

Beyond Bitcoin

Software & Services

Financial Services

Block chain technology is inciting change across the Financial Services spectrum.

Block Chain technology is being tailored to suit a range of different application areas. Current testing will culminate in commercial roll out of multiple applications in 2017. Failure to rapidly adopt it may lead to companies being caught out, effectively becoming permanent outsiders.

Development of Distributed Ledgers moving into high gear

Block Chain technology, also known as Distributed Ledger technology, has come a long way since the early days of Bitcoin and has found its way into many different application areas. Application-specific development of the technology is being driven at a relentless rate by some of the world's largest financial institutions as well as highly agile start-ups funded by venture capital.

Major cost savings opportunities, but threat of disintermediation

The advantages Distributed Ledger technology can bring the Financial Services industry include substantially faster speed of execution, lower transaction costs, irrevocable audit trails, increased transparency and automated contract execution through the use of smart contracts on Block Chains. At the same time, disintermediation and loss of revenue opportunities threaten companies' top line.

Insiders, outsiders and "residual distrust"

Application areas, such as Commercial Paper and trade finance, are currently being developed by banking groups in private Block Chains and are fenced off to outsiders. Not taking part in early development of Block Chain technology may leave companies permanently shut out.

However, "residual distrust" in private Block Chains may limit their efficiencies.

Large scale roll out to commence in the near term

While many hurdles remain, TMT Analytics expects agile players to roll out multiple commercial applications using Distributed Ledger technology on a large scale in 2017, likely catching many peers off guard. Companies would be wise to acknowledge the fast rise of the technology and take immediate action to adopt and implement it.

This report explores Block Chain and Distributed Ledger technology and aims to analyze in which way and how quickly it will drive change in the transfer of value, as well as which (sub)sectors are likely to be most disrupted.

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The rise and rise of Block Chain technology

Many readers will have heard of Bitcoin before, whether as a new digital currency, or as a means to transfer Euros out of Greece and Cyprus during times of crisis, or even as the preferred method of payment for a variety of shady transactions on Silk Road, an online marketplace for narcotics, arms and other illegal merchandise. However, fewer people will be familiar with the technology that underlies and drives Bitcoin, viz. Block Chain, also known as Distributed Ledger technology.

Despite its lower profile, Block Chain technology has the potential to fundamentally change the way value is transferred in the modern economy. As a result, the financial services industry is most susceptible to disruption from the technology, as Block Chain technology offers a platform to thoroughly disintermediate the gatekeepers of the financial services eco-system by allowing parties to trade directly with each other freely.

Today, Block Chain technology is being developed for a host of applications, particularly in the areas of financial services and ledgers of ownership. Further, developments of these applications are occurring at a much faster pace than many realize.

Given this fast development of Block Chain technology, we believe Financial Services Providers, including stockbrokers, insurers, real estate agents, exchanges, banks and payment providers, ignore Block Chain technology at their peril. Indeed, late adopters may forego the benefits entirely, even risking obsolescence.

The essence of Block Chain technology

A Block Chain is essentially a digital record-keeping service, or ledger, that uses advanced cryptography to maintain the integrity of the records being kept and the transactions that take place.

Transactions are transparent and secure

One of the key elements of a Block Chain is that it relies on a peer-to-peer network and does not require an intermediary, such as a bank, insurance broker or share registry, to verify transactions. Instead, a Block Chain network verifies each block of transactions internally through member-generated cryptography and verification.

This verification process is done by the members of the network, or nodes, such as a consortium of banks, each contributing their own computer processing power. Once a block of transactions has been verified to be genuine it is added to the chain of existing transactions (hence the name). Transactions are visible to the entire network and are irrevocable, which provides a valuable layer of security within the context of asset transfers.

Transactions rely on encryption and collaborative decryption

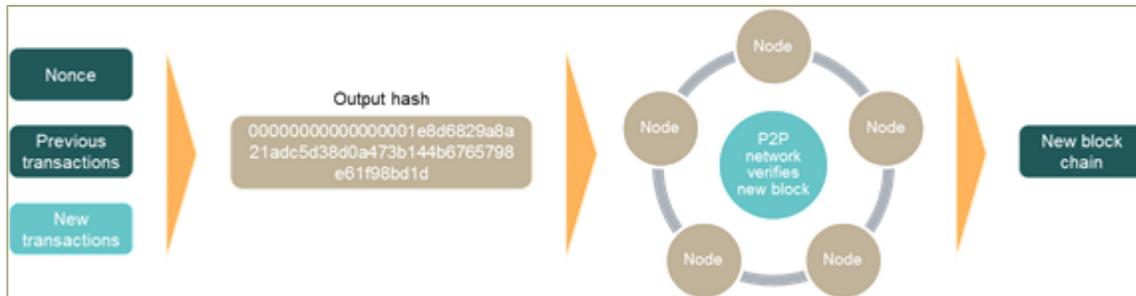
The Block Chain's actual transaction verification process is relatively complex (see Figure 1). It involves all network members trying to decrypt packets of data that have been encrypted by the Block Chain protocol. The encrypted data has three components:

- 1) The transactions to be verified. These include, but are not limited to, share trades, insurance policies, transfers of property ownership and the purchase of Bitcoins
- 2) A log of all previous transactions recorded on the particular Block Chain
- 3) A 'nonce', which is a random number used in authentication protocols to ensure that old communications cannot be reused.

The three components are encrypted using a so-called hash (encryption) function, which converts digital data of arbitrary size (e.g. a notary document or currency transactions) to digital

data of fixed size (64 digits). A key attribute of a hash function is that slight differences in input data produce very large differences in output data. When the three components are hashed up, the encrypted information looks similar to the output hash in Figure 1.

FIGURE 1: OVERVIEW OF THE BLOCK CHAIN ENCRYPTION AND DECRYPTION PROCESS



Source: TMT Analytics, Venture Insights

The essence of the decryption process for Block Chain network participants is trying to find the nonce (the random number) that, together with the known previous transactions on the Block Chain and all the known new transactions, results in the exact output hash that was given at the start. This is done by a process of trial-and-error, incrementing the value of the nonce with each new attempt, starting with a nonce value of, say, zero and increasing it after each failed attempt. The members of the Block Chain network then verify whether the new block of transactions is legitimate and, if approved, adds the new block to the existing chain.

Block Chains are like finding the missing ingredient

To better understand this decryption process, we might compare it to identifying the ingredients of a smoothie that contains three different fruits. We know two of the ingredients, say raspberry and apple, but not the third. The only way to identify the missing ingredient is to recreate the smoothie through trial-and-error, blending raspberry and apple with all the different sorts of fruit that exist, until the original mix is successfully reproduced.

Now imagine there are about 200 quintillion (200 million trillion) different types of fruit in the world to be tested, and we begin to understand the scope of the decryption work taking place on a Block Chain network. Essentially, participants in a particular Block Chain are systematically checking all possible keys until the correct one is found, in what is known as a brute force method. It requires tremendous computing power to work through all the possible combinations.

An elegant solution in a low-trust environment

The beauty of the Block Chain protocol is that trying to find the nonce (the third piece of fruit) that goes with a given set of new transactions (the raspberry) and all previous transactions (the apple) is extremely difficult if we only have the output hash (the smoothie) to start from.

However, once the nonce is found by a Block Chain network participant, it is very easy for others in the network to verify that this nonce correctly combines with the other two sets of data (old and new transactions) to form the original hash. They simply need to blend the three known components, that are now known, to verify that they produce the correct hash.

Once more than 50% of the other Block Chain participants verify that the nonce is correct, the new transactions are added to the existing chain of transactions, at which time the new transactions are considered to be legitimate and have become irrevocable. The process then starts over with a block of new transactions. As an example, a block of new Bitcoin transactions is added to the Bitcoin Block Chain approximately every ten minutes.

The Block Chain protocol can be used between various market participants without the need for an intermediary or central authority, like commercial and central bank respectively, to verify all transactions. It provides trust in an environment where trust is scarce, such as when dealing with unfamiliar counterparties whose financial positions are unknown or in situations where it is difficult to verify if counterparties actually own the asset they are selling.

A bright future for smart contracts on Block Chains

Smart contracts are contracts programmed in computer code that can trigger payouts or other actions between two parties without involving an intermediary, once certain criteria have been met. These contracts can be secured in Block Chains as self-executing contracts, which eliminate the risk of relying on others to honor their commitments. For instance, in the not-too-distant future, if a car payment to the dealer were missed, the car could be automatically locked until the payment was made, without the car dealer having to take any action or even be aware of a missed payment.

Smart contracts are a further extension of the application of Block Chain technology as they can be recorded in a way similar to, for instance, a Bitcoin transaction. They can be applied to real-world assets and financial instruments. Further, Block Chain-dependent smart contracts may see large-scale adoption once the Internet of Things (IoT) attains critical mass, as this will allow a growing number of transactions to automatically execute across connected devices.

Block Chains will change the face of financial services

Block Chain efficiency and security are attractive to start-ups and incumbents alike

The elegance of Block Chain technology has given rise to a wide range of start-up companies researching and developing applications for Block Chain technology. For instance, Chain.com enables institutions to design, deploy and operate Block Chain networks that can power any type of asset in any market. Chroma.fund, meanwhile, provides a Block Chain-based platform for initial public offerings (IPOs) and secondary share trading. The platform enables companies to raise capital outside traditional channels and provides investors with a low-cost way to trade shares in these companies.

In addition to typical start-up companies, established companies and groups of companies, such as banks and stock exchanges, have begun development of dedicated, private, Block Chains, which are specific to sectoral requirements. For instance, R3 - a consortium of more than 40 financial institutions including Goldman Sachs, CBA and UBS - aims to establish consistent standards and protocols around Distributed Ledger technology.

Through R3, financial institutions can collaborate on research, experimentation and design of Block Chain prototypes and create a dedicated financial services Block Chain network. R3 is currently working on different use cases for the technology, including commercial papers (short-term debt instruments) and the digitization of trade finance. The latter involves the use of smart contracts; for example, if sea freight container A clears customs in port B, funds will automatically be transferred from customer C to supplier D. Other areas of recent experimentation include credit default swaps and repurchase agreements on Distributed Ledger technology, in an effort to reduce friction associated with counterparty risk and general market illiquidity. Clearly, these applications of Block Chain technology have the potential to deliver benefits to the financial services industry in terms of efficiency, security and cost.

Consumers are set to benefit from Block Chain technology as well

Imagine a world where all settlement aspects of a typical stock trade were executed within seconds rather than days, including payment and delivery of shares, and where transaction costs could be as low as a few cents. A Block Chain dedicated to share trading and managed

by an exchange, such as the Australian Stock Exchange (ASX), could facilitate trades on this near-real time basis. The decentralized nature of distributed ledgers avoids the need for a central clearing house, while the transparent verification process need not sacrifice security for efficiency. Compare this to a standard retail stock trade on the ASX today, which takes two business days to settle and can cost hundreds of dollars in brokerage fees, depending on the broker.

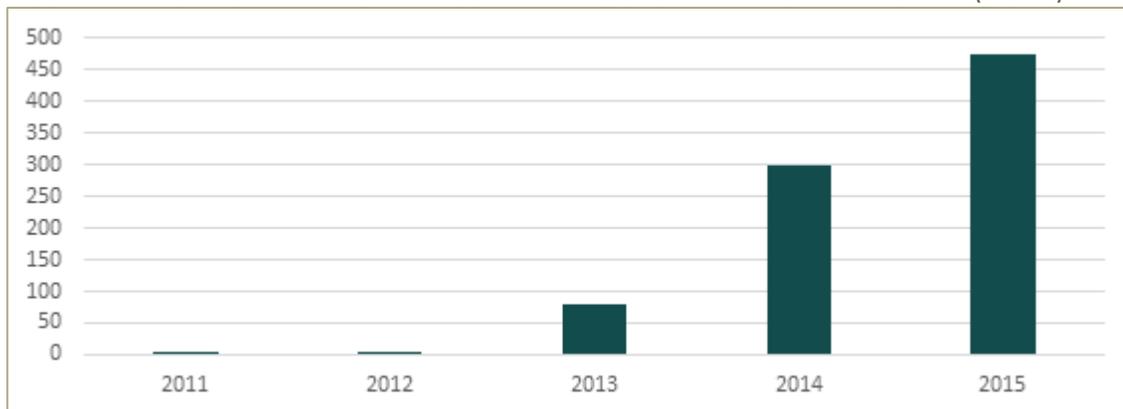
Remittance is another area of financial services that is ripe for disruption by Block Chain technology, particularly cross-border remittance. Currently, banks and other money transfer companies charge up to 10% in transaction fees for cross border money transfers, which can take several days to process. Multiple start-up companies are developing distributed ledger technology for cross border remittance with the aim to improve speed and reduce transaction costs.

TMT Analytics believes these sorts of speed and cost benefits will start to trickle down to consumers over time. This need not be limited to stock trading and remittance, but may apply to a host of other areas as well, as a result of the competitive forces driving innovation in Block Chains, Distributed Ledger technology and smart contracts.

Block Chain technology is undergoing rapid adoption

While most development of application-specific Block Chain and Distributed Ledger technology has only begun in the last two years, it has already gained very significant traction and is growing rapidly. In the past five years, investment in Block Chain and Distributed ledger technology has grown from US\$3M in 2011 to nearly US\$500M in 2015 (see Figure 2). While R3 is the most high-profile example of early Block Chain investment from the financial services industry, there have been other instances of investment. For example, tier 1 financial institutions have made investments in a host of Block Chain start-ups.

FIGURE 2: VENTURE CAPITAL-BACKED BITCOIN AND BLOCK CHAIN INVESTMENT ACTIVITY (US\$M)



Source: TMT Analytics, BI Intelligence, Venture Insights

Initially, tier 1 institutional investments focused on Block Chain applications for digital currencies like Bitcoin, such as early investments in Ripple and Coinbase by institutions like BBVA, Santander, MasterCard, NASDAQ, TransAmerica and NYSE. Further, early adopters in the venture capital industry started funding Bitcoin-related ventures like Bitcoin exchanges in 2013.

However, in the past twelve months investments by the financial services industry have become much more broad-based and go well beyond Bitcoin. Generally speaking, investments are now going into a variety of application-specific ventures building on Distributed Ledger technology, such as currency and share exchanges, specific applications for smart contracts on Block Chains, identity management and ledgers of digital assets. Growing investment across a larger

array of applications is likely to see Block Chain adoption increase, and may see initial rollout as early as next year.

Initial rollout of Block Chain technology expected in 2017

Substantial manpower inside financial institutions has been dedicated to developing Block Chain technology since early 2015. Combined with the high growth rate of financial investment in the technology, this leads us to believe that the first major roll out of financial services-related distributed ledger technology could occur as early as in 2017. We expect the rapid pace of this development will catch more complacent industry players off guard, imposing potentially severe penalties for late adoption as we will elaborate on below.

Block Chain's only flaw will lead to insiders and outsiders

The Block Chain protocol can be altered by an absolute majority of participants ...

The protocol of the original Block Chain used for Bitcoin prescribes that the protocol itself can be altered if a majority of more than 50% of the contributors, i.e. individuals or institutions willing to contribute expensive computer processing power to the network (Bitcoin miners), decide to change it. Theoretically, a group of Bitcoin miners controlling more than 50% of the total processing power on Bitcoin's Block Chain could change the protocol to favor their own transactions over the transactions of others. This so-called 51%-attack is considered to be Block Chain's only flaw. However, it should be noted that the chance of a 51%-attack is largely academic as explained below.

... but Block Chain incentives can dilute individuals' network share

Bitcoin, reliant on Block Chain technology, offers a demonstration of how the risk of a 51%-attack can be alleviated. In order to attract large numbers of Bitcoin miners to the network and minimize the chances of a 51%-attack, Bitcoin's Block Chain attracts miners to the network by rewarding 25 Bitcoins to whoever finds the nonce first. (In Bitcoin's Block Chain protocol, the mining reward halves approximately every four years. In July 2016 the mining reward will fall to 12,5 Bitcoins). When the price of Bitcoin rose to more than US\$ 1,000 in late 2013, this reward was worth US\$25,000 and was awarded every ten minutes, which is the approximate time it takes the entire Bitcoin network to find the nonce in a new block of transactions to be decrypted. At today's Bitcoin price of around US\$694 (14 June, 2016), this reward is still worth approximately US\$17,300 every ten minutes.

Because of this attractive monetary reward, there are many thousands of individual Bitcoin miners, some of whom are professionally organized with large scale computer servers set up in countries with low energy costs, such as Iceland, Inner Mongolia and Washington State in the United States. Due to the sheer number of miners contributing computer power to Bitcoin's Block Chain, the threat of a 51%-attack is reduced. This is because rational participants in the network are unlikely to undermine the integrity of Bitcoin's Block Chain, as doing so would diminish the monetary value of their mining reward due to an erosion of trust in the underlying asset.

However, financial institutions will not be using public Block Chains ...

A Block Chain network in which a number of participants are unknown would be unthinkable in today's compliance-driven environment. Financial institutions require a very high degree of security around their transactions, and in the absence of a direct financial reward for Block Chain miners, introducing unidentified nodes to the network would introduce the risk of a 51% attack. For this reason, Block Chains currently being developed for financial services, such as the ones R3 is working on, are private Block Chains used by well-known and heavily regulated financial institutions.

... leading to limited access to tier 1 Block Chains

Going forward, we expect access to these private Block Chains will be restricted to institutions with the highest credit ratings and best reputations, insiders, in order to minimize risks to the integrity of the particular Block Chain.

Large, well-known banking organizations should have no trouble finding suitable Block Chain partners or join existing initiatives. However, we expect lesser-known tier 2 and tier 3 institutions with lower credit ratings and reputations, outsiders, will struggle to join leading Block Chain initiatives, thereby missing out on commercial and cost savings opportunities. Additionally, they may suffer security issues when joining private Block Chain initiatives of lower reputation.

A role for regulators and the emergence of lower tier Block Chains

As with existing financial transactions and instruments, we believe regulators will also want to have their say. This may come in the form of vetting potential new participants in future commercial Block Chains and Distributed Ledgers. We also expect the emergence of off-the-shelf private Block Chain solutions for tier 2 and tier 3 market participants that may potentially be run by Central Banks on a localized basis. For example, in certain jurisdictions where local financial institutions struggle to gain access to tier 1 Block Chains, central authorities may operate Block Chain networks for local institutions.

Where do private Block Chains fit in?

Private Block Chains don't need full-blown encryption

A slightly ironic twist in the development of private Block Chains is that private networks establish trust at a higher level, and don't require encryption procedures to the extent of Bitcoin and public Block Chains. Public Block Chain technology for Bitcoin was developed with lack of trust in mind. Unknown parties contributing to the Bitcoin Block Chain are required to show proof-of-work, i.e. sufficient processing power to decrypt transactions, to show good faith and minimize the chance of an individual Bitcoin miner defrauding the system.

However, we expect private Block Chains will have a vetting process that all potential participants will need to go through. For instance, a future Block Chain for car insurance may see all insurance companies and underwriters vetted by either an industry association, a group of leading insurers, or by regulatory authorities. In other words, trust would already be established in this private Block Chain, eliminating the need for full-blown encryption. Consequently, all transactions could be added to the existing chain of transactions without encryption protocols as elaborate as the Bitcoin Block Chain.

Private Block Chains aren't the revolution you've been searching for

We would argue that the lack of a full-blown encryption protocol requirement makes private Block Chains less revolutionary than Bitcoin's original Block Chain. Private Block Chains could be considered evolutionary in that they represent a migration to a next technology generation, but are not fully open source technologies.

Private Block Chains can't safeguard against crisis illiquidity

Residual distrust limits efficiency

We believe that while setting up private Block Chains will likely lead to substantial efficiency gains throughout the financial system, the inherently limited numbers of participants may prove to be a major drawback during times of crisis. Further, the technology is susceptible to the same illiquidity risks as the broader market.

Bitcoin's Block Chain works because of the many individual participants providing liquidity to the network. The sheer number of miners keeps the network running even if the number of Bitcoin transactions were to fall during a certain period. Trust is provided by encryption, which prevents double spending of Bitcoins and ensures delivery of the asset.

In contrast, private Block Chains are comprised of relatively few, known, parties. In times of crisis, it is possible that Block Chain liquidity may dry up, simply because the number of participants is too low to ensure transactions continue. The private Block Chain requirement of prior vetting ensures that this number is likely to remain low.

Further, recent history has shown that in times of financial crises, an identifiable network is by no means a guarantee of liquidity. Indeed, even the parties that trust each other enough to participate in a private Block Chain may choose not to trade with each other during a crisis. This is precisely what happened in 2008 when Lehman Brothers failed.

We believe this vicious circle of 'residual distrust' in private Block Chains may prevent the financial system from reaping the full benefits that Distributed Ledger technology has to offer.

Public Block Chains: a positive outlook, despite challenges

Large opportunity for fully open source Distributed ledgers

Public Block Chains go some way to solving the issue of residual distrust in private Block Chains, by ensuring that transactions are transparent and secure. As a result, we believe that there will be a substantial opportunity for fully open distributed ledgers to maintain liquidity in the underlying market. However, fully open source ledgers have technological challenges of their own.

Despite the clear advantages of Distributed Ledger technology, we see three categories of short- to medium-term inhibitors to large-scale commercial adoption of Block Chain and Distributed Ledger technology. These challenges concern regulatory, technological and commercial concerns.

Regulatory issues likely to be the main inhibitors to adoption of Distributed Ledgers

Regulatory hurdles may slow the rollout of Block Chains in financial services. Distributed Ledger technology will likely lead to 'existential' questions, such as whether open source technology is actually a financial product and whether distributed ledgers require a financial services license to operate. Regarding competitive issues, the ACCC might question whether private Block Chains limit competition as they create insider-outsider models, potentially leading to a lack of trust in outsiders from consumers and counterparties. In each of these cases, regulatory authorities will need to consider how the new kid on the block, as it were, fits into the existing system.

As a result, we believe that one of the key challenges regulators face is understanding distributed ledgers, i.e. what they are, how they work, what they facilitate and whom they disrupt. To this end, regulators need to establish internal and external networks to build knowledge around the technology matching that of the private sector. In our view, this is not only true for

the usual suspects, such as the ASIC, APRA, the ASX and the RBA, but also for the ATO and ACCC.

Technology: something old and something new

We believe new applications using Distributed Ledger technology will initially need to function alongside older technologies, as most administrative information, current asset ownership and operating procedures are stored on legacy systems. As a result, we expect commercial applications of Distributed Ledger technology will be hybrids, incorporating existing back office systems, smart contracts and Block Chains. The challenge for financial institutions is to effectively integrate Block Chain developments with legacy systems.

Another technological hurdle is the expected lack of contributed processing power on fully open source distributed ledgers. We expect open source applications of distributed ledger technology may initially struggle to attract sufficient processing power to ensure the necessary levels of security in the absence of financial incentives.

In our view, these challenges may inhibit the roll out of some commercial applications of distributed ledger technology.

A brave new (commercial) world?

We expect the adoption of Distributed Ledgers to drive substantial changes for financial services revenue, in addition to the cost and efficiency implications discussed earlier. For instance, the immediate execution of transactions and settlements in share trading implies that banks and clearing houses will have substantially reduced opportunity to generate interest income from funds that they hold, such as in T+2 settlements. These so-called interest days are a main source of revenues for financial institutions.

Consequently, while we believe disintermediation in heavily regulated industries like financial services, due to the adoption of Block Chain technology, will be relatively limited at first, we expect that increased transparency and speed of execution may affect industry revenues. Naturally, loss of revenues will in part be offset by lower costs, but overall we believe many companies will need to revisit their current business models and seek out alternative revenue opportunities.

Conclusion: The early adopters get the worm

Despite the remaining hurdles and challenges, we believe the anticipated benefits of distributed ledger technology are substantial, which will continue to relentlessly drive technological development in this field. We believe alpha and beta trials of Distributed Ledger technology currently being conducted in a range of financial services will result in commercial roll out in 2017, likely catching many industry participants off guard. As the disadvantages of becoming an 'outsider' are potentially of an existential nature, we believe companies would be wise to fully embrace Block Chain technology and distributed ledgers sooner rather than later.

As a footnote, the effects of Block Chain technology may even extend beyond the financial services industry. Further to the subsectors and application areas identified in this report, such as commercial papers, stock trading and settlement, ID management, remittance, credit default swaps, repurchase agreements and trade finance, other application areas for Distributed Ledger technology include funds management, real estate and rental markets. Indeed, additional unanticipated benefits may emerge as the technology advances further and new applications are developed.

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