Seeing the Source

Using blockchain as a traceability tool in the minerals supply chain

Improving minerals supply chain transparency

The process of extracting and refining mineral ore often comes with severe risks to human rights and the environment. Without insight into the point of origin of minerals, it's difficult or impossible for companies along the minerals supply chain to address the risks specific to their supply chain. The minerals supply chain also has characteristics that make traceability uniquely challenging. For example, because minerals are aggregated and transformed at many points, it can be difficult to prove or verify a transformed product's origin. However, blockchain technology has the potential to improve the transparency of minerals supply chains, particularly from mine to smelter.

This white paper is a joint effort from Cisco and BSR that examines the use of blockchain to improve visibility in minerals supply chains. It discusses key features of what makes blockchain a unique emerging technology in this space and the efforts the electronics industry, including Cisco, is making to develop solutions that can lead to greater transparency. The opportunity is to develop innovative approaches to achieve supply chain transparency that further advances the human rights of miners and their local communities.

A Note from Cisco

Using technology to make the world a better place begins with how that technology is made. We are committed to upholding human rights, promoting worker health and well-being, and minimizing negative environmental impacts. This not only aligns with Cisco's core values, but directly benefits business outcomes, including business continuity, worker retention, productivity, and customer satisfaction.

There are a number of emerging technologies that provide opportunity to rethink our current business model and secure an ethical supply chain. Blockchain offers a decentralized way to make transactions more auditable, secure, and transparent. The technology provides incredible value by creating a framework for trusted assurance at the beginning of the electronics supply chain.

We are proud to share key learnings from our own exploration of blockchain in the minerals supply chain. Our goal is to advance the discussion around creating a blockchain minerals solution that works for everyone—from electronics brands and suppliers, to upstream mining communities, large and small.

This white paper is an invitation for other companies to help us design a solution that drives meaningful change. Our mineral traceability initiative is part of our commitment to our industry peers to push the envelope and enable more transparency for everyone. Work with us on this issue, as we learn more about the real value blockchain can drive for the entire supply chain, including the communities that live where we source our minerals and raw materials.

We believe that co-creation of these transformational solutions is the best way to generate real impact. The time for action is now—we hope you will join us.

John Kern
SVP, Supply Chain Operations, Cisco

A Note from BSR

BSR believes that it is vital for business to act within our organizations, enable peers and suppliers, and to influence the broader policy-making environment create a just and sustainable economy in a fast-changing world. We encourage businesses, the public sector, and civil society to seize this moment of technological advancements to foster environmental, social, and economic benefits for all. Our legacy of founding and launching the EICC is a clear example.

We see emerging technologies, such as blockchain, as an important tool to advance sustainable business strategies. Effective sustainability strategies must include an element of collaboration because the challenges that business now face are much larger and more complex than can be address by any one actor. Enabling suppliers and influencing civil society is a necessary step to creating opportunity in some of the most challenging parts of the global economy.

Minerals and mining have long been a challenging human rights risk for companies because it is often a long and complex supply chain to the final product. Getting a clear picture of where a mineral sourcing takes place is key to deploying resources effectively to ensure human rights are respected. New technology, like blockchain can be a powerful tool to getting traceability to those mines. However, traceability alone does not respect human rights, but inform how a company might support local communities and influence broader conditions.

BSR is proud to partner with Cisco to highlight blockchain technologies that can advance economic benefits for all. This white paper, "Seeing the Source," identifies ways that blockchain technologies can be a traceability tool that helps companies effectuate responsible sourcing strategies. We hope this paper highlights that potential and illuminates a path toward achieving it. We look forward to working with Cisco, other corporations, and a range of other stakeholders on the journey ahead.

Tara Norton
Managing Director of Supply Chain, BSR

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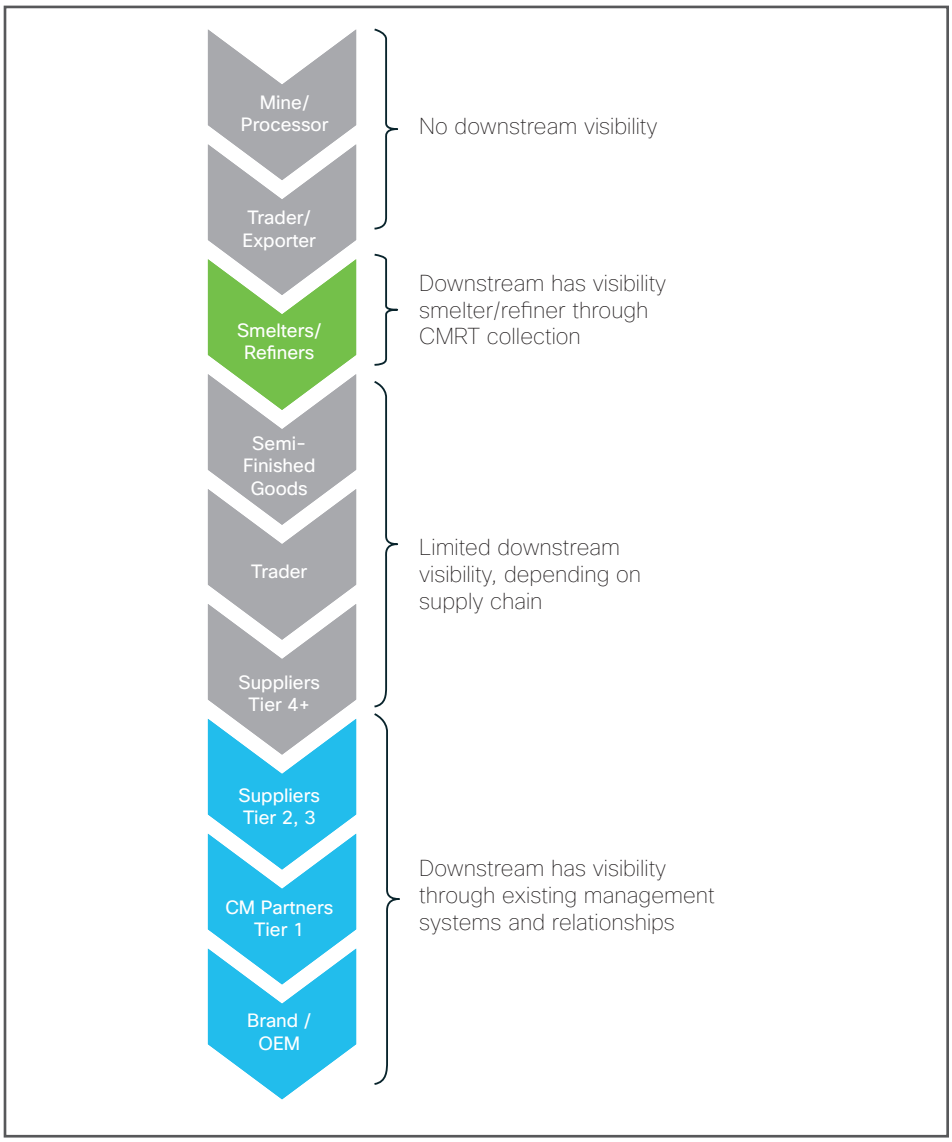
Supply chain starts at the mine

The minerals supply chain is long and complex. And like any modern supply chain, it's made up of a web of business relationships that often obscure participants beyond first-tier relationships with direct suppliers. Companies more than one tier away or without direct contracts often have little reason to share information, which can create a haze of uncertainty.

For mineral ore to be turned into an electronic component, the roughly processed ore generally goes "downstream" from the mine to a trader, an exporter, a smelter, then to a distributor, a manufacturer, and then another distributor or the end user, as shown in Figure 1.

Figure 1. The minerals supply chain and downstream visibility



Assuring sustainable minerals supply chains requires visibility to the mine of origin through this complex and sometimes opaque multi-tier network of suppliers, to address severe human rights risks and environmental impacts associated with the extraction and processing of mineral ore. Traceability isn't a solution to the root causes of human rights abuses, but traceability can illuminate where and when companies might develop ongoing programs or support experts on the ground in local communities so that miners and their communities can realize their rights.

As part of their sustainability initiatives, many companies are incorporating traceability into their supply chains, so that they can determine where and how to address those issues. However, the minerals supply chain currently has several traceability challenges.

First, implementing traceability systems is complicated by issues of standardization and competing incentives for transparency. There is a lack of standard documentation methods and processes to transfer data through the entire supply chain, especially from the extraction source to the smelter. Additionally, sharing information about suppliers could have competitive consequences for minerals supply chain participants.

Second, the minerals supply chain has many points where minerals are aggregated and transformed, such as at the smelter or refiner level. At these points, product characteristics such as size, weight, and grade may change. Proving and verifying the origin of a transformed product has historically been difficult or impossible.[1]

Finally, the remote nature of mining and a lack of access to technology, particularly at the earliest points in the supply chain, often cause issues related to both collecting and transferring data.

The promise of a system that provides trust, immutability, and selective visibility would address the challenges supply chain participants face when attempting to create sustainable and just sourcing networks starting at the mine. These, plus other attributes such as verification and the use of pseudonyms to protect confidentiality, make blockchain a viable option for providing a level of traceability, data security, and accountability that could radically transform minerals supply chains.

Foundations of traceability

The foundations of a traceable minerals supply chain were laid by collaborative industry approaches such as the Responsible Minerals Initiative (RMI), part of the Responsible Business Alliance (RBA), and the Organisation for Economic Co-operation and Development's (OECD) Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. Current responsible minerals sourcing practices primarily use third-party assessments to validate smelter- and refiner-level management processes for responsible mineral procurement. There are relatively few actors at this point in the supply chain, which makes it an effective place to focus.

The Conflict Minerals Reporting Template (CMRT) from RMI is the standard way downstream companies collect data that helps them determine possible risks and red flags occurring early in the supply chain. The CMRT has a set of simple questions that companies cascade to their suppliers and eventually send back to the requesting company to obtain a self-reported list of smelters and refiners in their supply chain.

Suppliers are willing to use this system because it allows them to preserve confidentiality in their direct supplier relationships while disclosing the smelters and refiners to interested customers. This approach is a good example of an innovative way to overcome the competing incentives around transparency.

Once the smelters and refiners in a given supply chain are identified, the RMI member companies encourage these smelters and refiners to undergo the Responsible

Responsible Business Alliance (RBA)

The RBA is an industry coalition dedicated to corporate social responsibility in global supply chains. Founded in 2004 by a group of leading electronics companies, the RBA is a nonprofit comprised of electronics, retail, auto, and toy companies committed to supporting the rights and wellbeing of workers and communities worldwide affected by the global supply chain. Over 150 RBA members commit and are held accountable to a common Code of Conduct and utilize a range of RBA training and assessment tools to support continual improvement in the social, environmental, and ethical responsibility of their supply chains.

Responsible Minerals Initiative (RMI)

Founded in 2008 by members of the RBA and the Global e-Sustainability Initiative, the RMI has grown into one of the most utilized and respected resources for companies from a range of industries that are addressing responsible mineral sourcing issues in their supply chains. Over 380 companies and associations from ten different industries participate in the RMI today, and they regularly collaborate with other complementary programs and initiatives in this area.

Minerals Assurance Process (RMAP). Specially trained third-party auditors independently verify that these smelters and refiners have systems in place to responsibly source minerals, using RMAP's audit standards. If the smelters and refiners meet those audit standards, their names are published on the RMI website. That public list allows companies to use their business drivers to encourage sourcing from the listed smelters whose practices are in line with their sustainable supply chain or responsible sourcing strategies.

First-mile visibility challenges

The CMRT is an example of the work companies at the manufacturer and end-user level of the supply chain have done to align on a common standard to gain visibility to the smelter or refiner level. However, the lack of visibility into what happens before the smelter remains a challenge.

For many smelter and refiner operations, minerals typically travel from a mine through many different hands before arriving at their site. At this point, the minerals and metals can be mixed with minerals from other sources or identified as coming from an unnamed other country. As a result, downstream companies don't know the provenance of those materials and don't have insight into mine-level or transportation risks, such as smuggling. Without information about where the minerals come from, they can't fully execute their responsible sourcing strategies at points that are upstream of the smelters and refiners.

For artisanal and small-scale mines, which produce 20-30% of the tin, tantalum, and gold in the world, implementing visibility systems is a challenge because of informal and fragmented markets, leading to a lack of leverage with traders to ensure provenance data is shared downstream.[2] These operations are also commonly found in areas with weak rule-of-law, which makes them more vulnerable to human rights abuses and other sustainability risks.

Additionally, various reports indicate that artisanal and small-scale miners generally have a lack of appropriate incentives to formalize and enhance transparency in minerals supply chains.[3] The cost of local due diligence initiatives to collect data in this segment of the chain tends to be borne by mining communities or other participants early in the supply chain. For many artisanal and small-scale miners, transparency doesn't provide any immediate gains, so it can be difficult to justify the cost.

In many cases, a lack of access to technology for collecting and transferring data presents issues. Artisanal and small-scale mines often suffer from unreliable internet connectivity, limited availability of devices, digital infrastructure challenges, and a low level of technical training. There are existing methods for using physical, paper, or plastic tags on bags of mineral ore that are then scanned into a database. This approach does provide assurance for smelters of the origin of the material, but that information is not always shared further downstream. Also, the physical tags could be sold or reallocated to non-conformant mines, or simply deteriorate while in transit, erasing the information that they contained.

Exploring traceability options in the field

Given the challenges of gaining visibility before the smelter, blockchain could potentially provide revolutionary new levels of traceability and accountability. As a contributor to the RMI blockchain working group established in 2017, and in partnership with other companies, Cisco began exploring this opportunity.

However, before even testing blockchain platforms or technologies, the team needed to gather insights about the mining context and the people who would interact with a traceability solution in the first-mile of the mineral's journey from mine to smelter.

Mineral traceability solution goals

In 2017, Cisco's supply chain organization participated in a multi-party innovation session with the Cisco Hyper Innovation Living Lab and other companies to identify key assumptions and criteria for a possible solution. The solution had to:

- Support and use cross-industry guidelines such as the RMI's Blockchain Guidelines.
- Be interoperable among blockchain and data collection applications and support the different management systems being used by supply chain participants.
- Decentralize authority to ensure that control does not rest in the hands of a single actor or one point of failure.
- Ensure that the supply chain data is secure and self-sovereign.
- Create a system that increases data sharing and that is able to distribute the value derived from the first-mile data to those who created the data in the first place.

The Transparensee traceability framework

The mineral traceability concept created in response to those criteria is called Transparensee and it has three components:

- **Tag:** Uniquely tag material as early as possible in the mining process.
- **Track:** Create a decentralized record of the lineage of materials for the supply chain.
- **Trust:** Secure the supply chain data and give the mines the opportunity to generate value.

The concept combines the integrity of digital data with the assurance of a unique digital fingerprint to provide immutable end-to-end supply chain traceability.

To implement this solution, mineral ore is given a unique digital fingerprint at its origin. Data is added to the chain of custody at each transfer point: the mine, the smelter, and the refinery.

The chain of custody data is added to a data marketplace, so it is secure and available to any supply chain participant. As a key part of this concept, the sale of data would fund investments in education and technology for mines and smelters.

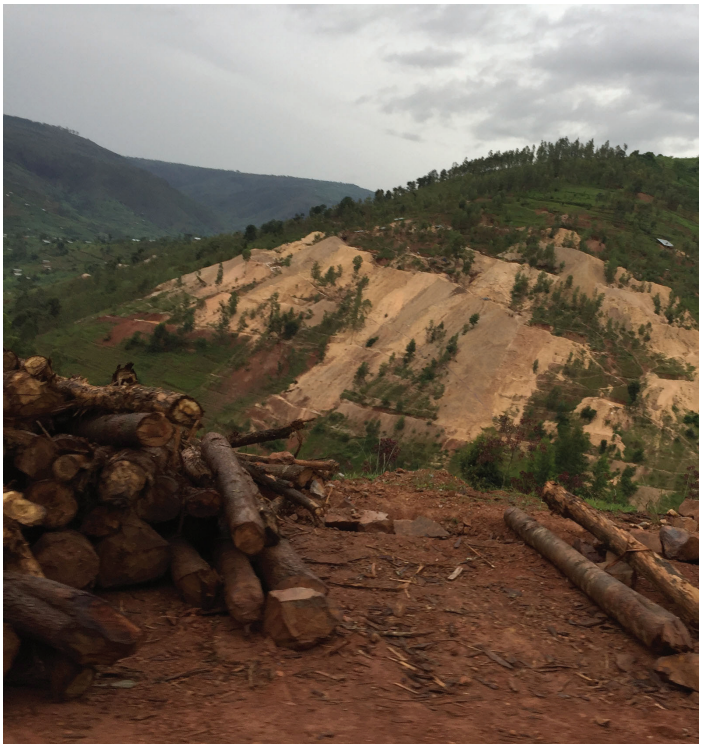
Lessons from the field study

Cisco's project team, including other downstream companies and a large-scale mining company, set out to learn more about the small-scale mining process and the larger context and politics of mineral extraction. The initial field study in Rwanda focused on interviews with miners, non-governmental organizations (NGOs), and government officials, in addition to testing tagging technologies.

During those interviews, the team tested prototypes of a smart phone application that would be used to tag and track minerals. This prototype was built on assumptions about mining workflows, types of data collected, and the experiences of the individuals working in mining operations. Using a prototype during interviews helped to validate and invalidate those assumptions quickly, and elicited more meaningful feedback about the proposed solution.

From their research, the team learned a number of other important lessons, which continue to move the initiative forward.

A hillside near mining operations in Rwanda.



Cooperation is important

The first lesson was that conflict minerals are a systemic problem that must be solved by cross-industry and cross-supply chain cooperation. Although this point may seem obvious, it's important to recognize the limitations of mapping a single company's supply chain, as opposed to a more open and inclusive approach.

If a company maps and implements traceability systems in its own supply chain without an industry effort to shift the market to responsible sourcing, inconsistent messaging to suppliers may disincentivize them from changing their practices or require them to manage multiple different systems for sharing data. In addition, the adjustments and interventions in the system need to be developed directly with mining communities because the local context varies in terms of mining operations, environment, and relationships. Any solution needs to be adaptable to the specifics of a given site or participant.

Reinforcing good behavior is necessary

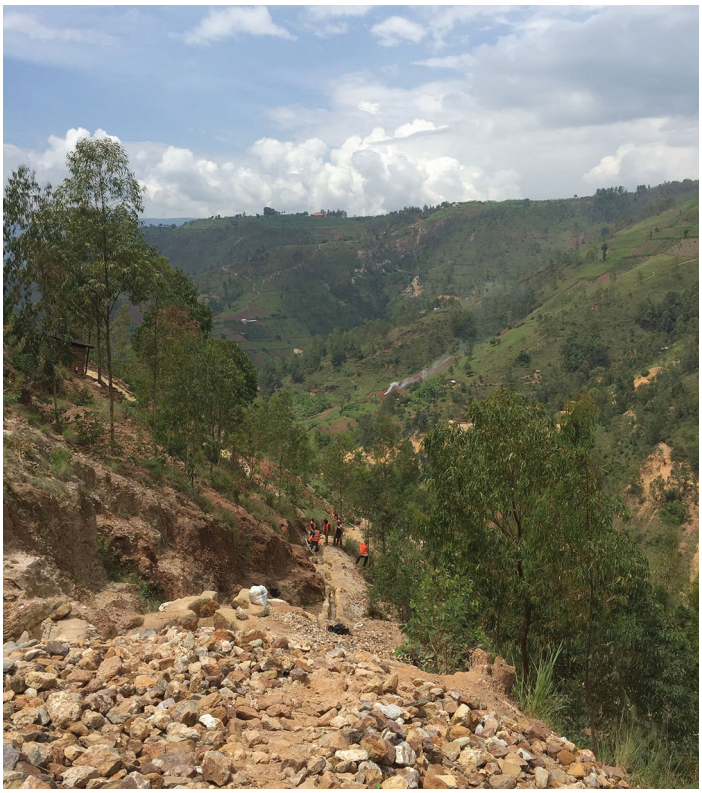
A second important lesson was that creating feedback loops to reinforce transparency are key to supporting mechanisms that encourage sustainable mining practices and disrupt entrenched corruption and human rights violations. One-time actions or single interventions are unlikely to influence the pressures and drivers of unsustainable practices.

The downstream companies also need feedback loops to determine which first-mile data is meaningful and creates values in their supply chain. Identifying metrics that show progress and the larger impacts of sustainable supply chains is critical to shift the dynamic toward sustainable practices.

Good data matters

The third lesson is that bridging the gap between the physical world and the digital blockchain can be challenging. In non-automated settings, there are increased chances for data entry errors or data manipulation. The integrity of the data is critical. If the digital identity on the blockchain isn't correctly linked to the physical mineral ore, the assurance of the blockchain is lost. Addressing the risk of errors or manipulation requires investment and continued innovation to make the technology more accessible to artisanal and small-scale operations.

A mine in Rwanda uses water and gravity to sort the crushed rock by size and density.



Data digitization in mining can be challenging for many reasons, including remote locations, inadequate infrastructure, and a dusty and wet environment for electronic equipment. During research in Rwanda, the project team tested tagging technologies including isotope tracers and RFID tags. The research showed that many types of tagging mechanisms provide a sufficient level of data and that it's important to have several technology options available, so mines can select the technology that is most suitable for their operations.

Not a quick fix

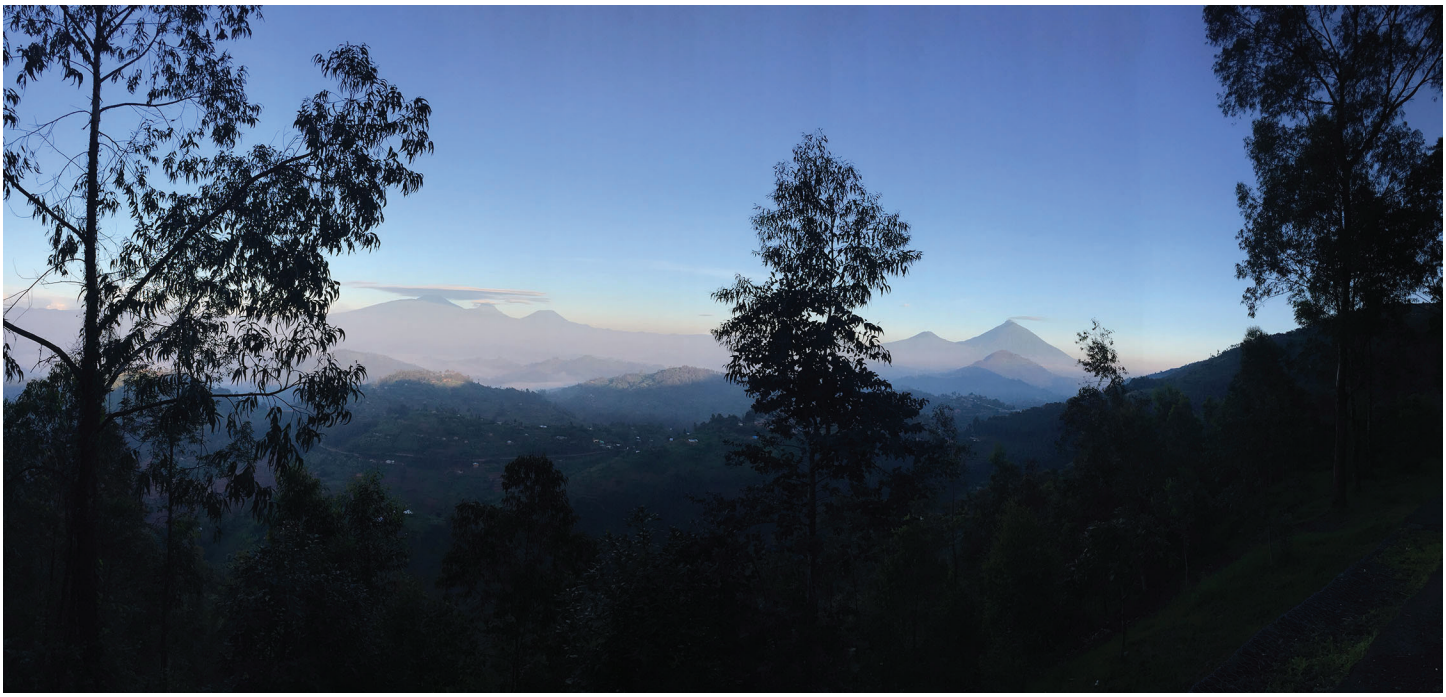
With more and better data, companies can execute their responsible sourcing strategies across the quickly evolving landscape. However, these improvements won't happen overnight or without investment and persistence. The expectations for immediate return on investments must be managed. However, the sooner the work begins, the sooner those returns will be realized.

The Cisco study in Rwanda demonstrated that data from the first-mile can be added to a blockchain and that there are workflows that can be implemented in the mining context. Beyond tracing minerals from one point to another, a blockchain traceability solution also can help downstream companies determine whether sourcing patterns can be shifted. The next phase of the project will examine exactly which data inputs help to make those shifts and determine the value of that data.

Why blockchain?

Using blockchain won't in and of itself address human rights violations, but it can be a powerful tool to overcome minerals supply chain challenges because it provides trust, immutability, and transparency. With these tools, collaboration and commitment across the supply chain, a more just and sustainable minerals market is achievable.

View of the Virunga mountains on the border between northwestern Rwanda and the Democratic Republic of the Congo. Minerals are smuggled across borders and end up in legitimate minerals supply chains.



A blockchain is a distributed ledger, which means that the entire record of transaction is available to all participants at all times. The blockchain shares information simultaneously across multiple entities that share the responsibility of maintaining and validating data.

In a blockchain, strict governance rules, cryptography, and immutability of transactions work together to provide strong security for the individuals who interact on the distributed network. The transactions are "immutable" which means they can't be changed or removed. The data is disaggregated across a distributed network of computers which, coupled with encryption, helps prevent attempts to destroy or change the record of transactions (see the Appendix for attribute definitions).

Blockchain considerations

In the case of mineral traceability, many transparency challenges stem from an absence of trusting relationships among the multiple actors across the supply chain. This is a key indicator of where a blockchain solution can provide unique value over a traditional database.

Blockchain provides assurance to customers because the records cannot be changed and each transaction is verified by the network, validating the value added by each participant. It additionally allows certain confidential business information to remain private. Blockchain is useful in situations where:

- Multiple parties need to input or update data.
- There is no trusted intermediary or central authority.
- Interaction and immutability of transactions is required.
- Transparency of interactions is necessary.
- Competing incentives inhibit transparency.

Traceability generally, and especially in minerals supply chains, faces all five of these key challenges. For example, sharing information about suppliers or prices makes many parties uneasy, even though some of that data is helpful to reduce risk for everyone. Blockchain is a tool well-suited to help companies overcome these hurdles. However, for adoption of the tool and for the success of a responsible sourcing strategy that incorporates traceability, there must be value and a clear business case created for all supply chain actors.

Blockchain and business value

Although blockchain can help overcome some challenges where trust between parties or actors may be absent, it will not succeed if those parties do not see the value in the tool or trust the broader strategy.

When a blockchain solution is designed with both business and sustainability in mind, downstream companies can use the data to make more informed decisions. They can gain insights about where to collaborate with peer companies, where to engage with policy makers and governments, and where to work with civil society. Companies can use this data to target their interventions, investment, and initiatives to support a minerals supply chain that respects human rights, justice, and the environment. For a downstream company, adding a blockchain-based traceability solution can help:

- Demonstrate a commitment to responsible mineral sourcing by reporting responsible sourcing performance at the mine level.
- Protect the company brand and reputation by allowing for greater due diligence in response to risks in mines that are known to be in a company's supply chain.
- Improve customer trust through more direct information sharing.
- Enable strategies for risk-mitigation and responsible procurement by providing sourcing teams with trusted data about sustainability performance.
- Improve operational efficiency and reduce the costs of performing due diligence by reducing communication needs, unnecessary paperwork, and data transfer errors.[4]
- Provide greater security for supply chain and compliance data due to blockchain's data encryption capabilities and decentralized structure.

There also needs to be strong value propositions for upstream actors to ensure their participation. For example, greater transparency in transactions also could help miners better understand the market for their minerals. They could obtain fair prices because they don't have to rely on unverifiable information from their customers.

Furthermore, blockchain requires unique identification of each supply chain actor to link blocks together. For miners, this digital identity might offer more direct

compensation in exchange for demonstrating responsible mining practices. Miners also could be paid not just for their mineral output, but also for the data output because the data may be valuable in and of itself. The additional value of traceable minerals over untraceable can be shared among the participants that provide traceability data to the system.

The trust, immutability, and transparency a blockchain solution can bring to bear provides a useful tool for addressing human rights issues and clear business value for all parties. However, the tool should be only a part of implementing a broader sustainability strategy that works with other committed stakeholders to confront root cause conditions leading to human rights risks.

Designing a solution

When designing a successful blockchain tool for minerals traceability, all companies should be sure to address these five design criteria:

- Blockchain is inherently a collaborative technology; it only succeeds if everyone is on-board to share data. Companies need to find precompetitive ways to work together and include mining communities from the start.
- An end-to-end blockchain solution in the minerals supply chain requires all the actors and users to agree on the type and format of data that is inserted into the solution.
- Minerals need to be tagged with a unique identifier to be traced through the supply chain. It will be important to strive for more automated tagging methods to ensure that mineral origin and quantity data is accurately recorded on the blockchain.
- Because the minerals supply chain features several aggregation and transformation points, the ability to layer verifiable inputs is required. Verification is especially important at the smelter or refiner level, where minerals from different sources are mixed together.
- The blockchain solution needs to consider and ensure that considered incentives and value exist for all of the actors in the supply chain. To motivate artisanal and small-scale mines to join a blockchain traceability solution, they need an incentive such as getting access to a global market and better business opportunities.

Other considerations

Several examples of blockchain supply chain solutions have been developed for an individual company and their respective supply chain partners, or multi-party supply chain solutions used by a limited number of players in the industry (see the Appendix for descriptions of examples). However, given the constantly shifting landscape of mineral sourcing, a cross-sectoral or industry-wide, interoperable approach would increase value for upstream and downstream participants because it would enable data to be shared across platforms.

An industry-wide, interoperable solution would require that all actors agree on the type and format of data that is shared, so everyone has the greatest flexibility. One option is the definitions and attributes laid out in the RMI's Blockchain Guidelines. For an interoperable solution to become an effective tool for responsible sourcing, however, downstream and upstream companies and other stakeholders would have to agree on responsible production standards and the role of auditors for documenting conformance. Additionally, any tool needs to share data through the complexities of the supply chain in a way that also protects confidential business information.

Finally, for a company to achieve its sustainability goals, the information gained through a blockchain solution must be aligned to an overall sustainability strategy. A blockchain traceability solution only works as part of the sustainability strategy if it provides clear business benefits. Losing sight of either the business benefits or the overall sustainability strategy may doom the blockchain solution to fail.

Learn more

To learn more about Cisco and our commitment to sustainability, visit https://www.cisco.com/c/en/us/about/supply-chain-sustainability.html

Fostering sustainable supply chains

A properly designed blockchain tool can add value to global minerals supply chains. The enhanced visibility through transparency supports the opportunity for companies to execute their responsible sourcing strategies.

However, it's critical to remember that blockchain is merely a tool to achieve minerals traceability and that traceability is only one way that companies can foster sustainable supply chains. To take the next step towards those outcomes, companies should follow these four recommendations:

- Develop a strong strategy for a collaborative minerals supply chain blockchain solution. The strategy needs to evaluate solutions for addressing and managing the considerations and factors for success, define all envisioned solution participants, assess potential vendors, and include a plan for developing and implementing the solution.
- Collaborate with all of the stakeholders who are affected by the system, including those that may not be using the system directly. Stakeholders may include companies throughout the supply chain, local communities, policymakers, industry groups, and others.
- Establish incentives that reinforce positive feedback loops and align with the goals for each affected stakeholder.
- Share the benefits of traceability data broadly to offset any costs associated with the new technology or system, with particular attention to the upstream actors from the mine to the smelter or refiner.

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4. Using blockchain to drive supply chain transparency: Future trends in supply chain." Deloitte.

5. LaPointe, Cara, and Fishbane, Lara. The Blockchain Ethical Design Framework. Beeck Center for Social Impact and Innovation, Georgetown University. 2018.

About this report

This report was funded by Cisco and written by Michael Rohwer and Mark Williams of BSR, and Joanna Dillon, Susan Daffron, and Maria Gorsuch-Kennedy of Cisco. The findings of the paper are based on:

- A review of public research, including academic, corporate, and non-governmental organization sources
- Interviews and engagement with select Cisco team members involved in sustainability, supply chain management, and technology
- Interviews and engagements with external stakeholders involved in the minerals supply chain and in blockchain initiatives

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About BSR

BSR is a global nonprofit organization that works with its network of more than 250 member companies and other partners to build a just and sustainable world. From its offices in Asia, Europe, and North America, BSR develops sustainable business strategies and solutions through consulting, research, and cross-sector collaboration.

BSR publishes occasional papers as a contribution to the understanding of the role of business in society and the trends related to corporate social responsibility and responsible business practices. It sometimes does so with partnership and financial support from particular BSR members. BSR maintains a policy of not acting as a representative of its membership, nor does it endorse specific policies, standards, products and services, or corporations. The views expressed in this publication do not reflect those of BSR members.

Learn more about BSR's 25 years of leadership in sustainability.

Appendix

Blockchain attributes and definitions

Blockchain is a distributed ledger sharing information simultaneously across multiple entities that shares the responsibility of maintaining and validating data. According to The Blockchain Ethical Design Framework, the technology can be summarized into eight attributes defined below.[5]

Term	Definition
Trust	Strict governance rules, cryptography, and immutability of transactions work together to provide strong security for individuals interacting directly on a distributed network without a central trusted authority.
Immutability	Immutable transactions recorded on a blockchain cannot be changed or removed. To change a transaction on the blockchain, a new transaction needs to be added to reverse the effects of the original. In immutable ledgers, there is no way to "expunge" the record of a transaction.
Pseudonymity	Using public and private key systems, participants have a public-facing digital "address" that is not publicly associated to them, but over which they exercise unique control. This provides pseudonymity through encryption that creates the possibility of effective anonymity for participants.
Verifiability	Transactions on a blockchain are immediately auditable in real time. As an immutable and sequenced digital ledger, a blockchain allows the complete record of transactions to be directly verified by a variety of existing systems, documentation requirements, or triangulation methodologies.
Controllability	The tracking of individual assets uniquely on a blockchain allows an individual to exercise effective and exclusive control over data or digital assets. Furthermore, transactions on a blockchain allow the secure transfer of control between individuals over the network.
Security	The use of encryption algorithms combined with the disaggregation of data across a distributed network of nodes (i.e., computers) provides security against attempts to destroy or change the record of transactions.
Disintermediated	Using direct transactions, blockchain technology can streamline processes by cutting out unnecessary intermediaries and process steps, as well as reduce the risk of errors that usually come with extra transactions in a system.
Transparency	Identical copies of the entire record of transactions are available to all participants at all times. This is often referred to as a distributed ledger. In some cases, these ledgers are publicly available to anyone. The ledger provides transparency of transactions to anyone with access.

Example blockchain applications

Although blockchain is fairly new, it's already being used in many applications that relate to supply chains. The following three examples are valuable for understanding the different ways blockchain can be implemented.

Everledger: Diamond Time-Lapse Protocol

Description and objective: The Diamond Time-Lapse Protocol is a traceability initiative built on a blockchain-based platform for the diamond and jewelry industry. The objective is to engage all industry participants including manufacturers, retailers, and consumers to provide information on a diamond's story from the origin to the end customer. It has been developed from the understanding that consumers have a strong interest in the lifetime journey of their diamonds and jewelry while streamlining the finance and insurance aspects of the market. In addition, it is based on the assumption that the industry has a desire to demonstrate authenticity, transparency, and provenance. Validation of supply chain data is conducted through a third-party inspection or self-declaration.

The solution is available and currently covers about 980,000 diamonds and is scaled to accommodate a pipeline of 10 million diamonds.

Challenges addressed: Multiple parties; Immutability required; Transparency necessary

Who is involved: Clients/users include banks, insurance companies, and diamond companies.

TradeLens

Description and objective: Blockchain-enabled shipping solution designed to promote more efficient and secure global trade, bringing together various parties to support information sharing and transparency, and spur industry-wide supply chain structure innovation.

How it works: TradeLens empowers multiple trading partners to collaborate by establishing a single shared view of a transaction without compromising details, privacy or confidentiality. Shippers, shipping lines, freight forwarders, port and terminal operators, inland transportation and customs authorities can interact more efficiently through real-time access to shipping data and shipping documents, including IoT and sensor data ranging from temperature control to container weight. Using blockchain smart contracts, TradeLens enables digital collaboration across the multiple parties involved in international trade. The platform is built on open standards and open governance, which enables TradeLens APIs to be open and available for developer access and feedback from participants in the platform.

Challenges addressed: Multiple parties; No trusted intermediary; Immutability required; Transparency necessary; Competing incentives

Who is involved: IBM and Maersk announced in a 2018 press release that 94 organizations were actively involved or had agreed to participate on the TradeLens platform.

Provenance: Increasing transparency in fashion with blockchain

Description and objective: Provenance, in collaboration with designer Martine Jarlgaard, is advocating for more transparency in the fashion industry. The goal is to track every aspect of a garment's life from textile procurement to cut-and-sew through to the consumer. With more transparency, consumers will know the clothing they purchase is not counterfeit and that it was produced in factories providing acceptable working conditions. Wash-proof chip is stored inside the clothing and can be scanned with a phone camera to unlock a link detailing each item of clothing's journey and locking in verified supply chain information from material sourcing, NGO projects and the individual craftspeople and workers.

Provenance has expanded their services and currently conducts various case studies on further integration of blockchain technology into the fashion industry.

Challenges addressed: Multiple parties; No trusted intermediary; Immutability required; Transparency necessary; Competing incentives

Who is involved: Provenance, Martine Jarlgaard, Fashion Innovation Agency (London College of Fashion, University of the Arts London), A Transparent Company Ltd., Fashion For Good, Circle Economy, Plug and Play Fashion Accelerator.