



Advanced Sensing and Blockchain Technologies Revolutionize Supply Chain Management

Introduction

As the COVID-19 pandemic disrupted supply chains across vital sectors including manufacturing, the National Center for Manufacturing Sciences (NCMS) launched an initiative to facilitate the production and distribution of critical supplies in the event of future pandemics. The collaboration brought together two industry partners, Presage Technologies and SIMBA Chain, along with supply chain and logistics leaders from the DOD. The team made two breakthroughs. First, they created a deep learning model that accurately predicts outbreaks of COVID-19 and can be used to forecast other infectious diseases. Second, they successfully used this model to automate supply and demand logistics decisions, enabling just-in-time inventory management of critical products and equipment.

This revolutionary new strategy for automated inventory management will serve the public good by helping companies to ensure that essential parts, medical supplies, personal protective equipment (PPE), and other vital products are available where needed. The forecasting model offers the opportunity for government leaders to make informed decisions to ensure that hospitals and other critical infrastructure remains operational; to sustain the unimpeded flow of water, food, and medical supplies; and to safeguard basic quality of life products and services.

Improving the Collection of Population Health and Signal Data

Before this NCMS collaboration, the collection of population health data was a slow, cumbersome process.

“Any public health information system that records Covid cases takes about five days for the process to even reach the system, but this technology provides the information immediately,” said Ian Taylor, CEO and co-founder of SIMBA Chain, which developed the project’s blockchain tools.

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—Mark Oliver, President and CEO, Presage Technologies

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“We think of this technology like a weather service,” said Mark Oliver, President and CEO of Presage Technologies, which builds software-based medical devices. “We were calling it ‘health weather’ for a while.”

The team improved the collection of population health signal data by documenting changes in the health, mobility, and economic activity of regions that impact suppliers.

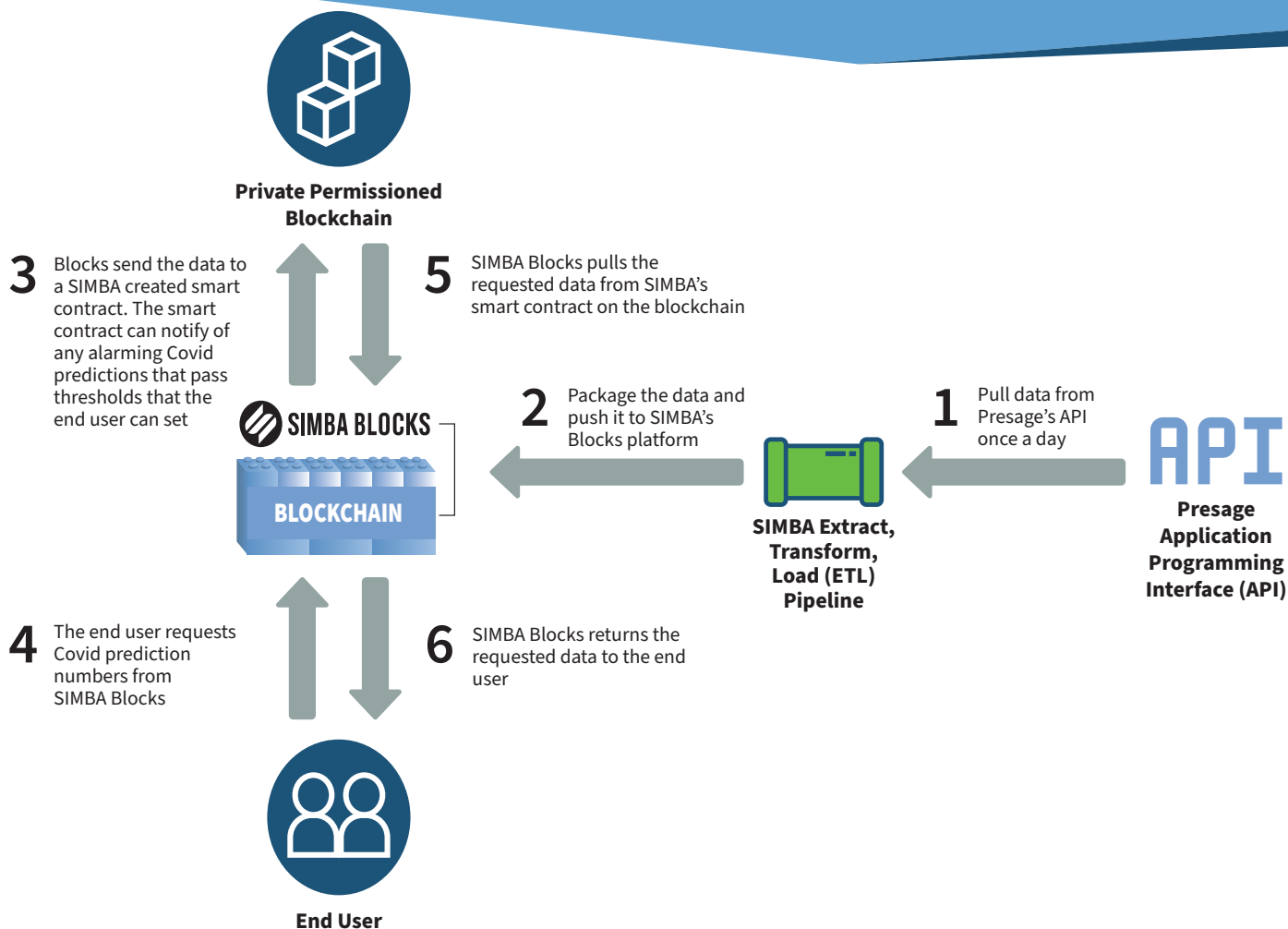


Figure 1. Solution Overview

This effort leveraged advanced sensing and aggregating technologies, along with artificial intelligence and machine learning (AI/ML) algorithms to help analysts predict future disruptions in the supply chain.

To provide the “health weather,” Presage Technologies’ team of biomedical and software engineers use remote photoplethysmography (rPPG), a camera-based, unobtrusive technology that allows continuous monitoring of changes in vital signs to help diagnose and treat diseases earlier. This technology can be used to gather anonymous vital sign metrics—pulse rate, heart rate variability, breathing rate frequency and volume, and blood oxygen saturation—from cell phone cameras.

“Imagine pulse oximeters or respiratory frequency monitors. We can do all of that now with just the camera on a phone,” said Oliver. “We’re achieving clinical-grade accuracy, and we produce vital signs metrics from videos in a privacy-oriented way. We aggregate videos into huge, square-mile blocks so that no one can ever point the health data back to any individual.”

By collecting data exclusively from social media and other open sources, the team solved a significant problem in assessing global health risks: gathering and modeling population-level biometric data in a manner that does not rely on host nations’ capabilities or willingness to share information, all while anonymizing the data to maintain robust individual privacy protections.

“We don’t want to turn this into a Big Brother tool that says whether someone has COVID-19 and possibly make them take a temperature test or kick them out of a venue,” said Dan Janes, Government Engineering Lead at Simba Chain. “We really wanted to approach it from a public health perspective by focusing on the aggregated data for a particular location.”

The team applied algorithms that provide epidemiological projections of infection rates in a specific area. They tested the accuracy of their method by using a deep learning model to forecast the actual COVID-19 infections per 100,000 people, using Germany as a case study. The collaborators checked their model’s precision against the actual infections per 100,000 people in Germany, which is reported every seven days. The results were stellar: 80% accuracy with a very low error rate, without requiring any on-the-ground information.

The data is shared via a commercial off-the-shelf application programming interface (API), a mechanism that enables two software components to communicate with each other. For example, the weather bureau’s software system contains daily weather data. Weather apps on cell phones communicate with this system via APIs, then display that data on the apps.

“Every day on the API we make available the ‘Covid weather,’ or the number of infections per 100,000 for the whole country,” said Oliver. “Any entity that we give access to our data can ping our API. Then, they can pull that data into the blockchain. From there, they have the demand-sensing piece. Now they can look at inventory and make sure, say, in the case of the flu, there is enough Tamiflu on hand.”

Using Blockchain to Facilitate Automated Inventory Management

This data facilitated the project team’s second accomplishment: using blockchain to automate the ordering and distribution of PPE and other health protection logistic items to areas in need. Blockchain is a digital, decentralized, and publicly accessible database that records transactions (blocks), across many computers, that are linked using cryptography. Each transaction contains a cryptographic hash of the previous block, a timestamp, and transaction data. As a result, data cannot be altered retroactively.

While blockchain is widely known for its role in cryptocurrencies, it is being used in multiple industries and is especially useful in supply chain management because it provides immediate, transparent access to information stored on an immutable ledger that can be accessed only by permissioned network members.

How does this technology work? First, SIMBA Chain pulls data from Presage’s API once a day. Next, the data is fed into the SIMBA Extract, Transform, Load (ETL) Pipeline—a process that packages the data and pushes it to SIMBA’s Blocks platform. Then, Blocks sends the data to a SIMBA-created smart contract, which notifies the end-user of any alarming COVID-19 predictions that pass thresholds set by the end-user.

“The way blockchain works is that a transaction comes through a smart contract, which is a piece of code that you can add logic to, and that results in something being recorded on the blockchain, which is not changeable,” said Taylor. “The data coming in and decisions being made on that data are being made available to the supply chain in a way that is completely transparent, trustworthy, and un-hackable.”

Blockchain facilitates automated inventory management because it can be connected directly to an enterprise resource planning (ERP) system to automate the ordering of needed supplies.

“If the COVID-19 rates are ramping up quite a lot, the system might order masks and other supplies, then have them shipped to that geographical region automatically to preempt the situation that’s about to occur,” said Taylor. This will ensure that PPE, medical supplies, and other vital goods are available where they are most needed.

Ensuring Supply Chain Resiliency

This new system will serve the public good by enabling decision-makers in multiple sectors to be more prepared than ever before for any significant infectious disease outbreak that

could impact the delivery of needed parts and supplies. Armed with this system, organizations will receive accurate infection predictions and integrate that information directly into their planning and ordering cycles to ensure preparedness. This data will give anyone whose organization relies on supply chain management access to critical information needed to improve their decision-making. The ability to receive advance warning of disease outbreaks will be a game-changer, helping to keep hospitals and other critical infrastructure operational while ensuring that supplies of vital goods are available to minimize disruptions to public health and economic activity.

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About NCMS

The National Center for Manufacturing Sciences (NCMS) is a cross-industry technology development consortium, dedicated to improving the competitiveness and strength of the U.S. industrial base. As a member-based organization, it leverages its network of industry, government, and academic partners to develop, demonstrate, and transition innovative technologies efficiently, with less risk and lower cost.

NCMS enables world-class member companies to work effectively with other members on new opportunities—bringing together highly capable companies with providers and end users who need their innovations and technology solutions. NCMS members benefit from an accelerated progression of idea creation through execution.