The ever-growing intersection of IoT, AI and blockchain

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The Internet of Things (IoT), artificial intelligence (AI) and blockchain technology are each transformative in their own right, but the combination of the three will prompt major disruption to established industries and modes of commerce. This spotlight report explores the ways in which these technologies will transform how companies work and provide value to customers, and how individuals interact with each other and with governments.

THE 451 TAKE

IoT, AI and blockchain are interlinked and together form the basis of a potentially radical change in the way we live and work. Simply put, IoT provides the data while AI provides the brains and blockchain the rules of engagement. Removing long-standing inefficiencies, automating and democratizing trust and creating new business models and value chains are just some of the many opportunities that these technologies can enable. However, at the junction of IoT, AI and blockchain there are not only exciting new opportunities, but also challenges and fears that need to be carefully considered and addressed.

THE VALUE OF IOT, AI AND BLOCKCHAIN

The fundamental value of IoT comes from the creation of a digital overlay onto our physical world as more devices become connected, monitored and controlled. With these digital twins, individuals and organizations will be able to expose the active status of the world around them, anticipate potential failures and create entirely new value chains.

The magnitude and complexity of data that is created by digital twins of our physical world would be beyond the ability of humans to process – this is where machine learning comes into the picture. General data analytics using basic algorithms can find patterns and trends in data, but in the field of machine learning, approaches exist that adjust and learn from data in a feedback loop. Some of these approaches uncover patterns that would otherwise be invisible to humans. Some of the approaches use principles based on how we think the human brain acts with its neuroplasticity, others simply use richer mathematics. The result is a new understanding of disparate data sources that can be presented to people for interpretation or acted upon automatically to improve processes.

But do we trust all this data that comes from disparate sources and devices? Blockchain can essentially provide that trust by verifying the identity of things and individuals connected to a network and establishing an immutable record of the provenance information all the way back to the source, without the need for intermediaries that add inefficiencies to the process. It can also help unlock the value of data by adding a mechanism for the exchange of value that is able to monetize the wide array of data that individuals or businesses capture at the edge through sensors and other devices.

Smart contracts (self-executing code running on blockchains) in particular will play a critical role in formalizing and automating the relationship between individuals, machines or organizations; for example, by ensuring payment of funds upon certain triggering events or imposing financial penalties if certain conditions are not met.

IMPACT ON ECONOMY AND SOCIETY

IoT, AI and blockchain are complementary technologies that are more valuable together than apart. This powerful combo holds the promise to the rise of an economy that is more automated, decentralized and trusted, and is driven by data. Its impact on both economy and society is expected to be gradual but profound, intertwining our business and personal lives more than ever.

Cities will eventually be equipped to monitor, report and react on all sorts of everyday life issues from streetlight power consumption to traffic patterns. Governments will become more (or even fully) digital in order to improve the citizen experience by focusing on speed, ease/convenience and transparency of interactions and transactions, while empowering citizens and giving them as much freedom and control over their own lives as possible.

Estonia is a good example of a digital nation with its digital initiative, e-Estonia, that was created to save time and money and facilitate citizen interactions. For example, each Estonian citizen has a trackable e-health record.

Citizens are identified by their electronic identity card and their medical data is accessible only by authorized individuals (e.g., other healthcare professionals). When a record is accessed or altered, the activity is logged into the blockchain, and a 'keyless signature' (timestamp) is returned and stored with the record, and the blockchain verifies who made the changes. Estonia's e-health services leverage the country's national electronic identity (eID) infrastructure – eIDs are used as unique patient identifiers – and its data exchange platform X-Road, where all databases (e.g., education, healthcare, tax, police) are digitally linked. Estonia has also launched an e-Residency program that allows anyone in the world to apply for a transnational digital identity, which can be used for establishing and running a location-independent company, signing contracts and documents digitally, accessing banking and other business services, and accepting payments.

We believe that many industries will be disrupted by IoT, AI and blockchain technology. For example, the internet alongside mobile applications has already brought disintermediation to transportation services, such as taxi companies, by empowering individual drivers to share rides through multiple services. A new combination of machine learning and sensors is powering the development of advanced driver-assistance systems and autonomous vehicles, which will once again disrupt traditional transportation services by eventually removing the driver entirely. Blockchain technology will allow these autonomous vehicles to verify the accuracy of the data collected from the environment and to automate certain operations such as payments based on predefined (and preprogrammed) terms and conditions without the involvement of third parties.

Multi-stakeholder environments such as supply chains will work more efficiently and transparently by adopting these technologies. Having a single source of truth – an irrefutable record of transactions or sensor readings – will disintermediate many current, often conflicting, systems of record that have been used to confirm data provenance. The impact of this disintermediation and inherent (automated) reconciliation will certainly be sizeable, given that there are industries that exist solely for information arbitrage.

In a manufacturing context, for example, the use of IoT combined with distributed ledgers, recording actions will offer an auditable trail that allows for confirmation that a task has been completed, which ensures not only supply chain quality in aftermarket services but also regulatory compliance in pharmaceutical production, among other things. Another example is that of the food ecosystem. IoT and blockchain technology will allow food to be tracked from farm to fork. In the event of food contamination, these technologies can assist retailers with quickly identifying the problem source and removing only affected items from shelves, rather than having to remove all stock of that type. Blockchain technology can also make just-in-time delivery more reliable, allowing optimization of the cold chain for fresher production. AI allows for identification of local trends to reroute goods to the right store based on real-time trend analysis. Being able to process multiple streams of data, with machine learning support, will help deliver more dynamic and timely responses.

Essentially, decentralized markets of any goods – commodity, music, pieces of art – will rely on these technologies to function properly. Imagine a scenario where commodities such as coffee beans are digitized and traded near real time – basically, the farmer will be paid while out in the field based on the preprogrammed terms and conditions of the relationship between the buyer and the seller. Being able to digitize and directly trade any asset around us has unimaginable potential.

EXCITING DISRUPTION BUT NOT WITHOUT FEARS AND CHALLENGES

Alongside promises and opportunities at the intersection of these three technologies, there lie challenges and threats to existing modes of trade. The automation of previously manual or human-assisted processes will inevitably bring about labor disruption for both blue- and white-collar jobs. Therefore, industry and governments must plan for redeployment of the current workforce by looking into how technology can be used not only to automate existing jobs, but also to create new jobs at skill levels achievable by those whose livelihoods have become obsolete. Artificial intelligence, in particular, has created fear and uncertainty in connection with the automation of many manual and knowledge-based jobs, as well as the discriminatory impact on certain classes of individuals due to bias in the data that feeds these systems or in the algorithms used. Development of corporate codes of conduct and internal policies and training can help avoid unintended or adverse consequences of engaging with these new technologies. Blockchains hold the promise of solving the truth/trust deficiency of the internet and digitally mediated interactions, but they also present business (e.g., governance) and regulatory challenges.

Early assessment of the legal and regulatory risks associated with data that is shared or exposed by these technologies will be necessary. In particular, issues regarding data privacy compliance have been getting substantial attention, especially since the General Data Protection Regulation (GDPR) entered into force in the European Union earlier this year. Assessment of data rights is desirable not only to support compliance with regulations, but also to help avoid putting at risk trade secrets, infringing the rights of individuals or undertaking significant cybersecurity risks.

Legal issues have arisen in the context of smart contracts too. In particular, there is uncertainty around their legal enforceability and the applicability of jurisdiction and arbitration. There is a strong desire in the blockchain community to move away from conventional thought processes of execution and enforceability; however, moving law to the digital space presents plenty of challenges. There are complex contractual arrangements that are very difficult, if not impossible, to program into a smart contract. Also, bugs in the code could result in breach of contract and financial losses. Much needs to be done before we can get to a stage where a smart contract can achieve the same desirable outcome as a legal contract. Lawyers and developers will need to work together on overcoming barriers, and for now, the best course of action is to find those immediate applications and simple transactions where smart contracts can help reduce transaction time, cost and risk.