founder and chief executive of Clearmatics, "The financial industry isn't interested in alternative money and digital currencies. It's interested in the distributed ledger. Distributed ledgers could replace the entire technological back end of dematerialized securities in real time, without the need for reconciliations and lots of financial controls. That's what financial institutions find interesting."[17]

A couple of quick definitions:

- **Permissionless:** In order to contribute to the processing of transactions and have your 'vote' counted, you do not need a previous relationship with the ledger, and your vote does not depend on having a prior identity of any kind within the ledger.

- **Permissioned:** Transactions are validated and processed by those who are already recognized by the ledger. Your vote counts proportionally against that of the other voters, based on the specific rules of the ledger.

The blockchain technology underlying Bitcoin is a **permissionless** ledger that relies on anonymous participants to validate transactions. Many financial institutions remain wary of Bitcoin for this reason. Bitcoin's designer attempted to create a permissionless system to accommodate pseudonymous actors. Bitcoin distinguishes friend from foe by requiring each participant to expend work on a math problem that on average takes about 10 minutes to solve.

By contrast, distributed but **permissioned** ledgers use legal entities to validate transactions, providing banks with official records of asset ownership and legally accountable participants. According to Tim Swanson in his recent report on the emergence of permissioned, distributed ledger systems, this approach makes more sense for banks since "in the real world of finance, all participants are already authenticated and entities like validators and transmitters require legal identities."[18]

This new type of platform—the distributed but permissioned ledger—has the potential to help banks send cross-border payments and also to settle and clear derivatives more efficiently, among other uses. Several companies, including Ripple, Eris Industries, Hyperledger and Clearmatics, currently offer permissioned distributed-ledger systems.

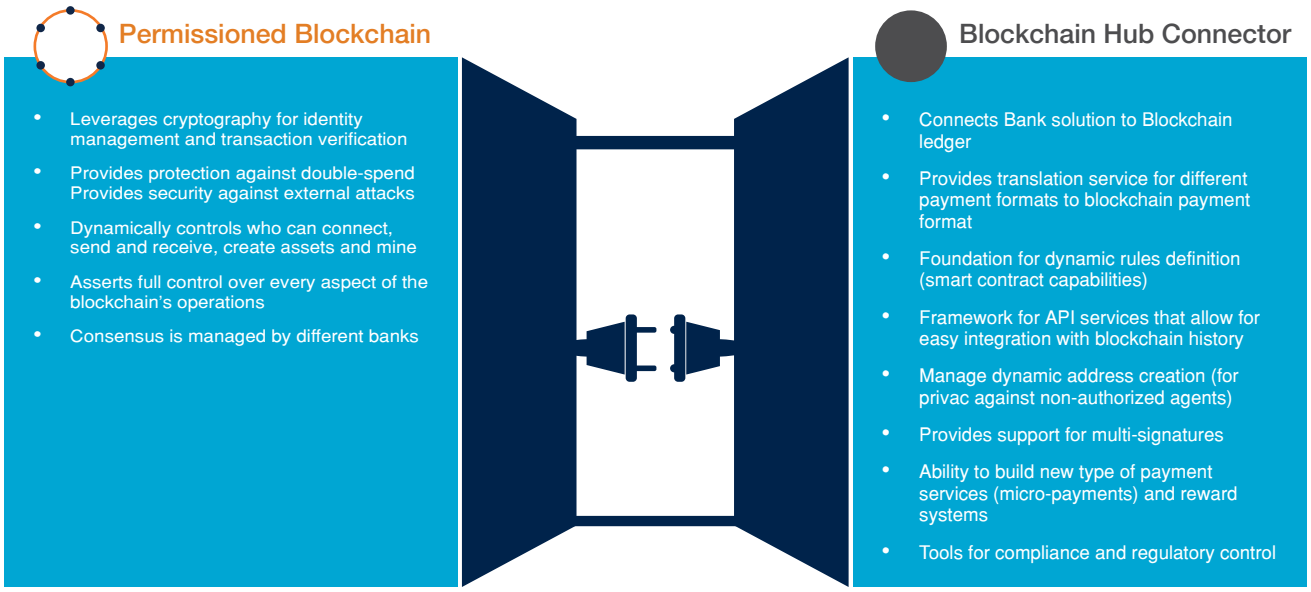
[17] Sarah Todd, "Banks Can Cherry-Pick the Best Bits from Bitcoin," April 7, 2015. American Banker

[18] Tim Swanson, "Consensus-as-a-service: a brief report on the emergence of permissioned, distributed ledger systems", April 6, 2015

## Permissioned Versus Permissionless Ledger: Which is Right for You?

In order to determine whether or not integrating a new network is beneficial to your firm, the total costs of ownership must be clearly understood. You need to look closely at your continuously changing business requirements to see if you might benefit from blockchain technology.

**Exhibit 2: Some Characteristics of a Permissioned Blockchain Using a Payment Hub Connector**




Source: Capgemini analysis

Also, new applications and tools are emerging from distributed ledger systems that may be indispensible to financial institutions. Nevertheless, the financial industry has a number of business-critical needs, including adherence to risk management, capital management, and compliance requirements. With its authorized validators and cryptographic auditability, it is possible that distributed ledger systems can meet these needs in a timelier, more cost-efficient manner than centralized-system alternatives.

Permissioned finance is different than permissionless finance, and you should look at which type of network best supports your organization's requirements. Since permissioned, distributed ledgers are congruent with the existing banking system, the primary question for banks is how to determine the value and utility these systems can provide to the organization and the business.

# 5. Evaluating the Technology

***Capgemini has created an 9-step approach for evaluating blockchain platforms***

Clearly the potential benefits of utilizing the more transparent, more secure, and lower cost blockchain technology at your institution is worth exploring. However, the field of emerging blockchain platforms is vibrant and growing; which available platform is the right investment for your firm?

Financial institutions need a framework for thoroughly evaluating these emerging platforms. To assist with this task, Capgemini has created a 9-step approach for evaluating blockchain platforms. The functional dimensions represented by these steps cover the business-critical questions that must be asked by any financial institution that is considering a move to blockchain technology.

## Step 1: Security

A good first step is to look at the security of blockchain systems; the potential damage that criminal hackers can do to either the system or the business. It is also important to consider the potential for disruption or misdirection of services. Evaluation can include:

- The cryptography used and its protection against security threats
- The protocol design and known possible threats (for example, Sybil attack, 51% attack, selfish miners attack, malleability) and measures for protection
- Oversight capabilities by government agencies

## Step 2: (De)centralization

One aspect of blockchain services that has the potential to significantly reduce operating costs is the way they are redistributed, eliminating the need for maintaining a data center or centralized authority. Important considerations include:

- The design of the protocol in terms of how the actors and participants interact with each other
- The governance and control by each of the different actors and participants
- Scenario analysis that covers the possible actions taken by different actors and how these actions could impact the operation of the platform

## Step 3: Privacy

It may be important to consider how a particular platform protects information that may compromise the privacy of customers and users during the processing of transactions. The institution must examine:

- The platform's cryptography or any other measures used to provide privacy to the user and transactions
- The tools that are used to collect, analyze and report on the identity of users
- Oversight capabilities by government agencies regarding identity management (Know Your Customer, AML, etc.)

## Step 4: Scalability

The blockchain platform you choose must be able to handle a large increase in users, workload or transactions without undue strain. You should look at:

- Historic transaction growth patterns and projections of future growth
- Business and industry/market drivers that could impact growth projections and create significant spikes or prolonged plateaus in transaction volumes
- Future/alternative designs to improve scalability and performance

## Step 5: Usability

Assess how easily a user can interact with the blockchain. You should know what methods are required to improve ease-of-use during the design and development process.

- Current user-design features that impact your adoption of the platform
- The tools/capabilities available to monitor and control operational processes
- The technical design components that increase developer usability during the design, development and testing process

## Step 6: Extensibility

How does the platform you are considering accommodate the addition of new functionality for future needs? It is important to understand the way the blockchain and its applications are designed so that users or developers can expand, or add to, its capabilities. The related considerations include:

- Other supplementary services/applications built on top of the platform
- Integration capabilities with existing financial services platforms
- Tools/capabilities to provide audit and compliance capabilities to external parties (auditors, government agencies, etc.)

## Step 7: Cost

Each blockchain application will have a start-up cost and an operations cost (including infrastructure, extension for specific application, and support for production environment). You should:

- Identify the different cost components for starting up and running a blockchain application
- Evaluate potential sources of additional blockchain-related costs (training, compliance, legal, etc.)
- Analyze different cost scenarios and the impact on ROI

## Step 8: Operational Impact

It is very clear that financial institutions will not switch everything to blockchain immediately. Therefore the integration for technology and operations are critical considerations. Analysis must be undertaken to

- Analyze integration points between Blockchain solution and existing banking systems
- Develop a new operating model for blockchain
- Establish a new support model that supports the business and tech communities

## Step 9: Community Support

Finally, you will need to evaluate the resources, services, and organizations available (formal or informal) to help sustain the blockchain-technology application(s) you choose. Related activities include:

- Taking inventory of different community support groups and models
- Developing support models required for sustained growth
- Operational risk analysis for scenarios where the availability of blockchain community support is reduced or scarce

# 6. Blockchain for Banks: An Inter-Banking Approach

While blockchain brings potential for increased profitability and the excitement of innovation and change, it also can create a period of potentially great disruption and confusion in the FS industry. The following Capgemini observations underscore this point.

- Blockchain technology could lead to a paradigm shift in the financial services industry.
- New non-traditional players threaten to increase the risk of disintermediation.
- Some banks and financial services organizations are already experimenting with cryptocurrency and blockchain.
- A number of financial institutions have expressed the need for help in understanding “the stakes” (aka the potential business impacts) for and against the adoption of blockchain technology.
- The knowledge base for this new technology is not yet fully developed.
- Government regulators in countries around the world are taking quite different approaches to cryptocurrencies, ranging from total prohibition of, to strong support for, its development.

In this environment, it seems that some common assessment, collective thinking, and sharing of potential opportunities for -- and impacts on -- banks could be useful. While some banks are independently analyzing the potential of blockchain technology, our current point of view is that a common understanding would help all banks develop blockchain solutions more quickly and efficiently.

Several banks have recently indicated that they would be interested in joining forces to conduct a thorough, industry-led assessment of blockchain. There are many advantages in undertaking an industry-wide effort, which include:

- Developing a common understanding of the impact of blockchain technology for banks
- Sharing resources (innovation/IT), knowledge, and experience
- Broader opportunities for exploring the business cases and operational applications
- Comprehensive assessments of the business, technology, and legal implications of blockchain for banks
- Developing a common vision for a new national/international system that better serves the interests of all constituencies

Capgemini is currently involved in helping to shape this common effort. The goal of this Capgemini program is to bring together banks and experts to exchange ideas and information and mobilize participants around an interbank opportunity assessment. The objectives of the initiative are to:

- Identify the most interesting use cases for banks
- Run proof-of-concepts on the use cases selected with various start-ups, proposing blockchain solutions, developers and banks
- Perform joint analyses of the findings in order to improve solutions for future use

## About the Authors

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