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Siemens Digital Industries Software

Blockchain in the food and beverage industry.

Traceable from farm to table

The supply chain from the farm to the consumer's kitchen table is becoming increasingly complex. Under the pressure of changing customer interests, increasing regulatory controls and growing global competition, the food and beverage industry is forced to create more transparency and gain more customer confidence.

They are increasingly interested in their food sources and want more individual products. These are just a few of the many factors driving the introduction of digital technologies in the industry. For example,the Internet of Things (IoT), Tracking & Tracing, Cloud and Edge Computing or the Blockchain.

Improving food safety and transparency
They ensure better food safety, more flexibility and reliability in production and greater transparency in supply chains. In the event of recalls, they reduce effort and costs. MindSphere, Siemens' open cloud-based IoT platform, offers the perfect way to capture data across the entire supply chain.

Pre-built blockchain applications make it easy to set up tamper-proof tracking systems. They allow sensitive information to be stored behind closed doors, while other participants in the supply chain only have access to the data they need, which is sent to the blockchain via secure cloud gateways.

Table of Contents

Trust worthy traceability Siemens is currently developing modules for existing software solutions as well as customer-specific IoT sensors that send data directly to the blockchain. This allows to detect "blind spots" in the supply chain and to create a complete traceability record.

MindSphere is able to process any data source. This combination and the use of advanced analysis functions offered on the platform can provide "trusted traceability" in the food and beverage industry.

Track & Trace solutions using the blockchain ensure complete traceability of all food and beverage ingredients and effectively help deliver on the promise of a trusted brand.

Food and beverages:
The industry is facing radical change

Today's consumers demand more variety in their food, tastier and healthier products. Industry trends such as low-sugar, gluten-free, lactose-free and locally grown food have led to new market segments in developed countries, as has the desire of consumers for convenience products that reflect their changing lifestyles.

Let's take milk as an example: around 9,000 years ago, people domesticated cows to drink their milk. Not much has changed in this respect over a long period of time.

Until about 50 years ago, a fat-free or chocolate-flavored variant was available in grocery stores in addition to normal whole milk.

Today, supermarkets have dozens of types, not including regional differences. They offer numerous products with different fat levels and flavors, as well as almond, oat and soy milk for lactose-sensitive consumers.After 9,000 years of stability worldwide, milk has become a complex and dy-namic product category.

"Selling trust" is the key to market success

This demand includes trends like low-sugar, locally grown, gluten-free, non-dairy, nut-free hypoallergenic foods, and more. Customersalso choose products that offer increased convenience, usually via specific packaging and/or preparation that fits their lifestyle.

As with this traditional drink, the market has also developed for many other foods: With special products that take into account all types of intolerances and are geared to specific consumer lifestyles.

For manufacturers, this leads to special requirements with regard to health and sustainability, and "selling trust" becomes decisive for market success.

"The consumer of tomorrow demands more transparency and new solutions", say the auditing and consulting firm PwC, the rheingold institute and the logistics standardization experts of GS1 Germany in their joint future scenario "2025: Smart Value Networks".

Tailor-made food, sustainably produced

Consumers in industrialised countries will then continue to change theirattitude to consumption and increasingly question the origin of products from a health, ethical and social point of view.

"In addition, they increasingly expect their individual needs to be taken into account and, for example, have high expectations of simplicity and convenience when buying food," the study says.

By 2025, products that are precisely tailored to the needs of individual consumers are no longer special. They are simply expected. Just like the supplier's ethically and ecologically sustainability profile, a transparent supply chain and extensive productinformation.

"Companies are well advised to know their customers as well as possible and to communicate with them in a transparent way. Through intelligent networking, the Internet of Things offers the opportunity to better understand the needs of consumers and make the desired information available to them in real time," the study concludes.
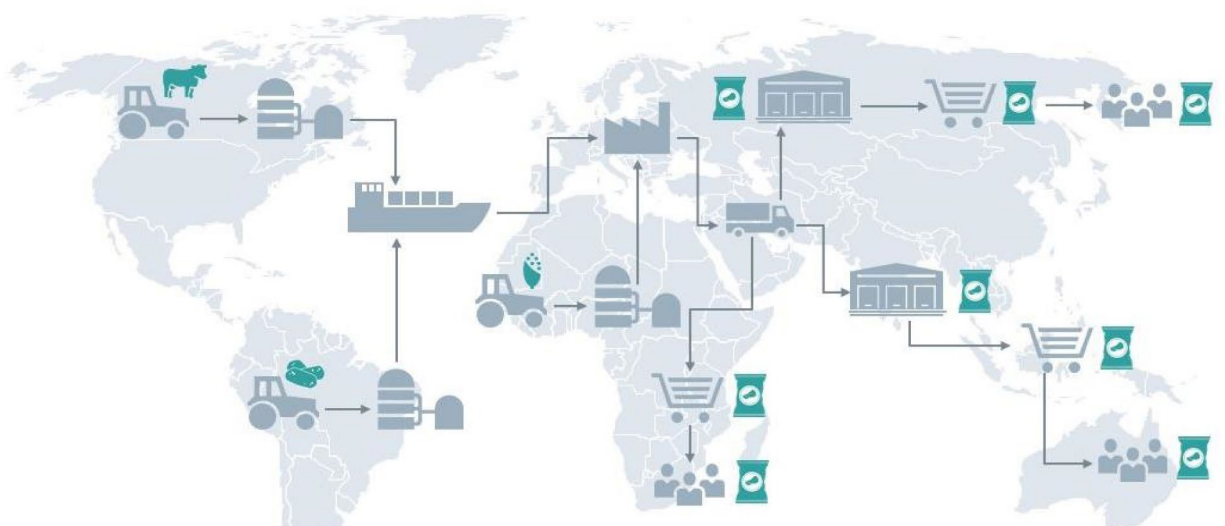
As global supply chains become more complex, food safety requirements rise,and trust issues arise. New solutions are needed to create greater transparency in the food and beverage industry.

At the same time, global supply chains in the food and beverage industry are becoming increasingly complex.

In order to meet consumer demand for greater variety and seasonal independence at competitive prices, manufacturers are purchasing their raw materials around the globe.

The aim is to effectively protect supply chains from spoilage, unintentional or deliberate tampering and product piracy.

Enormous damage caused by food scandals

Food-borne diseases, which affect one in 10 consumers worldwide every year and cause the deaths of 400,000 people[1]), cause lasting damage to the image of manufacturers and result in immense costs through recalls, legal disputes and penalties.

56% of all food and beverage manufacturers are affected by at least one recall per year. The average direct cost is €9.5 million[2]). Between €50 and €60 million additional costs are incurred due to image damage and sales losses[3]).

Increasing regulatory requirements as a result of food scandals, which have led to diseases and damage caused by food, are another challenge for the industry today.

So is the damage caused by counterfeit branded food. This global problem is exacerbated not least by the rapid growth of online retailing.

Consumers post negative experience on social media

After a bad experience, brands are shunned by consumers for an average of two years and, according to studies, they now postin 45% of cases their negative experience on social media.

At the same time, 61% of all consumers worldwide[4])say that they are more likely to buy products from brands that act responsibly –even if this means spending more money on food and drink.

Knowledge about the origin of food becomes an important argument when shopping –especially for younger people. Studies of human psychology have shown that 20 positive experiences are needed to mitigate and overcome a failure. Having a consistently positive product experience provides the basis for being a trusted brand.

15 percent of all food sold is fake

Experts estimate that about 15% of all food sold is now fake[5]). Incorrect weight claims, the relabellingof expired foods or the declaration of conventional foods as organic –given the enormous profit opportunities, the criminal energy in this sector is high. Especially since the risk of being caught in this fraud is so far rather low.

The damage is borneby the brand producers. Not only do they miss revenues of up to 13 billion € per year[6]). Even worse, however, is the health risk to consumers and the associated loss of confidence if damage actually occurs.

Track & trace solutions with the help of block chains offer the necessary transparency to successfully manage supply chains. They guarantee the complete traceability of all food and drink ingredients and effectively help to keep the promise of a trustworthy brand.

Sources:
1) Press release of the WorldHealth Organization WHO on the UN World Food Safety Day, 6/2019.

2) Joint study by Food Marketing Institute, Association of Food, Beverage and Consumer Product Companies (GMA) and Deloitte, 1/2016.

3) Capturing Recall Costs, GMA White Paper, 2/2011.

4) The Harris Poll, 2/2014.

5) UK Food Standards Agency (FSA), 2016.

6) Geo, "These foods are particularly frequently counterfeited", 5/2016.

1 in 10
people fall ill every year from contaminated food or beberages

400,000
die

15%
of food and beberages sold are counter feit and dangerous

56%
of food and beberages companies suffer at least one recall each year

€9.5M
the direct cost of a recall

€50-60
the impact on sales and reputation of each recall

86%
of millenial and younger consumers would pay more for transparent products

70%
would switch brands

Blockchain & Internet of Things:
The best of both worlds optimally combined

When the term blockchain is used, almost everyone thinks of Bitcoin. But the crypto currency is only one of the many possible applications of this technology: blockchains are digital decentralized registers that offer high trust-worthiness through crypto-graphic methods and decentralized storage.

Blockchain is a special form of distributed ledger technology (DLT), a digital logbook for transactions that are combined into a block and chained together in chronological order– hence the name "block chain".

The correctness of the information and transactions is not verified by a central authority, but confirmed by all participants using a consensus algorithm. The blockchain technology therefore offers a high degree of data integrity and trustworthiness.

Special requirements for the blockchain in the industry

With the help of the Internet of Things (IoT), it is now possible to effectively generate, manage and analyze large amounts of data.

It can be ideally combined with blockchain technology to revolutionize the food and beverage supply chain and solve many of the challenges facing the industry today in an efficient and cost-effective manner.

In the industrial environment, however, there are special requirements for a blockchain, for example in areas such as performance and scalability. In contrast to Bitcoin open blockchains are not used for industrial applications, but rather consortia –i.e.private –blockchains.

The Siemens Company Core Technologies (CCT) is currently pursuing around 150 ideas on how new business models can be created on the basis of blockchain technology.

Among the applications currently being investigated for business relevance and feasibility is improved traceability in food and beverage production.

Together with Siemens Digital Industries, CCT is developing a method to document supply chains in the food and beverages industry in a way that prevents forgery. This also involves close cooperationwith startups.

For example, Parity in Berlin is developing a modular system for blockchain applications: Depending on requirements, various elements can be intelligently combined to create tailor-made blockchains.

Transparent supply chain from barley tobottle

In the future, every supplier of a brewery –be it the hop grower or the malting plant –could store in an unchangeable blockchain which raw materials he delivered when and to whom. This makes the entire digital supply chain, from the barley grain to the beer bottle, transparent for consumers, breweries and authorities.

Using a QR code on the bottle label, consumers can then view the information with an app on their smartphone. And the brewery itself can document its supply chain at any time without any doubt, for example with its own production data and information on delivery logistics.

Together with their raw material suppliers, this makes them transparent to the consumer: a competitive advantage in the highly competitive beer market.

The "world's first blockchain beer" is now distributed

Some pioneers from the international craft beer scene, who are already experimenting with blockchain technology in practice, have proven that this approach does not have to remain a beautiful technology vision.

For example, the Northern Irish craft beer manufacturer Downstream Beer uses them to inform consumers about everything they want to know about ingredients and brewing processes. Customers simply scan with their smartphone a QR code attached to the bottle label or visit the manufacturer's website.

For each batch of the four different varieties currently brewed, they can find out which raw materials –such as malt, hops, yeast and water –have been used.

The "world's first blockchain beer" is now distributed throughout the UK and is enjoying increasingpopularity. "Our product is a radical blend of artisanal brewing techniques and the strong spirit of digital technology," the young producer advertises.

Accelerating global shipping and reducing costs

The multinational beverage and brewing company Anheuser-Busch InBev, which includes beer brands such as Budweiser, Corona, Stella Artois, Leffe and Becks, has a slightly different concept.

It does not use the blockchain in the production process, but it does use it for a trustful exchange with raw material suppliers and in logistics.Here it is intended to noticeably simplify the hitherto often cumbersome shipping process across national borders.

Together with a consortium of companies from the consulting and transport business as well as customs authorities, the brewing giant tested the solution fortwelve genuine international beer deliveries, each of which went to a different location and had to overcomedifferent regulatory requirements.

It turned out that international shipments of food and beverages today usually require more than 20 different documents in order to get from the exporter to the final consumer. This results in a lack of transparency and poor data quality.

The blockchain solution used made it unnecessary to print shipping documents and 80% of the usual data entries. By accelerating and simplifying the flow of documents throughout the entire shipping process, it is expected that hundreds ofmillions of dollars can be saved and errors reduced every year.

Connecting local producers and global supply chains

In African Zambia, Anheuser-Busch InBev, together with the blockchain startup BanQu, has launched a pilot project to connect 2,000 cassava farmers directly with breweries in the country.

These farmers, who grow raw materials for beer production, often lack the qualifications to open bank accounts. They are therefore dependent on severalintermediaries who re-duce their income.

The BanQu platform uses the blockchain to ensure that local producers are brought into direct contact with global supply chains at an early stage and can do business without a bank account using forgery-proof identities.

Application scenario:
Potato chips with certificate show their origin

Siemens is working on an intelligent solution so that recalls can be dealt with more quickly and specifically in the future. The open, cloud-based MindSphere IoT system will enable suppliers, distributors and manufacturers to collect data at every stage of the transport and production chain and store it in the Siemens blockchain.

This makes it possible to narrow down a recall to a specific batch or production day. The risk of contaminated food entering the supermarketcan thusbe minimized as much as unnecessary effort and costs for a reasonless recall.

Seamless information chain that can be viewed at any time
In a possible scenario, for example, a Frankfurt-based manufacturer of potato chips with an organic certificate who obtains his potatoes from Germany, the salt from France and the sunflower oil from Italy would have immediate access to all relevant information: From the cultivation of organic potatoes and other ingredients, their storage and transport, processing such as cutting, frying and seasoning to packaging and distribution at the retailer.

At the end of the day, the consumer is provided with a complete information chain that can be viewed at any time and guarantees that his chips consist of, for example, 100 percent organically grown potatoes and that they have been processed under optimal conditions.

Benefits for consumers, retailers and manufacturers
The transparent supply chain for food traceability ensures that products and their ingredients are safe and genuine. Wholesalers and supermarkets receive detailed information on where they were last stored. The manufacturer can identify the place of origin of the ingredients used at any time and obtain detailed information about their producers. The unchangeable time stamps provide all ingredients with a forgery-proof bestbefore date.

Click: The interactive application scenario can be viewed here.

By scanning the QR code on the chip bag, customers can track the origin and route of a product as well as retrieve detailed and batch-precise information.

1

2 Last Registered Location
Carefour, Genova, IT
20/04/2018 15:45:36

3 Production Information
Wegemans, Munich, DE
15/02/2018 12:33:15

4 Use by Date: 20/04/2019

SERIAL NUMBER
982349823984

MindSphere:
IoT operating system in the middle

The global food and beverage industry produces billions of product units eachyear. The data generated along the entire value chain would completely overload a classic blockchain infrastructure in terms of both data volume and transaction frequency.

Siemens has therefore been looking for solutions and modifications to harmonize the security and reliability of blockchain with the characteristics of the Internet of Things and to create a non-manipulable control chain.

Collecting information from multiple data sources

The open IoT operating system MindSphere acts as a mediator, buffering and filtering all useful information. This includes, for example, data from IoT sensors, programmable logic controllers or process control, ERP and MES systems.

But also,consumer feedback, weather forecasts and data from agriculture, such as the use of fertilizers or pesticides or during transport, can be processed.

However, only a certain subset of this information is for-warded via a Blockchain Secure Gateway to the Blockchain, where it is encrypted and stored with links to the remaining data in the secure private cloud.

In addition to the hardware components, the architecture of the Siemens Blockchain consists of a Blockchain Manager and a Blockchain Viewer, which are usedin a smartphone app to access the required information.

By combining new data written to the blockchain with all systems and applying advanced analytics capabilities offered on the platform, new insights can be achieved.


Global standard guarantees universal compatibility

The use of the worldwide Electronic Product Code (EPC) for the individual identification of objects, created by the non-profit organization GS1 (Global Standards One), guarantees universal compatibility.

The EPCInformation Services (EPCIS), which are based on this, enable a transparent, efficient and reliable exchange of information along the entire value chain between all parties involved.

Especially in a blockchain for traceability, products, companies and shipment units must be clearly identified.

Therefore, the message types of the global interface stand-ard include, for example, information on material, owner, condition monitoring, and production.
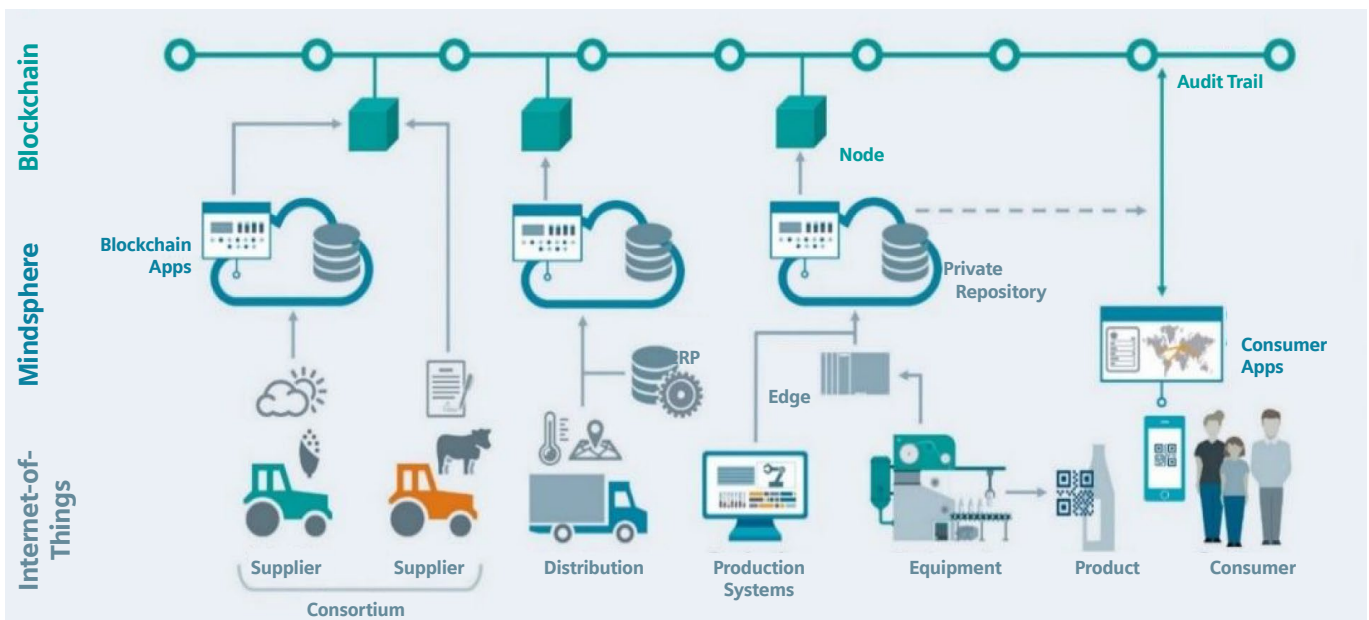
Case Study:
Seamless traceability at Hochdorf Swiss Nutrition AG

Hochdorf Swiss Nutrition AG is a Swiss specialist in the production of food from milk, oilseeds and cereals. In the new 30-metre-high production tower, one of the largest of its kind in Europe, around 75 million litres of milk are processed each year into around 30,000 tonnes of baby food.

Precise process control around the clock is essential to ensure that the milk powder has the right consistency at the end and does not become too dusty or too moist.

High hygiene and quality requirements for baby food
Hochdorf relies on modern technology from Siemens. This enables reliable 24-hour monitoring of the plant and complete traceability of the entire production process. The composition of baby food is strongly regulated – hygiene and quality requirements are high– and every processing step must be traceable.

663 digital and 637 analogue sensors continuously record parameters such as pressure, temperature or filling levels. 300 motors provide the drive and 1,700 valves regulate the pressure and flow rates of the media and ingredients required for production.

All production data is stored on a long-term basis
Data processing and automation are carried out via ten Simaticcontrollers with 64 peripheral stations. Two F controls are used exclusively for safety technology and ensure that the system –incase ofan emergency, for example –can be shut down in a controlled and safe manner. It produces continuously for one to two weeks in 24-hour operation. In the control room, all process variables are continuously recorded,and important key data is automatically stored on a central server.

This procedure ensures complete traceability of the entire production process –all data can still be retrieved years later. If blockchain technology were used to extend this traceability beyond the company's boundaries and, for example, to include milk suppliers, the cycle would be completely closed.

Click: The complete case study can be downloaded here. All production data is stored on a long-term basis
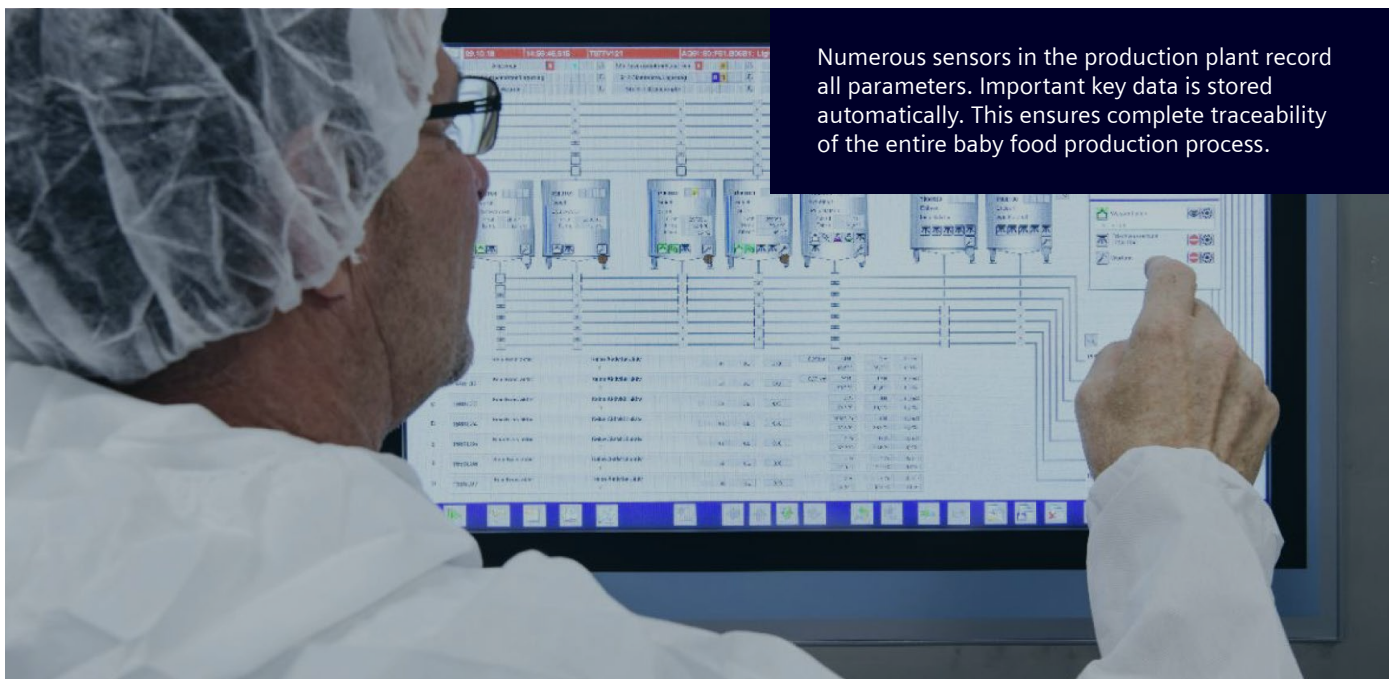
Numerous sensors in the production plant record all parameters. Important key data is stored automatically. This ensures complete traceability of the entire baby food production process.

Research Network EIT Food:
Sustainable design of food production

A network of over 50 universities, research institutions and companies –including Siemens –has been commissioned by the EU to use new technologies to help produce food in a more sustainable and resource-conserving way by 2025.

The Budapest-based European Institute of Innovation and Technology (EIT) is funding several Knowledge and Innovation Communities (KICs) on various topics.

One of them is "EIT Food", a cross-border innovation initiative aimed at reducing food waste. From production to consumption, 32% of all food is lost today if it spoils in transit, in supermarkets or in private households or ends up as food leftovers in the garbage.

The consortium, in which the Technical University of Munich(TUM), the Fraunhofer Society and Siemens, among others, are involved from Germany, aims to remedy this situation by offering training and continuing education measures, supporting startups and promoting research activities.

It describes itself as "Europe's leading food innovation initiative, working to make the food system more sustainable, healthy and trusted".

Digitization of supply chains in the food sector
The "Digital Twin Management" project focuses on the digitization and automation of supply chains in the food sector –to which Siemens solutions for plant management, plant engineering and product lifecycle management (PLM) or the open IoT operating system MindSphere contribute.

This will also make it possible to create a digital twin for food and beverages that can be used to read what a product is, where it comes from, how it was produced and what ingredients it contains.

Among other things, it is planned to make pallets of fruit or meat traceable using blockchain technology. In this way, a tamper-proof control chain will restoreconsumer confidence in their food, while strictly respecting data protec-tion.

Just as in medicine, where patient-specific treatments are the latest research trend, personalised nutrition also plays an important role at EIT Food.

The goal: Thanks to automation, people with special needs – such as in nursing homes –or special preferences and food intolerances can in the future receive healthy food tailored to their needs, which is produced individually in batch size 1 for them in fully automatic factories.

Recognizing aroma substances in pudding by barcode
As food safety is one of the major concerns in food production, improving tracking & tracing can solve several problems at once.

In a joint use case with Givaudan, the world leader in the production of fragrances and flavours for food and beverages based in Switzerland, Siemens has already implemented a digital twin and a tracking & tracing solution for the Milki pudding of the Israeli-based food and beverage company Strauss Group Ltd. in Switzerland.

The product will be sold internationally through supermarkets, retail stores, hotels, restaurants and canteens and will have a barcode on each package which can be scanned with a smartphone and which will provide comprehensive information about the flavourings processed.

This involves extracting data from factory automation and enterprise systems, creating digital product and production twins, and transferring the data to MindSphere. The aim is to share selected information –such as recipes, suppliers, quality, times and transport routes –with customers, suppliers and the regulatory authority.

The manufacturer himself is now better informed as well
But the food manufacturer itself is also better informed about the ingredients of its products, for example by making certified analysis results of the aromas available online.

In addition, the system provides the current status of the production of a flavouring substance at any time, thus improving the planning process and product optimization.

And in the event of a recall, the causes can be pinpointed faster and better, which also leads to cost savings. "The best way to prepare for the future is to shape it," is Givaudan's motto.

Case Study:
Blockchain to prevent illegal tuna fishing in the Pacific Ocean

The World Wildlife Fund (WWF) in Australia, Fiji and New Zealand has launched a unique pilot project to fully track tuna's journey from "fishing vessel to supermarket", thereby curbing illegal fishing in the Pacific Ocean.

A combination of RFID (radio-frequency identification) tags, QR (quick response) codes and scanning devices isused to collect information along the supply chain from fisherman to end customer.

Every single fish is checked with scanners
The scanners, which are installed on the ship, at the dock and in the processing factory, recognize the tags and automatically upload information to the blockchain. Once the fish has been processed, the reusable RFID label is replaced with a cheaper QR code label attached to the product packaging.

The individual QR code is linked to the blockchain record associated with the particular fish and its original RFID tag. This allows the rest of the marine animal's journey to be traced back to the consumer. At the moment, linking thetags is not difficult as the project focuses on the whole export –i.e. the whole fresh fish minus the head, gills and intestines.

Extension of the pilot project to an open platform
The process becomes somewhat more complicated when the tuna is cut into loins, steaks, cubes and cans –but again the pilot project is looking for a viable and cost-effective solution to link the QR code tags on the packaging of the processed product to the records of the original catch in the blockchain. With the launch of the OpenSC platform in early 2019, the WWF extended the pilot project in Australia to other fish species.

It should help to better identify illegal, environmentally harmful or unethical products. After scanning the QR code tag on the packaging at the destination with their smartphone or tablet, the end user is shown information about where a particular food product comes from, when and how it was produced and how it has moved along the supply chain. Blockchain can also be used to store additional information, such as the temperature of stored food, in a forgery-proof manner.

The OpenSC platform reliably locates the location where a food fish was caught. With the help of machine learning, it can be determined in real time whether it comes legally from a certified sustainable fishery and not from a marine reserve or an ecologically sensitive area.

Terms and Abbreviations

Blockchain Although blockchain or distributed ledger technology (DLT) is already celebrating its tenth birthday in 2019, there is still no uniform definition of the term. One possible description refers to "forgery-proof, distributed data structures in which transactions are logged in chronological order, traceable, unalterable and depicted without a central instance". Typical characteristics – whether with a private or a public block-chain – are in any case decentralization, unchangeability, transparency and privacy.

Digital Twin Digital twins are virtual images of the product, production or performance along the entire value chain and enable seamless linking of the individual process steps. In this way, efficiency can be consistently increased, the error rate minimized, develop-ment cycles shortened, and new business opportunities opened up.

GS1-Standards Global Standards One. Worldwide valid, overlap-free numbering and coding systems for the unambiguous identification of goods and services. With the GS1 standards, specific logistical information, such as article descriptions, addresses or shipping unit features, is numerically encrypted and made machine readable.

Photos: Siemens AG, Downstream Beer, EIT Food, Shutterstock, WWF, istockPhotos

Tracking & Tracing Tracking and tracing of products. Nowadays, it is common for products to be available on the Internet in real time. GS1 (Global Standards One) differentiates between the tracking of the raw material to the end product and the tracing of the end product to the raw material. Both terms together result in traceability as a special transparency at all levels of the supply chain.

QR-Code Quick Response Code. A two-dimensional code that has a square format and consists of black and white dots in which the information is stored. The data is protected by an error-correcting code so that it can still be decoded with a scanner or smartphone app even if it is lost by up to 30 percent. Therefore, the QR code is now also used for many consumer-oriented applications, for example to provide customers with additional information on products.

Internet of Things The Internet of Things (IoT) makes it possible to intelligently network physical things and applications via the Internet. With the help of their sensors, the networked devices collect data that they can exchange and make available among themselves and via the Internet. With MindSphere, Siemens provides companies and software developers with a complete operating system for the Internet of Things. The cloud-based, open platform connects products, plants, systems and machines and thus makes it possible to transform masses of IoT data with comprehensive analyses into insights – and thus into added value.

About Siemens

Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. Our solutions help companies of all sizes create and leverage digital twins that provide organizations with new insights, opportunities and levels of automation to drive innovation.

For more information on, visit siemens.com/software or follow us on LinkedIn and Twitter.

Siemens Digital Industries Software,
Where today meets tomorrow.

Headquarters:	**+1 972 987 3000**
Americas:	**+1 314 264 8499**
EMEA:	**+44 (0) 1276 413200**
Asia-Pacific:	**+852 2230 3333**

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