# Blockchain benefits for electronics

*Taming complexity with better supply chain visibility*

IBM Institute for Business Value

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## *Addressing complexity*

*Electronics organizations face an increasingly complex market as value chains expand across companies and tiers. Blockchain technology is a new tool that can offer significant benefits to the industry. Its features as a shared, synchronized ledger can help organizations manage complexity across their value chains. Our recent blockchain survey revealed key use cases in which enthusiastic adopters anticipate a high level of benefit, including the reduction of frictions to improve the cost, time and risk associated with complex business processes.*

# Executive summary

With the support of the Economist Intelligence Unit, the IBM Institute for Business Value surveyed 200 electronics leaders in 16 countries about their experience with, and expectations for, blockchains. We found that electronics organizations are beginning to explore blockchain technology by identifying key areas of benefit.

Fourteen percent of respondents indicated that their organization would develop commercial blockchain solutions at scale in 2017. These respondents, who we call Trailblazers, are those who are most enthusiastic about the potential of blockchains for their industry. They demonstrate this enthusiasm by predicting a high level of investment in the technology across business areas in 2018.

Trailblazers report that blockchains will help them reduce the frictions causing complexity in their industry. They have identified inaccessible information, restrictive regulation and invisible threats as the top frictions that blockchains could mitigate. This mitigation may improve Trailblazers' ability to identify new business models, improve regulatory compliance and better anticipate disruption.

To begin, Trailblazers identified use cases with the greatest potential benefits of time, cost and risk. Blockchains can be used for asset and inventory management and component provenance to improve visibility across the supply chain and achieve these benefits while enabling organizations to explore new business models. Trailblazers also identified edge computing and digital marketplaces as use cases where new business models may emerge as industry adoption improves.

In this report, we share key insights into the market adoption of blockchain solutions. We also explore what differentiates early adopters — the Trailblazers — and how other electronics organizations can learn from their blockchain explorations.

**14% of electronics organizations** — the Trailblazers — expect to have blockchains in production and at scale by 2017.

**80% of Trailblazer electronics executives** expect blockchains to provide the greatest benefits for asset and inventory management, component provenance, edge computing and digital marketplaces.

**60% of Trailblazer electronics executives** expect blockchains to create the greatest disruption in digital marketplaces.

## Trailblazers set a fast pace

"The future is here," William Gibson once famously said, "it's just not evenly distributed." It will be soon. Decentralized, geographically distributed production and logistics networks already dominate the electronics industry. Every product is an amalgam of parts, manufacturers, processes and distribution complexities that require orchestration from ideation to customer delivery.

The challenge for a complex multi-company, multi-tier value chain in the electronics industry is for its components to optimally — and swiftly — act in concert. As the number of organizations participating in the electronics value chain grows, deficiencies in data become more readily apparent. Data that adds valuable context is increasingly likely to be missing from whole parts of an extended process. Alternatively, data can fall out of sync as it travels from party to party along the chain.

So, to maintain data fidelity and knowledge, a lot of little processes and complexities crop up. These steps seek to ensure that participants along the value chain have both the trust and the data they need to make decisions and maintain the flow of economic activity.

Earlier technologies, such as electronic data interchange (EDI), have facilitated the exchange of data between two parties for standardized high-volume transactions, including purchase orders and invoices between a component supplier and manufacturer. However, as this mechanism extends to multi-party transactions, it becomes less well-suited and far less efficient, especially for transactions that occur at a relatively low frequency. It's much harder to design a solution that is timely and efficient for transactions that occur between a component supplier, an OEM, a logistics company (or two) and an electronics manufacturing services (EMS) provider. The more parties involved and the greater the need for speed, the higher the chances of data being lost along the way.

These complications arise even if the transaction is relatively simple — for instance, when a manufacturer purchases equipment from a supplier. What if the two parties are in different countries and don't have a relationship? Often, electronics organizations rely on intermediaries. The manufacturer may need to obtain a letter of credit from a bank, which then has to establish a relationship to assure the supplier that it will, in fact, get paid. At the same time, the shipper that transports the equipment needs to document the moment when ownership shifts from one party to the other. An auditor may need to verify that the equipment has been received and installed satisfactorily at the manufacturer's site, and then inform the bank. Even in this Information Age, many of the steps in the process rely on a person reading a transaction record and initiating the next step. As a result, the transaction may take extra days, or even weeks, to complete.

The end result is high-friction processes that span multiple parties and exert pressures on traditional operating structures. The volume of transactions and the imperfections in the underlying data impede systems designed to carry out specialized processes, such as managing trade finance or keeping conflict minerals out of their products.

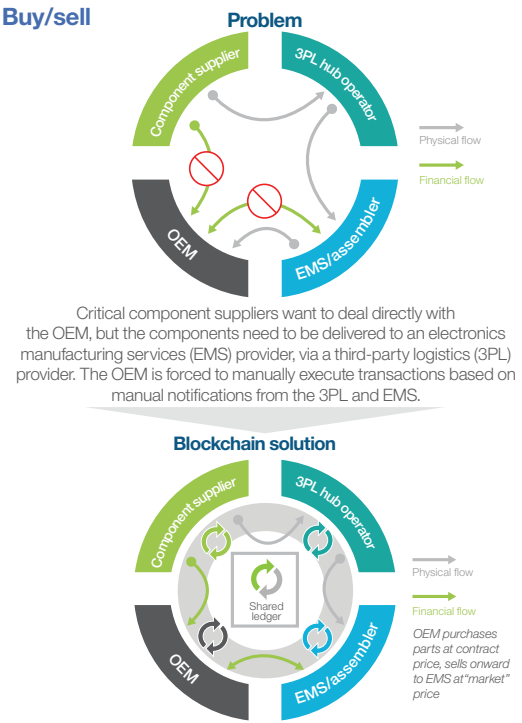
But there is an emerging and elegant solution: Blockchains, which are shared distributed ledgers that parties can use to create a common record of every transaction associated with an asset. Blockchains can reduce the friction that comes with complexity to improve the cost, time and risk associated with business processes (see sidebar, "Speed lane").

### Speed lane

Letters of credit aren't typically shared or stored in digital form. Instead, buyers and sellers and their respective banks exchange paper documents — often sent by courier — to sign, countersign and verify that the conditions of a sales contract have been executed in order to make payment. Recently, UBS Financial Services Inc. completed a proof-of-concept (PoC) on a Hyperledger blockchain. By linking sales invoices and contracts to letters of credit, they now expect that instead of seven days, the whole process could take as little as an hour.[1]

**Figure 1**

*Managing OEM complexity with blockchains*




**Blockchains: Addressing value chain challenges in the electronics industry**

Traditionally, companies have maintained ledgers containing only their own transactions — currency or property, including intellectual property, for example. Each ledger reflects the information held by a single party. For example, when purchasing components, an OEM doesn't track what happens after it transfers these assets to others, such as partners, suppliers or customers. But on a blockchain, where the ledger is shared and distributed across multiple parties, the information can be updated every time a transaction occurs to reflect both the physical and financial flows of goods (see sidebar, "Message-based versus state-based communications").

Each participant in a blockchain transaction has a complete copy of the ledger, although security provisions can prevent some participants from viewing every detail of every transaction. When an OEM purchases components from another country, for instance, information about the bank holding a letter of credit, the EMS, third-party logistics (3PL) providers, customers and regulators can also be updated via the shared ledger (see Figure 1). The physical flow of goods between parties, the transfer of ownership of the components and the stream of forecast data can all be tracked in a synchronized manner. These updates occur through peer-to-peer replication, and as a result, each participant's ledger synchronizes with minimum lag time.

Data captured on blockchains becomes part of ever lengthening chains, immutable records of every transaction as it occurs. On permissioned blockchains, participants can view specific data elements based on their roles and access privileges.

Permissioned blockchains can maintain two levels of security. The first defines which participants are authorized to see the ledger, and the second stipulates which information those participants are allowed to see. Further, the ledger is stable, or "immutable," which means that no one can alter a transaction after the fact. Transparency and access to events as they occur can even discourage bad actors, reducing fraud.

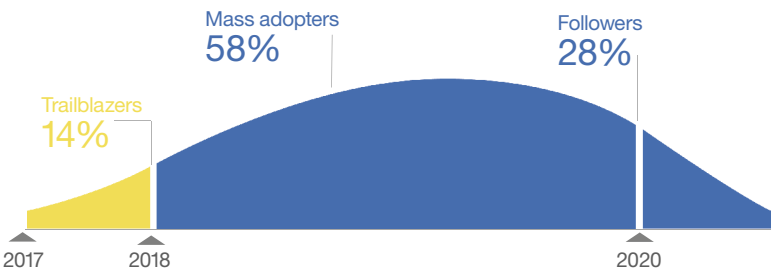
Smart contracts embedded in blockchains can determine the conditions under which a transaction can be automatically processed. This feature eliminates costly manual efforts, which are prone to errors and delay. And that's just the beginning of how blockchains could create value.

**Trailblazers: Sparked by enthusiasm**

We asked executives across the electronics industry how prepared they were to implement blockchains. Fourteen percent of respondents told us they expect to have blockchains in commercial-scale production in 2017. We call this group the Trailblazers. By 2020, nearly three-quarters of electronics organizations anticipate that they will be operating with blockchains (see Figure 2).

**Figure 2**

*First on the block: When respondents expect that they will implement blockchains in commercial production and at scale*




## Message-based versus state-based communications

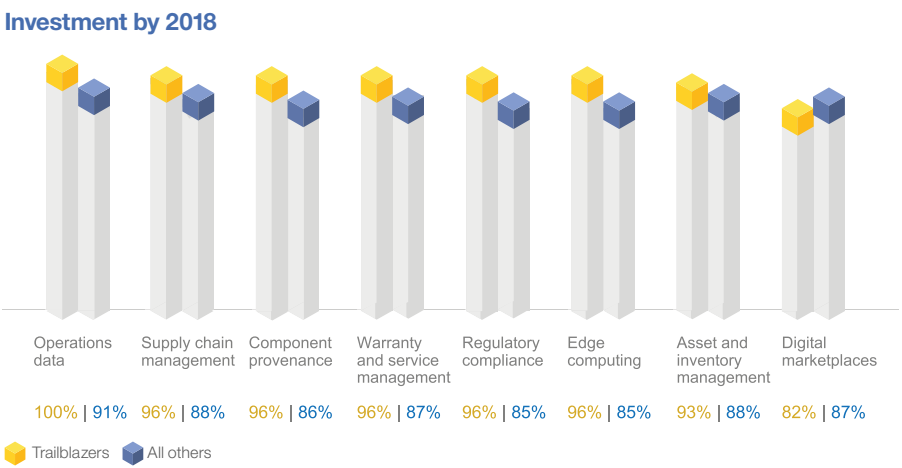
Today, organizations send messages back and forth to accomplish various tasks, with each organization maintaining its state of the task locally. On blockchains, messages represent the shared state of the task, with each message moving the task to the next state in its lifecycle. Blockchains shift the paradigm from information held by a single owner to a shared lifetime history of an asset or transaction. Instead of message-based communications, the new paradigm is state-based.

To date, blockchain PoCs have been most evident in the service industries. Recently, however, blockchains have made inroads into the supply chains of other industries — most often to facilitate logistics or track the provenance or ownership of goods.

Trailblazers in the electronics industry are those most interested in applying blockchains to their business networks. They demonstrate their enthusiasm for innovation by predicting a high level of investment across business areas by 2018, beginning with key areas in the supply chain (see Figure 3).

**Figure 3**

*Organizations invest in blockchains across the board*



Trailblazers' eagerness to get started may be driven by early successes in the financial services. For example, IBM Global Financing extends credit to thousands of partners who purchase from IBM suppliers. It has piloted a blockchain for dispute resolution that can handle the 2.9 million transactions that lead to an average of 25,000 disputes annually and tie up about USD 100 million in capital. By transferring data to the blockchain, IBM has reduced dispute resolution times from more than 40 days to fewer than 10, improving capital efficiency by 40 percent.

**Friction in freefall**

In our first blockchain study, "Fast forward," we examined the potential for blockchains to eradicate the kinds of friction that hold companies back, limit their growth and constrain innovation.[2]

We found that all electronics organizations expect blockchains to diminish most of the sources of friction we identified. But Trailblazers stand apart from their later-to-market peers in one respect. They're 36 percent more likely than others to expect blockchains to help them gain advantage from previously inaccessible information.

The information electronics organizations can't easily access may sit at the edge of the Internet of Things (IoT) and be difficult to share due to the sheer volume of data streaming from devices. Or it may reside in another organization's database and isn't shared for fear of relinquishing competitive advantage. But on permissioned blockchains, the identity of the party can be masked. An OEM could acknowledge receipt of goods, for example, without revealing the name of the vendor to others in the ecosystem.

With increased access to new sources of information comes enhanced visibility. Trailblazers anticipate that this increased transparency could lift the burden of complying with restrictive regulations, where the complexity of multi-tier organizations masks accountability and constrains the choice of partners. Likewise, with access to more information from blockchains, threats that were once invisible — new and unanticipated business models and competitors — could be detected before they disrupt business (see Figure 4).

**Figure 4**

*Path to growth: Trailblazers identify the three frictions that blockchains can most reduce*

# First moves on blockchains: Where to start

Many organizations recognize that they can use blockchains to address complexity and greatly reduce the time, cost and risk associated with intransigent processes. For the electronics industry, the technology is particularly well suited to aspects of the supply chain, which is a good place for electronics organizations to start.

**Brand protection and risk prevention**

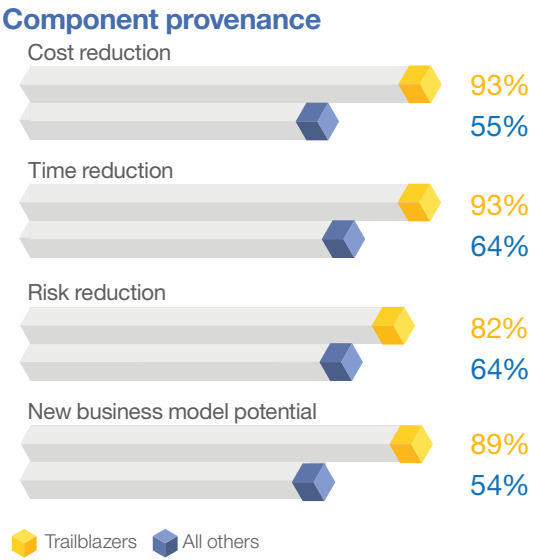
Blockchains can help trace the provenance ofgoods (see Figure 5). This feature is useful in helping companies detect counterfeits and conflict minerals, thus protecting their brand reputation. Avoiding counterfeits helps to ensure that customers get the brand quality and experience they expect. Likewise, blockchains that trace the minerals that go into electronics and assure they don't come from conflict zones protect brand reputation and simplify regulatory compliance.

When electronics supply chains are several tiers deep, managing components and compliance can be difficult. Suppliers and OEMs can be far removed from finished goods. On blockchains, however, data can identify and follow components wherever they go. Proof of ownership, location in near real time, even the condition under which goods are transported can be captured, shared and stored to become a trusted audit trail.

Tracing component provenance on blockchains is already preventing the transfer and sale of conflict diamonds (see sidebar, "Forever safe"). Blockchain technology could help to assure that no one tampers with or changes minerals coming from compliant, non-conflict mines as they move through production, from smelters to component manufacturers and product assemblers. Proof of compliance for trace minerals — especially around batteries — could accompany the product, easing barriers to entry in some localities.

**Figure 5**

*Percentage of respondents who anticipate significant business benefits from component provenance on blockchains*



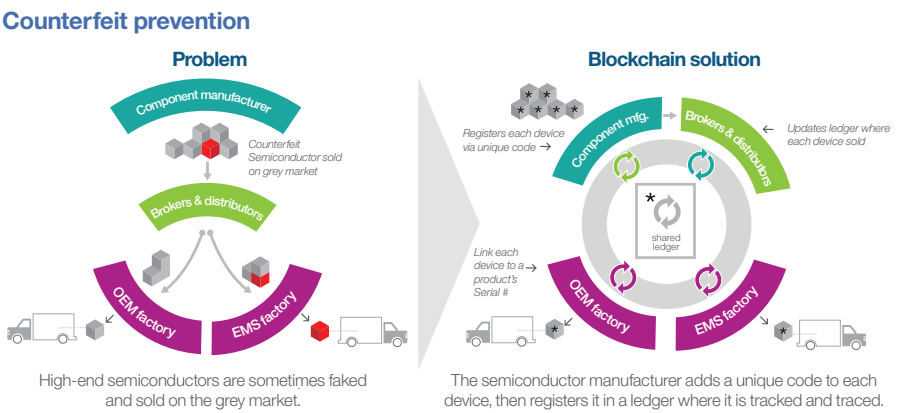
### Forever safe

London-based Everledger is helping companies track the provenance of diamonds. Everledger's solution replaces paper documents, which are easily forged and separated from shipments, with data on the blockchain that can trace each individual diamond. As a result, "blood diamonds," which are those produced by forced labor, can't enter the market, and a stolen diamond can be traced in perpetuity, easing the risks for insurers.

In a similar manner, provenance could be applied to counterfeits. In the semiconductor sector, counterfeits may pass initial tests but then fail once they are in the field, creating enormous liabilities and reputational risk. Attempting to determine authenticity by testing can add delays and costs to the process and may not always be effective.[3] Registering semiconductors on a blockchain could strip out the costs from intermediaries and even deter bad actors from the outset (see Figure 6).

**Figure 6**

*Counterfeit prevention: An immutable audit trail*




Manufacturers of mission-critical military and medical products may be the earliest adopters of blockchain-enabled provenance solutions. Ultimately, the technology could benefit nearly every manufacturer of products with advanced functionality — everything from smart phones to home appliances.

Regulators in many industries are already working with organizations to develop blockchains that establish the origins of goods, the chain of custody and an immutable audit trail.

Companies can use blockchains to track the disposal of electronic waste and even certify that goods have met energy requirements. Because there are so many tiers, it has been difficult for partners to identify the source of violations. Too often, enforcement rests simply on suppliers' assertions via questionnaires and audits — and an organization's ability to get any answers runs just one tier deep. These time-intensive manual audits are one reason why the electronics industry pays a compliance "tax" on its goods and services to maintain accountability.

For each of these use cases, blockchains can help organizations support the audit process by maintaining a distributed and immutable ledger.

**Managing the virtual supply chain**

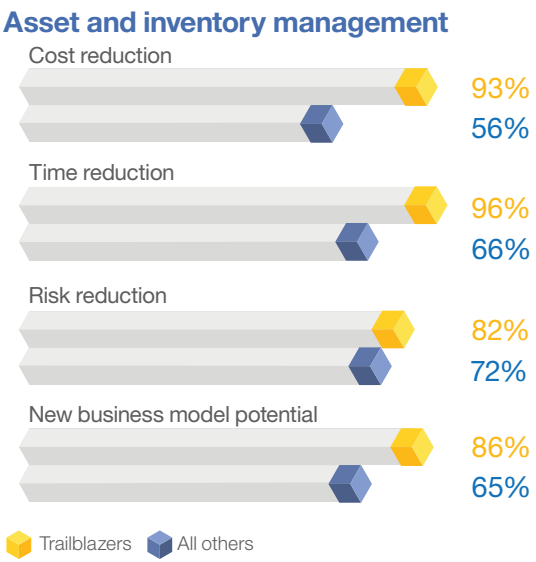
Blockchains can help OEMs understand precisely where their products are. This insight is especially important in cases where the OEM may never actually come into contact with the product, instead managing its movement from EMS provider to 3PL provider, then on to the customer. Applying blockchains coupled with analytics and cognitive capabilities, electronic companies can extend visibility end-to-end, creating new opportunities for dynamic, just-in-time optimization across value chains.

For the electronics industry, the average gross value of inventory as a percentage of revenue is 10 percent.[4] Blockchain-enabled asset and inventory management strips out the high costs of complexity that arise from multiple sourcing providers, asset transfers and local production requirements (see Figure 7). The technology also readily extends to other blockchain applications. When a cellphone is already identified and tracked as it moves from the warehouse to the retailer or consumer, it can be linked or extended to blockchains that manage later stages in the lifecycle, like preventing fraud and improving services related to warranties.

*"Radical visibility from blockchains should make it far more efficient to comply with certainty to complex regulations," says Wayne Balta, Vice President of Corporate Environmental Affairs and Product Safety at IBM. "And I believe forward-thinking electronic companies will also use that new transparency to better manage their environmental stewardship and enhance their brand to consumers."*

**Figure 7**

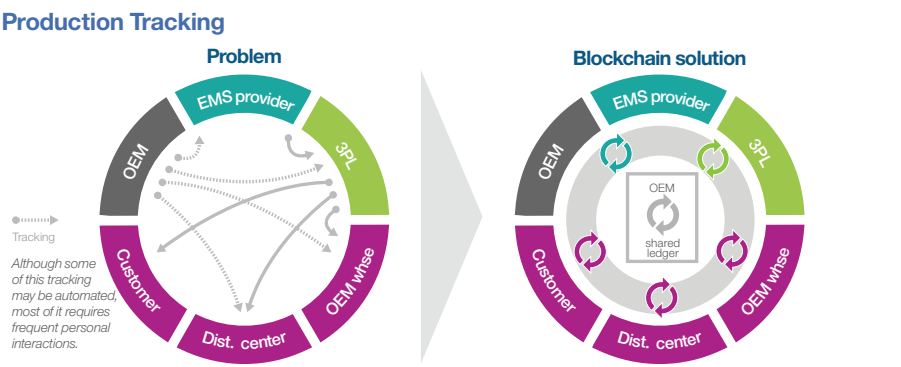
*Percentage of respondents who expect significant business benefits from blockchain-enabled asset and inventory management*




OEMs spend an enormous amount of time determining how many products EMS providers have completed and tracking those goods as they are shipped to the OEM's warehouses or direct to customers. Products registered on blockchains can be tracked from the EMS's production line to each possible destination (see Figure 8).

**Figure 8**

*Tracking products on blockchains*




OEMs working with EMS providers can spend a large amount of time tracking and determining exactly how many products have been completed.

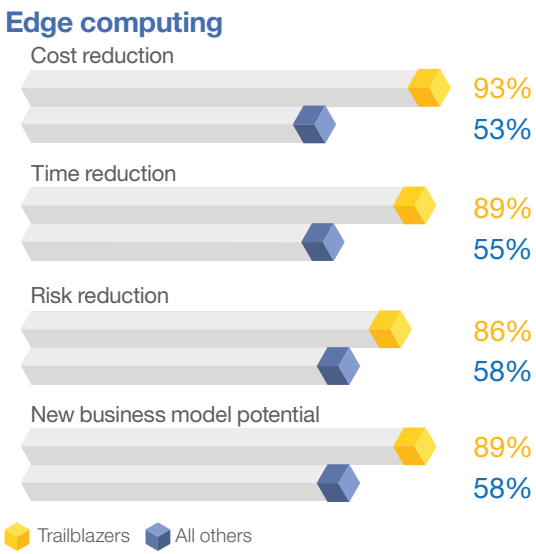
Use a blockchain shared ledger to track and trace product all the way from the EMS's production line, through the shipping process, to each possible destination.

For the most part, tracking systems, like manufacturing execution systems that monitor work on the factory floor, have been limited to the activity of a single organization. With blockchains, a cross-company tracking system becomes viable. Once this chain-of-data is established and updated in near real time, organizations can spot sudden disruptions or bottlenecks — the shipment of partial orders, goods held at a customs port or parts that don't pass certifications and quality tests — as they occur.

By extending the chain of custody throughout the field service phase of a device's lifecycle, an organization can detect anomalies and thwart a range of fraudulent activities related to warranties and services. Such anomalies include fake proofs of purchase or the misuse of exception warranties assigned by a call center when a device died during a self-service software update. Blockchains that prevent fraud could also enable new levels of customer service such as warranty extensions and insurance.

**Figure 9**

*Percentage of respondents who anticipate significant benefits and transformation from blockchains.*




# Up ahead: New business models from blockchains

As organizations gain experience with blockchains and adopt them more widely across the full value chain, new business models could begin to emerge (see sidebar, "Blockchains and parking"). For example, the technology is particularly well suited to circumvent complexity and innovate edge computing and digital marketplace business models. While these two areas are nascent at best, electronics executives identified them as having the highest potential for industry transformation.

**Edge computing: Pulling data from the IoT**

Technologists are racing to the edge. For the electronics industry, the expectation is that blockchains in tandem with edge computing could yield solid business benefits by improving the management of the torrents of data streaming from IoT devices (see Figure 9).

Edge computing pushes data analytics to the devices at the edge of the network, negating the need for data to return to the cloud for processing. Blockchains could secure each network node with a unique ID that verifies the identity of IoT devices and the integrity of the data that stream from them.

An embedded sensor could provide an indelible history of parts from manufacture and assembly through the supply chain, potentially including critical events that affect life or scheduled maintenance. This information could be shared on a blockchain with supply chain partners, OEMs and regulators in secure way.

A shared IoT and blockchain ledger maintains a record for usage, maintenance, warranties and replacement parts. In the event of a recall, the ledger can pinpoint specific batches of parts that may fail, avoiding a broad retraction.

Organizations can achieve greater transparency of true history when they have proof of good parts, completed maintenance and certifications. This transparency increases confidence and safety because replacement part origin and all services are indelibly recorded. Moreover, insurers, lenders and warranty service providers can recognize new business opportunities. [5]

The sharing of data from IoT devices through single routers and the computational cost of verifying transactions are just two of the obstacles constraining the kinds of low-latency, high-reliability networks that could fuel the Industrial IoT. For the time being, the technical challenges are steep. However, the payoff could be extraordinary. By one estimate, companies could recover as much as half their annual maintenance budget by continuously monitoring the current status of their equipment to predict and take corrective actions.

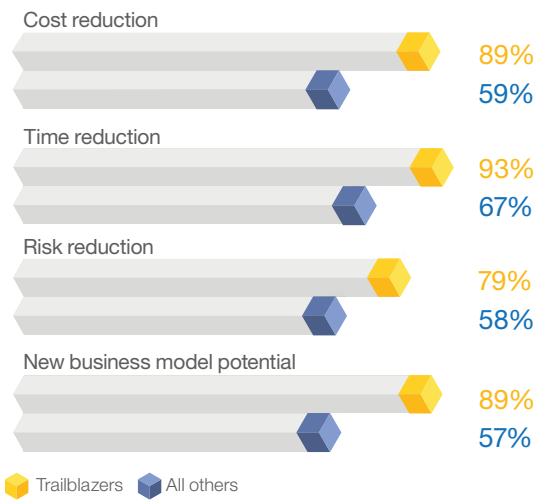
As edge computing and blockchains advance in capability and become integrated or interoperable, operations could reach peak efficiency and flexibility. Any number of new business models becomes possible.

### Blockchains and parking

The IBM Watson IoT Blockchain Parking Meter uses a mobile phone to transfer an asset — in this case, the use of a parking space for a defined length of time — in exchange for payment. It's possible that some day this same method could be used for real-time payment for electronic parts as they're consumed in production or pay-per-use consumer electronics.

**Figure 10**

*Percentage of respondents that anticipate significant benefits and transformation from blockchains.*




## Digital marketplaces

Few electronics organizations — with the exception of consumer products — are as yet obtaining significant value from digital marketplaces. But they do see the potential to radically change the way they engage clients and business partners (see Figure 10).

Of the eight areas we surveyed, a blockchain-enabled digital marketplace is the one area where organizations anticipate significant disruption. Two-thirds of Trailblazers expect these new blockchain-enabled marketplaces to spark significant disruption, compared to 7–14 percent of Trailblazers in all other areas.

As more organizations anticipate a higher percentage of their revenues shifting into services, digital marketplaces that support blockchain-based peer-to-peer messaging and transactions could be more widely used. This could significantly improve services related to Enterprise License Agreements and traceability to software updates, for example. Smart contracts could automatically track consumption, recording every time a software license is pulled down for use and when one is returned to the pool.

Tracking clients' software usage virtually rather than relying on after-the-fact in-person audits could ease the tensions so common to these encounters. Functionality could be extended to provide "at a drink" level usage — scaling up or down as needed and layering potential services, such as cognitive agents and recommendation bots atop.

Blockchains could also facilitate an entirely new approach to safeguarding, managing and exploiting intellectual property rights. New blockchain enabled proof-of-existence platforms are already in use today, primarily to register copyrights for creative content like music. New digital markets for downloading music are expected to arrive in 2017.

Just as they have for copyrights, blockchains could provide an indisputable record of intellectual property managed across jurisdictions, enforcing ownership while at the same time supporting new models for licensing. Payments automated via smart contracts could be efficiently divvied up among multiple owners, investors and users.

Because of the complexity of cross-jurisdiction registry and licensing, the transaction costs associated with managing licensing has constrained how organizations exploit what could be one of their biggest assets. With blockchains, it's possible to efficiently manage even minor or infrequently used intellectual property. Ultimately, intellectual property could become a revenue generator rather than a cost center for companies.

### For more information

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# Recommendations

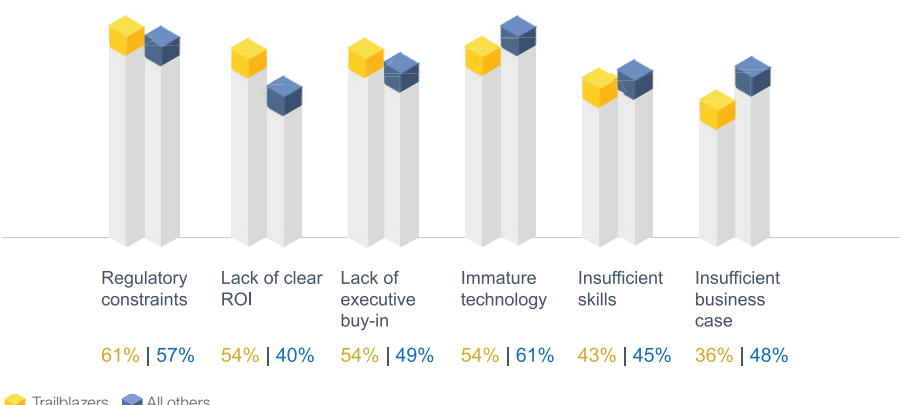
### How fast should I move?

Fourteen percent of electronics industry respondents — the Trailblazers — have already started. These organizations are setting a fast pace and charting a direction for early advantage. Mass adopters can look to Trailblazers for lessons learned, but they should be prepared to join them as soon as possible. Organizations should be conducting deep dives into business areas where complex processes are proving most inefficient, then talking to key partners to conduct joint root-cause analysis.

Sixty-one percent of respondents are concerned that regulatory constraints could stall adoption (see Figure 11). But because blockchain transparency could make it easier to enforce and to comply with regulations, regulators have every reason to collaborate with institutions in the electronics industry.

**Figure 11**

*Stalled at the gate: Barriers to adoption*



**Can we achieve network-wide standards?**

Trailblazers are already working on the new business and technology standards required for scale. Mass adopters should join them and begin building strong partnerships, including joining the consortia that are establishing business standards today.

Fifty-four percent of organizations view lack of ROI, executive buy-in and mature technology as barriers (see Figure 11). Technical standards may be established with projects like Hyperledger that focus on open standards and interoperability as well as privacy and security.

Concerns about ROI may in part be a reflection of the complexity of the industry's value chain. Instead of getting mired in the analysis paralysis that comes with ROI, organizations should keep in mind that in these early stages, what's most important is to learn. Rather than waiting for more proof points, move forward to experiment, monitor results and then refine those learnings. Once organizations have done that, they can get a much better handle on ROI.

**Related publications**

Cuomo, Jerry; Shanker Ramamurthy; James Wallis et al. "Fast forward: Rethinking enterprises, ecosystems and economies with blockchains." IBM Institute for Business Value. June 2016. ibm.biz/blockchainstudy

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**Where should I start?**
Ask yourself if the issue you've identified is common across the industry. Although blockchains that are limited to a single enterprise and its trading partners do have value, industry-wide issues are more likely to gain traction and be adopted by others. Since virtually all companies will, over time, work with new partners, you will likely soon be out of synch if only your current partners adopt your solution.

**Can we scale with new revenue models?**
Consortia lay the groundwork for a better understanding of blockchains' benefits, but many in the electronics industry already recognize that more focused collaborations with a few key partners are more suited to innovating business models.

Although respondents in our study weren't too concerned about the potential for disruption, electronics organizations that take the long view on transformative change should keep an eye on the application of blockchains that link to the IoT. New revenue models, including consumption-based pricing, are most likely to emerge here.

## Notes and sources


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2 Cuomo, Jerry, Shanker Ramamurthy, James Wallis et al. “Fast forward: Rethinking enterprises, ecosystems and economies with blockchains.” IBM Institute for Business Value. June 2016. ibm.biz/blockchainstudy

3 del Castillo, Michael. “UBS Unveils Blockchain for Trade Finance at Sibos.” Coindesk. September 29, 2016. http://www.coindesk.com/ubs-blockchain-prototype-trade/

4 IBM Institute for Business Value benchmark analysis. 2017.

5 “Trusting the transaction of things: IoT and blockchain intersect.” IBM. 2016. http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=WWS12352USEN



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