

THE BLOCKCHAIN IN THE IoT REPORT

HOW DISTRIBUTED LEDGERS ENHANCE
THE IoT THROUGH BETTER VISIBILITY AND
CREATE TRUST

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BI INTELLIGENCE

KEY POINTS

- **Blockchain is emerging as a key tool with numerous applications throughout the IoT.** Companies are developing innovative solutions that use blockchain to cut costs and improve services.
- **The unique properties of blockchain allow data from IoT devices to be collected, stored, and shared in new, simpler ways.**
- **Blockchain is poised to transform practices in a number of IoT sectors, including:**
 - **The supply chain:** Tracking the location of goods as they are shipped, and ensuring that they stay within specified conditions.
 - **Asset tracking:** Monitoring assets and machinery to record activity and output as an alternative to cloud solutions.
 - **Health care:** Enabling logging and sharing of medical data between numerous stakeholders with versatile permissioning, directly holding some data while offering encrypted links to other information.
- **While solutions address a number of potential pain points in the IoT, several challenges exist that could hold back widespread adoption.** These issues include blockchain's complexity, companies' loss of control, regulation, and hardware requirements.
- **Blockchain is poised to provide a new, powerful tool for companies developing and implementing IoT solutions, offering increased versatility, security, and efficiency.**

[Download the charts and associated data in Excel »](#)

INTRODUCTION

Blockchain isn't just for bankers anymore. Most of the buzz around the distributed ledger has focused on its uses in finance, where it originated (see BI Intelligence's recent [Blockchain In Banking Report](#)). But one of the most promising blockchain trends is its growing relevance to the IoT. Firms developing blockchain technologies have raised more than \$1.55 billion since 2012 in venture funding, according to [CB Insights](#).

Blockchain is a shared, distributed database that acts as an immutable ledger, recording events or transactions and verifying them across a number of independent participants. That makes it well suited to tasks like tracking goods as they move and change hands in the supply chain, monitoring the location and condition of assets like industrial machinery at remote work sites, or storing medical data. In some cases, devices use blockchain to become economic actors, making entries in a distributed database that trigger transfers based upon conditions. In others, blockchain allows portions of operational data to be shared with stakeholders in settings ranging from manufacturing plants to doctors' offices.

In this report, BI Intelligence looks at the developing role of blockchain in the Internet of Things ecosystem. First, we look at how blockchain works, both generally and as part of an IoT solution. We then identify the areas most suited to use blockchain as part of larger IoT projects, specifically looking into the supply chain, asset tracking and monitoring, and health care. Finally, we discuss the challenges companies looking into blockchain solutions for IoT programs will face, and explore what the future holds for blockchain in the IoT.

BLOCKCHAIN BEYOND BITCOIN

The first thing to know about blockchain is that it's not a monolithic, single entity. In other words, it isn't a thing — it's a technology. A blockchain is a distributed ledger or database that's collectively built and maintained by every party that uses it.

It's made up of a number of entries, called blocks, which are composed of the data being stored. These blocks are transmitted to the partners in the distributed ledger so that they can be verified by unaffiliated parties. Each block contains a hash code that identifies the block that immediately preceded it, making the blocks sequential and chaining them together, hence the term "blockchain." [The Blockchain Report](#) explains in greater detail how the distributed ledger works.

Bitcoin is the best-known example of blockchain technology. The cryptocurrency isn't governed by any central body, deriving its worth from the computing power necessary to operate the central nodes that process bitcoin transactions and add them to the blockchain. The bitcoin blockchain ensures that any transfer of bitcoin is recorded in the distributed ledger, which notes the amount of the transfer and where the transfer fell in the chronology of bitcoin exchanges. The unique hash codes make the entries almost impossible to duplicate, meaning that any entry is permanently recorded and the blockchain can be trusted implicitly.

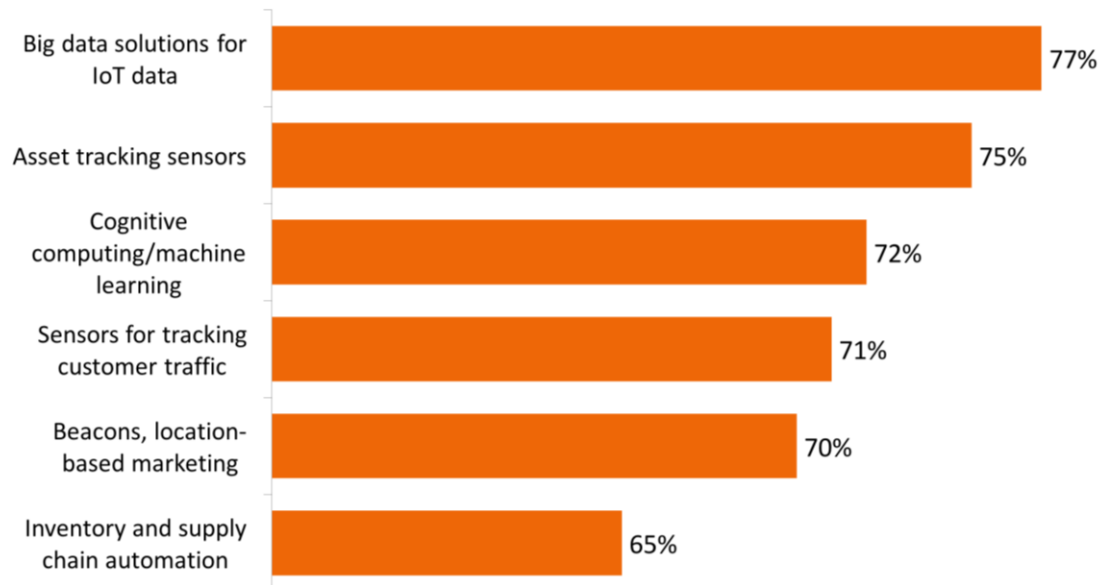
The same model that's used in the bitcoin blockchain generally applies to any other use of blockchain technology. Some type of transactional data is stored in blocks — such as manufacturing output, location, or health care information — which are encoded and verified by multiple independent parties participating in the ledger. Just like with bitcoin, the blockchain is immutable, so any participant can observe and base rules and actions on those observed conditions.

THE SUPPLY CHAIN

One of the areas most primed for disruption due to the introduction and expanded use of blockchain is supply chain management. This is critical for operations in many industries, impacting companies that transport goods and services through chains as well as those that rely upon those goods and services. Companies are investing heavily in IoT technologies to get better insight and visibility into these formerly opaque areas, with more than [three-quarters](#) of retailers planning to invest in sensors or big data solutions by 2021.

Percentage Of Retailers Planning To Invest In AI And IoT Technologies By 2021

Global



n=1,700

Source: Zebra Technologies, 2017

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Tracking The Location Of Goods

Blockchain is ideally suited to record data generated by the RFID tags, Bluetooth beacons, and NFC chips that logistics providers use to track goods. Here's how it would work: When an RFID tag attached to a shipping container, for example, is scanned, the identity of the tag, the time, and the location of the scanner can be logged using a blockchain. All of that information would be part of a block, and it would be entered sequentially into the immutable ledger. This blockchain can be available for all involved parties to view, including the manufacturer, the transportation provider, and the recipient, as well as anyone else with an interest in the good in transit.

Using a blockchain opens up a range of options for companies transporting these goods. Entries on a blockchain can be used to queue up events with a supply chain — allocating goods newly arrived at a port to different shipping containers, for instance. Blockchain provides a new and dynamic means of organizing tracking data and putting it to use. Companies like [Skuchain](#) and [Factom](#) offer solutions that utilize blockchain in supply chain management.

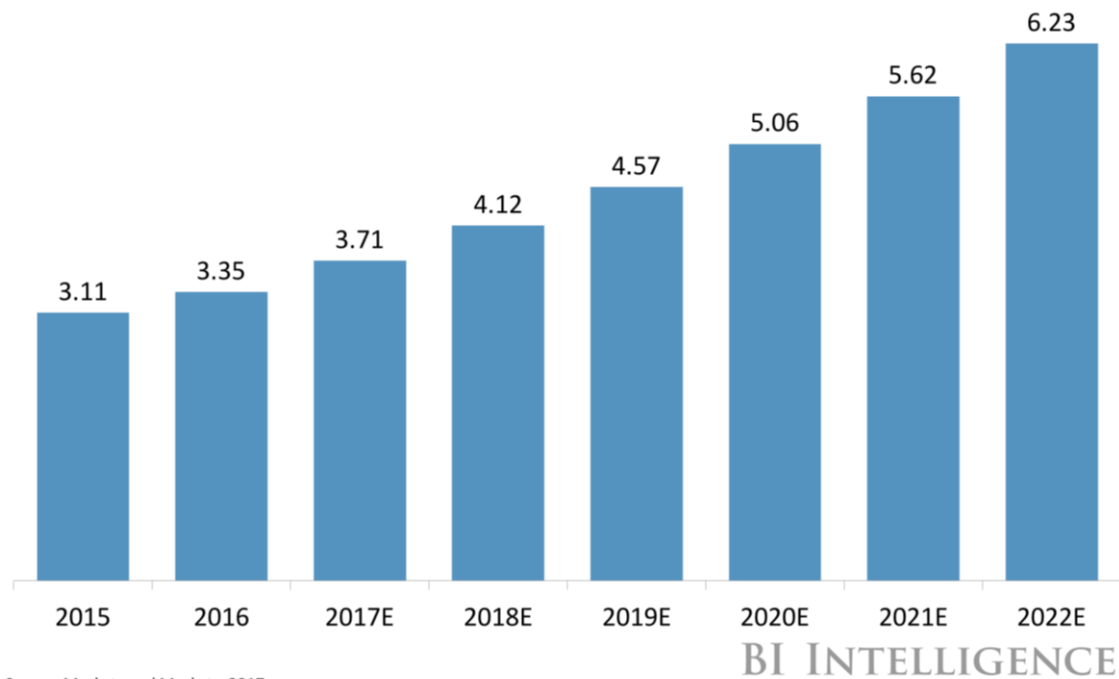
Monitoring Asset Conditions

Distributed ledgers can be used to record important information about goods besides just their location. For instance, blockchain technology could be used to store temperature data gathered by sensors inside a shipping container of frozen food. That would allow health inspectors, distributors, retailers, and other stakeholders to more easily check whether temperatures exceeded permissible levels in transit, potentially increasing the risk of food-borne illness.

Markets and Markets [estimates](#) that cold chain monitoring will be a \$6.2 billion industry by 2022. The granular and specific nature of the data that's recorded on a blockchain lets companies track their products more clearly all the way back to their point of origin. That's why [Walmart](#) is testing out blockchain to ensure that food in its stores is safe and to track outbreaks of food-borne illness all the way back to their source. From a customer's receipt, the retailer will be able to tell where a problematic package of food came from, tracing it as far back as the farm of origin just using data recorded to a blockchain.

Cold Supply Chain Monitoring Costs

Global, Billions (\$)



Source: Markets and Markets, 2017

Blockchain's transparency makes it well-suited for many of these supply chain monitoring tasks. It provides a common point of reference for all stakeholders in the supply chain, rather than siloing information in each party's preferred IoT solution.

Everyone involved sees and knows the mechanisms by which entries on the blockchain are made, as the blockchain is decentralized and externally verified. Due to the immutable nature of the blockchain, there can be no questions as to whether information was changed or adjusted after the fact in a possible effort to avoid accountability.

ASSET TRACKING AND MONITORING

Companies need to know the location and condition of all their assets, not just the goods they've shipped. Blockchain can take the place of many IoT monitoring platforms currently used for this purpose. The data generated by sensors and tracking devices can be recorded in a blockchain ledger, eliminating the need for specialized software or a cloud-based software-as-a-service (SaaS) solution.

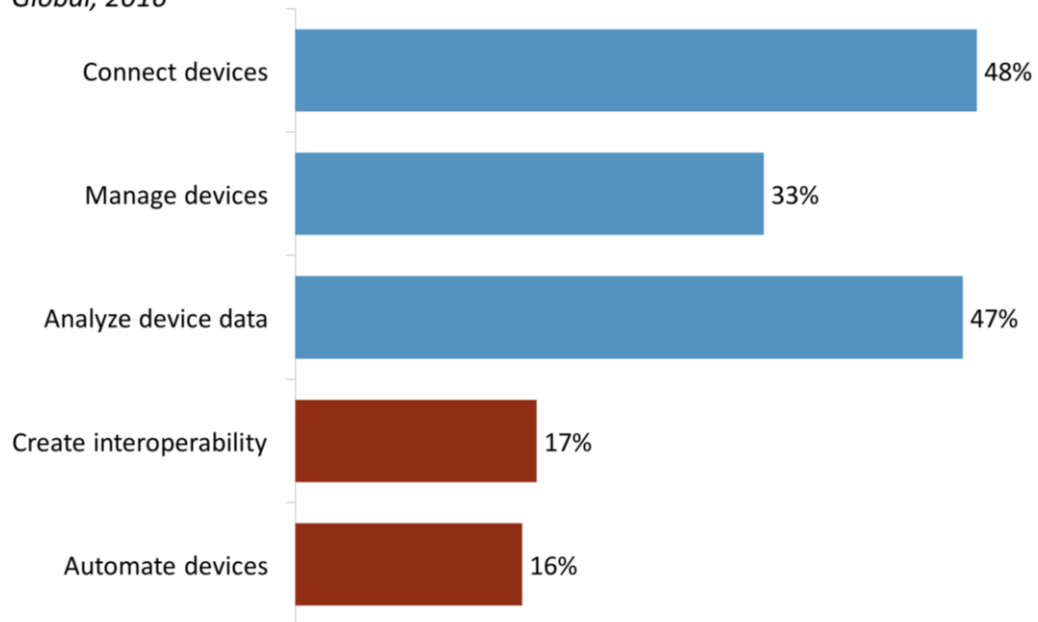
BI Intelligence spoke with Allison Clift-Jennings, the CEO of [Filament](#), a leading startup in the IoT blockchain solution space, which provides a combination of hardware and software that allows companies to implement solutions to manage their assets, using hardened devices to monitor asset, vibration, temperature, and a number of other key operational indicators. Each of these factors is monitored by the device and logged using a blockchain.

The devices offered by Filament and its competitors can be used in all sorts of settings, ranging from factories to remote construction sites with limited or no connectivity. The blockchain ledger sequentially and simply logs all information generated by a device, appending it to a larger blockchain when network connectivity allows. Companies can develop software and analytical tools to make use of the data stored on the blockchain — analyzing vibration data, for instance, to determine output levels for machinery.

Blockchain provides an alternative to cloud services for many companies. They are able to decentralize their operations, relying on a number of processing nodes to provide the necessary computing power. Such nodes can take on a variety of forms, including as edge computing devices. Using blockchain can allow for a company to cut down the number of vendors it needs to go about its primary business and reduce the complexity needed to implement IoT solutions. It provides an alternative to the traditional IoT projects, allowing companies different means of achieving increased device connectivity, data analysis, interoperability, and even automation through smart rules and dynamic, automated contracts and ledger entries.

The 5 Stages Of The IoT — What Companies Do With Their IoT Solutions

Global, 2016



Source: Business Insider Global IoT Executive Survey, Q4 2016 (n=233 IoT Users)
intelligence.businessinsider.com

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HEALTH CARE

Hospitals, offices, insurance companies, and governments can work together to use blockchain to secure patient information. Not only can [distributed ledgers](#) store such data, but they can also be used to provide a roadmap to highly sensitive details that are kept elsewhere.

Health data that's suitable for blockchain would include general information like age, gender, and potentially basic medical history data like immunization history or vital signs. None of this should be able to identify any particular patient, which is what allows it to be stored on a shared blockchain that can be accessed by numerous individuals without undue privacy concerns.

Other data is linked to on the blockchain but is actually stored off the chain. This is done through encrypted links. The type of info that's stored off the chain includes all personal and personally identifiable patient data, as well as data that isn't configured well to go on the blockchain. Patients, doctors, and other personnel authorized to view that medical data are able to use private encryption keys or some other means of identifying a user to view the data linked to on the blockchain.

The nature of a blockchain doesn't allow for all of a patient's data to be stored there directly for a couple of reasons:

- **The way a blockchain stores data:** Blockchains can be used for numeric and textual data, which comprises a good portion of medical data. Patient records, though, also include larger and more complex files like X-rays and other imaging, which cannot be stored directly on a blockchain.
- **Who can access blockchain data:** In health care, a blockchain would be available for a number of people in a facility, office, or organization to access and add to the ledger. This means that protected patient data could potentially be exposed to individuals who aren't supposed to be able to see it. This type of information needs the security provided by unique encryption keys in order to comply with health data privacy regulations.

The anonymized data that's stored on the blockchain can be critical in enabling expanded medical research. Widespread use of medical blockchains populated with anonymized patient data can give doctors engaged in high-level research far more resources and a much wider range of potential patients to recruit to engage in studies. **Blockchain can also give patients more control over their own medical records by giving them more power over who can and cannot see them.**

As specialized connected medical devices become more common and increasingly linked to a person's health record, blockchain can connect those devices with that record. Devices will be able to store the data that they generate on a health care blockchain that can append that data to a person's medical record. A key issue facing connected medical devices is the siloing of the data they generate — blockchain can be the link that bridges those silos.

In the US, the Food and Drug Administration (FDA) [partnered](#) with computing giant IBM to explore uses for blockchain technology in securely exchanging health care data. [Estonia](#) is using blockchain to secure patient medical records for its citizens. Vendors including Cisco, Foxconn, and Hashed Health [met](#) to discuss blockchain protocols for health care and the IoT more broadly.

THE CHALLENGES FACING BLOCKCHAIN IN THE IoT

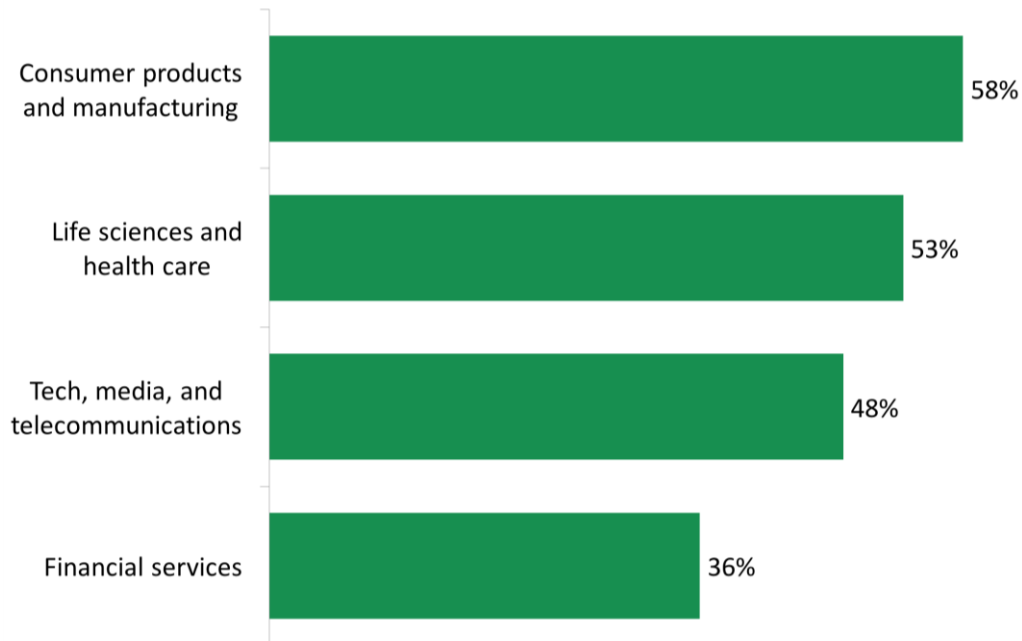
Blockchain can address a number of key issues facing the IoT, serving as a useful tool in the arsenal of a developer or provider looking to implement or add to an IoT project. But it's still just a tool that can be applied in certain circumstances, not a panacea for all issues facing the IoT. Here are a few of the top challenges that IoT solutions using blockchain will face:

Complexity

Blockchain is a complex, confusing tool; 39% of senior executives that [Deloitte](#) surveyed claimed little or no knowledge of blockchain technology. Among those claiming high levels of blockchain knowledge, 42% think blockchain will disrupt their industry, and 55% believe that failing to adopt blockchain tech will lead to a competitive disadvantage. These aren't just financial services executives — companies in consumer products and manufacturing (58%), life sciences and health care (52%), and technology, media, and telecommunications (48%) planned to deploy some aspect of blockchain by the end of 2017. Blockchain is going to change the way companies and organizations operate in a number of economic sectors, but creating and implementing solutions will require understanding and education for those creating the solution as well as decision makers who need to be convinced to give the green light.

Companies Deploying Blockchain Solutions By 2017

By Industry Sector



Source: Deloitte, 2017 (n=308 senior executives)

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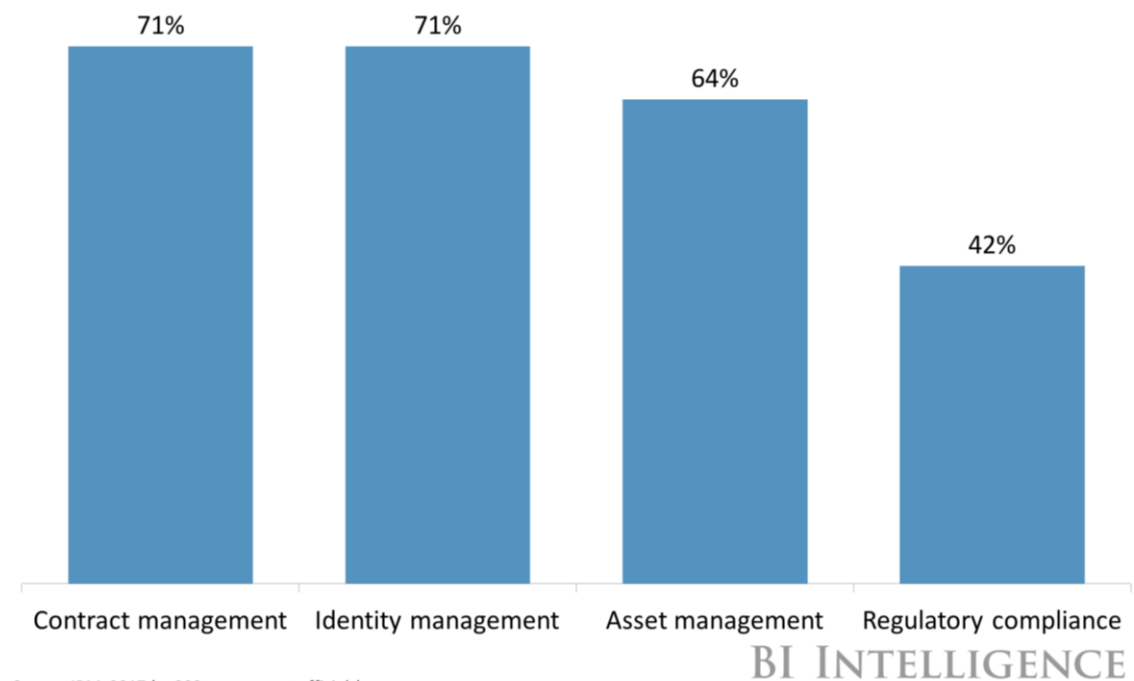
Loss Of Control

One of the key advantages of a blockchain solution is that it makes use of a distributed and decentralized ledger. By removing any central authority and creating immutable logs, blockchain is supposed to create trust, as no party can exercise control over the ledger or manipulate data. In use cases where blockchain programs are implemented to manage asset use or a supply chain, companies can use the distributed ledger to take the place of a cloud platform or an IoT platform provider. To make this transition, however, a company needs to accept ceding central control over its products and the logging of its data — or take on the creation of a private blockchain, which can be prohibitively expensive due to the costs of running all the computing systems needed to process entries. The idea of relinquishing this control is difficult to accept, as it's a new mode of operation. As blockchain becomes more common, this will fade as an issue, but in early days this could limit uptake in the IoT.

Regulation

Much of the data that would be stored on a blockchain, especially in health care fields, is private and heavily regulated by governments. Existing regulations don't necessarily have the flexibility that would be needed to accommodate disruptive technologies like blockchain — they have difficulty even allowing the digital sharing of electronic medical records between institutions — and without special consideration and regulatory exemptions, innovation may not take hold. The information that's kept on-chain as opposed to off-chain, though, can be problematic, as on-chain information is supposed to be anonymized, but basic data like date of birth, sex, and location can potentially be used to identify someone, especially in lower-population areas. The health sector will have to address these issues before blockchain can see wider use.

Where Government Officials Anticipate Blockchain Disruption



Costs And Device Requirements

Implementing a blockchain solution can require major upfront investment — 53% of large companies Deloitte surveyed will have invested over \$5 million in blockchain solutions by the end of 2017. In order to append a transaction to a blockchain, a computing device needs to have fairly robust processing capabilities and memory.

As they exist today, though, IoT devices are designed to be as small, light, and inexpensive as possible. They are built to accomplish one task well, at the expense of versatility. This makes it harder to use hardware already in place in an IoT project or on the market currently as part of a solution using blockchain. Companies like Filament offer hardware that's custom-built to allow clients to get the most out of a blockchain solution. The inexorable increase in processor power will help with these problems, as computing hardware will grow in power and drop in cost for devices across the board, but different requirements from the majority of IoT devices will slow down blockchain adoption.

WHAT THE FUTURE HOLDS

In the years to come, we expect to see companies develop their blockchain IoT solutions to address the issues posed by these challenges. Blockchain is a promising tool that will transform parts of the IoT, enabling solutions that provide greater insight into assets, operations, and supply chains while also transforming how health records and connected medical devices store and transmit data. It won't be usable everywhere, but in many cases, it will be a part of the solution that makes the best use of the tools in the IoT arsenal. Blockchain can help to address particular problems, improve workflows, and reduce costs — the ultimate goal of any IoT project.

THE BOTTOM LINE

- Blockchain is a key emerging tool with numerous potential uses throughout the IoT.
- Solutions using blockchain are set to transform supply chain management, asset tracking, and health care.
- A number of challenges exist that still need to be addressed and overcome for blockchain solutions to see wider use within the IoT.
- Blockchain is a critical tool that can increase versatility, improve security, and augment efficiency in all sorts of IoT solutions.

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