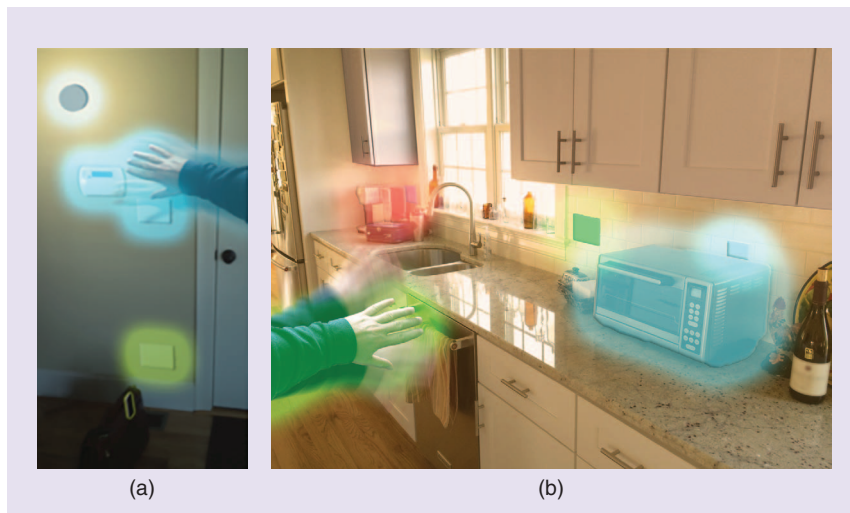


By early 2016, Pabellon achieved another major milestone: a first touch-free control panel using solely the body's electrolytes to control a matrix of magnetic pixels. Unlike conventional passive near-field communication technology that relies on receiver loop antennas for detection and identification, the magnetic pixel needs only our body salts to work. Each pixel represents a discrete sensing element. When arrayed or matrixed, the collection of pixels can be used to position index fingers approaching but not touching the surface. Pabellon's power-transfer emitter turns into a touch-free pad. Unlike motion and other optical-sensing methods, the position of objects like fingers can be resolved by small changes in the magnetic near field. The ability to finely control the vast amount of things we contact on a daily basis may not require contact alone. The magnetic pixel has a very exciting future in the look-but-don't-touch world that Pabellon envisions.

ABOUT THE AUTHOR

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The subtle changes of a finger or hand approaching the pixel can be used to detect both (a) presence and (b) proximity to the pixel surface.

Campbell, California, with chief technology officer Mike Simon. He has served as Pabellon's chief executive officer and vice president of engineering since 2015. His interests in quantum physics and near-field magnetics led to the founding of Pabellon.

His 35-year career has spanned a number of technology development

efforts in aerospace, life sciences, semiconductor manufacturing, nuclear fusion, and robotics. He is a rainforest conservationist serving on the board of Tropical Rainforest Coalition, a nonprofit working in the neotropics of Central and South America. He lives just south of Silicon Valley surrounded by beautiful wineries and very creative nerds.

How the Blockchain Revolution Will Reshape the Consumer Electronics Industry

By Jong-Hyok Lee and Marc Pilkington

Blockchains have attracted wide attention as the basis of the cryptocurrencies, e.g., bitcoin. Cryptocurrencies may or may not be the future of money, but blockchains are a different matter. Blockchains are considered a new form of information

technology that could revolutionize technology, industry, and commerce.

In this article, we analyze the winds of change currently blowing on the booming multibillion-dollar global consumer electronics (CE) industry. The revolutionary impact of blockchain technology on supply chain management is discussed as well as potential use cases for CE. We conclude by stating that

blockchain technology has the power to make the CE industry a more transparent, safer, and honest place.

BLOCKCHAIN OVERVIEW

Sparked by a wave of innovation in distributed and trust computing, we are witnessing the birth of something that could revolutionize various areas of the economy and society, called *blockchains*.

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The Blockchain France Hub defines a blockchain as “a transparent, secure data storage and transfer technology that works without a central controlling body. By extension, a blockchain is a database containing a ledger of all the transactions carried out between users since it was set up. The database is secure and distributed: it’s shared by its various users, with no intermediary, which means each member can check the validity of the chain” [1].

Beyond cryptocurrency use, blockchains are being used to build new information systems that have no central points of trust. This new technology will significantly impact the CE industry as well.

The Internet of Things (IoT), the network of connected devices, vehicles, buildings, and all other things, will be in use worldwide, and that number will reach 20.4 billion by 2020 according to Gartner’s report in 2017 February [2]. Various IoT solutions and use cases for the CE industry have been introduced that are promising to generate revenue opportunities and boost the innovation of connected things. But they are also creating many challenges, one of which is the urgent need for a secure model that must be able to provide secure communications among nontrusted things without a central controlling node.

Blockchain is also considered as a platform to provide this secure model, thanks to blockchain data integrity and nonrepudiation supports between nontrusted things. Rather than focusing on the IoT, in this article, we are focused on how blockchain impacts the CE industry, especially supply chain management.

WINDS OF CHANGE IN THE GLOBAL CE INDUSTRY

The CE industry comprises companies engaged in manufacturing of smartphones, personal computers, laptops, tablets, digital cameras, televisions, audio equipment, and game consoles, among others. Of course, all emerging technologies for enabling smart homes, connected cars, autonomous vehicles, augmented reality, and virtual reality are associated with the CE industry. The CE segment of the global electronics



The CE industry is undergoing drastic change to meet new consumer requirements.

industry is also global in scope and covers all electronic devices used for entertainment, communications, and office work [3]. The global CE industry is expected to surpass US\$1.8 trillion by 2023 and grow at a compound annual growth rate (CAGR) of over 5% from 2016 to 2023 [4].

SHIFTING CONSUMER PREFERENCES AND CHARACTERISTICS

The CE industry is undergoing drastic change to meet new consumer requirements. Under the combined impulse of cost-cutting strategies of major CE players, technological innovation, and the emergence of a sizeable middle class in emerging countries, the global CE industry is growing apace [3]. Other drivers include sustainability concerns, shrinking product life cycles, rapid obsolescence of CE products [5], regulatory change, and social-media-driven open innovation [6]. Under the impulse of rising demand and increased competition, CE manufacturers are devising new forecasting, sourcing, distribution, and inventory management strategies that are contingent on supply chain management [3].

MARKET ANALYSIS

The highest market revenues are generated by smartphones, personal computers, and televisions. The global smartphone market, which is the fastest-growing segment, was valued at US\$544 billion in 2015 and is projected to increase at a CAGR of nearly 22% to exceed US\$1.45 billion by 2020. Tablets and smart televisions will be the second and third fastest-growing segment [7].

Smartphones with enhanced features are replacing the need for other CE products, such as cameras, audio players, wristwatches, and game consoles. Therefore, the market is experiencing a decline in the revenue of the CE

products being replaced, while there is pressure to produce new attractive functions on them with lower prices. To thrive in a competitive environment, market players are offering low-cost CE products in price-sensitive regions, such as Asia Pacific, the Middle East, and Africa. Chinese smartphone manufacturer Xiaomi, which provides various smartphones with lower prices than others, has recently clocked record sales in India [8]. Market growth in North America is mainly fueled by technologically advanced products, driving consumers to replace the old products with the latest ones [3].

SUPPLY CHAIN MANAGEMENT

NEED FOR TRANSPARENCY

The European Parliament [9] reminds us that global trade is enabled by “a €16 trillion supply chain sector producers, retailers, distributors, transporters and suppliers in a complex arrangement of processes for managing contracts, payments, labeling, sealing, logistics, anti-counterfeit and antifraud.” Supply chain management pertains to the processes of planning, implementing, and controlling the movement of materials and finished goods all the way to end users. From the initial customer order to the final delivery to end users, it requires a network of contributions from retailers, wholesalers, distributors, manufacturers, and raw materials suppliers.

Currently, supply chains in the CE industry span over numerous production stages and geographical locations. Steiner [10] explains that every commodity we consume corresponds to “a journey of people, places and materials,” which makes it difficult to trace events or investigate incidents. Customers and buyers have no reliable way to verify and validate the true value of the products and services they purchase because of the lack of transparency across supply chains, which effectively means that the prices we pay are an inaccurate reflection of the true costs of production. Further, there exists no way to track any environmental damage that goes into these value chains.

Nonetheless, transparency, accountability, and social responsibility are in high demand from consumers, thereby exacerbating both reputational risks and creating new opportunities for supply chain management. This requires a new toolbox drawing on the capabilities of digital technology and big data [11].

The focus of supply chain management is defined by Anantadjaya et al. [12] as the maximization of the supply chain's profitability. For Williams [13], supply chain management involves the recreation of transparency and new relationships to enable active consumer participation and verify product authenticity and ethical standards [14].

We believe that blockchain is a revolutionary technology that enables the tracking of items through complex supply chains, as in the diamond industry, where gems are traced from mines to end consumers [9], [15]. Transparency being at the heart of blockchain technology, it is worthwhile investigating the intersection between the two fields to open new business and technological possibilities.

AGENT OF CHANGE

In its fourth decade of existence, supply chain management has witnessed numerous changes shaped by market drivers, miscellaneous industry factors, and product cycles. Yet, being fundamentally innovation led, the CE industry has been the primary agent of change in complexity management, productivity gains, and multitier inventory management. It has outperformed other industries due to its holistic focus on value network design geared at end-to-end value-chain improvements [16].

This trend has been boosted by the recent access to discretionary income by millions of consumers in both developed and developing countries. Yet, falling prices, the pace of disruptive innovation, and significant regulatory changes [17] that require more stringent methods of evaluating vendors and suppliers [18] have all intensified the challenges for the CE industry [16].

OTHER KEY CHALLENGES

Supply chain management in the CE industry has increasingly become a



Supply chain risk management is paramount in the CE industry.

collaborative effort, with manufacturers outsourcing noncore operations and retaining core competencies in design and innovation. This gives rise to the need for real-time data flows between supply chain experts and retail stores [9]. Supply chain risk management is paramount in the CE industry, characterized by vertically integrated supply chains [16]. This is achieved by means of data integration, key performance indicators tracking for suppliers, and event-tracking capabilities that can benefit from new forms of decentralized risk management enabled by blockchain technology.

HOW CAN THE BLOCKCHAIN IMPROVE SUPPLY CHAIN MANAGEMENT?

The blockchain is a distributed ledger whose two main properties are transparency and immutability [14], thereby paving the way for evident use cases in the supply chain industry.

TAMPERPROOF HISTORY OF PRODUCT MANUFACTURING, HANDLING, AND MAINTENANCE

The transfer and ownership of goods (through cryptography-based transactions) across the supply chain can be traced back on a blockchain ledger over a peer-to-peer network. For Dickson [20], the decentralization of blockchains discards the possibility of a single-point failure, while metadata, such as price, date, quality, and state, ensure the completeness of the information. The public nature of the blockchain thus ensures supply chain transparency.

Drawing on its LinuxONE system, IBM has developed a new blockchain-based service that is designed to track high-value items through complex supply chains in a secure cloud system [21]. Another stunning innovation is a fine-wine provenance-tracking service called the Chai Wine vault, developed by London-based company Everledger

[22] in collaboration with fine-wine expert Maureen Downey. Everledger had already made a significant breakthrough in the diamond supply chain [9] to ensure theft prevention and compliance with ethical standards in Africa [23]. Another rising star in the blockchain-based supply chain segment that tackles the issue of ethical standards is the London-based company Provenance [9].

DIGITAL IDENTITY FOR OWNERSHIP AND PACKAGING

As explained by Brenda Smith, executive assistant commissioner for the Office of International Trade, U.S. Customs and Border Protection [24], "Counterfeiting is often viewed as a victimless crime, but it damages the economy and can potentially threaten the health and safety of consumers." For the fiscal year 2016, the CE industry was the second most afflicted by counterfeiting in the United States, with 5,043 seizures accounting for 16% of the total [25]. In early 2017, U.S. Customs and Border Protection seized US\$1.1 million in counterfeit electronics in a joint operation with Hong Kong Customs [24].

For Irrera [26], blockchain technology provides digital identity tools for physical property and packaging purposes to enhance high-value parts of the logistics supply chain. Hulseapple [27] explains how BlockVerify, a blockchain-based anticounterfeit solution, aims to have a global social positive impact and make the world a more honest place.

TENDERING ACROSS THE SUPPLY CHAIN THROUGH SMART CONTRACTS

A European Union-sponsored blockchain solution developed by startup Kouvola Innovation, based in Kouvola, Finland, in partnership with IBM, allows for smart tendering across the supply chain. Pallets equipped with radio frequency identification tags regularly publish their needs and move down the supply chain while registering the information on the blockchain ledger. Banker [28] describes the process of bidding/awarding subsequently enabled by means of an automatic blockchain smart contract.

On 1 September 2016, a new project called SmartLog was launched by Kouvola [29]. It uses smart contracts built into shipping containers, which send location-specific information to enterprise-resource-planning systems.

ENGAGEMENT OF THE CONSUMER AND THE PROMOTION OF RESPONSIBLE CONSUMPTION

ConsenSys is a blockchain company that aims to put forward a “supply circle” [30] wherein producers and consumers actively cooperate and collaborate with local communities, thereby giving rise to the concept of the prosumer. A smart contract infrastructure provides local producers with a trustless decentralized platform whereby they share and exchange skills, resources, and products. Following the recent adoption by the French Senate [31] of a law defining a “duty of vigilance” for France-headquartered multinational corporations regarding the enforcement of human and environmental rights by foreign suppliers and subsidiaries, the idea of blockchain smart contracts was put forward [31] to comply with these new regulatory measures.

MARKETING AND BLOCKCHAIN

Matthew Winters [33], the chief executive officer at Veoo, explains how smartphone users have become the principal target for digital marketers. About 94% of smartphone users who currently use a mobile wallet have reported that they are likely to save personalized mobile wallet offers and coupons, while 82% think that digital coupons are more convenient than their paper counterparts. Because blockchain technology ensures anonymity, promotions and discounts could be sent to users via a blockchain-enabled smartphone application without disclosing users’ personal information [14].

ALL-INCLUSIVE SUPPLY CHAIN AND TRADE FINANCE PROOF OF CONCEPT

In an effort to modernize trade finance and bring blockchain capabilities thereto, the company Skuchain [9] is implementing a service of electronic letters of credit and scrip payables finance



IBM has developed a new blockchain-based service that is designed to track high-value items through complex supply chains in a secure cloud system.

through a smart contract approach, thereby providing a replacement to traditional trade finance documents [34]. Supply chain finance (notably through trade finance) as a discretionary variable and cost driver in supply chain management is relatively new. Therefore, as sketched out by Saigal [35], blockchain technology could well prove to be the virtual locus where supply chain finance and supply chain management will intersect in the future. A pilot project in Dubai [36], which associates the Hyperledger Fabric blockchain protocol and IBM’s cloud-computing resources, aims to harmonize the trade finance lifecycle and streamline the trade finance process within a single blockchain-based platform.

CONCLUSION

We have presented how the blockchain impacts the supply chain management areas of the CE industry. Ongoing initiatives and startups have been introduced with potential use cases for the CE industry. All key indicators are pointing to disruptive change in various industries. In all likelihood, the CE industry will greatly benefit from blockchain technology. It is obvious that the CE industry is taking on a new dimension with blockchain technology today.

As explained in this article, blockchain technology has the potential to ensure supply chain traceability and transparency, but it does not mean that the time is ripe yet for applying blockchain technology to all supply chain management areas of the CE industry. A lack of awareness currently exists around successful businesses using the blockchain, due to its nascent stage in the CE industry. There are a few trial balloons, and we are still awaiting the

first success stories. In addition, in many cases, applying blockchain technology into any area of the CE industry requires the full cooperation of all stakeholders, which represents a tall order and a real challenge beyond the mere technological viewpoint.

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