



Whitepaper

DATA INTEGRITY FOR SUPPLY CHAIN OPERATIONS, POWERED BY BLOCKCHAIN TECHNOLOGY

modum.io sensor devices record environmental conditions while physical products are in transit. When a change in ownership occurs, the collected data is checked against a specific smart contract in the blockchain. This contract validates that the transaction meets all of the standards set out by the sender, their clients, or the regulator and triggers various actions: notifications to sender and receiver, release of goods, payment, etc.

www.modum.io
Technoparkstrasse 1
CH - 8005 Zurich
info@modum.io

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Blockchain for supply chain

“Blockchain for supply chains” has become a prominent, and very promising application scenario for blockchains, enabling transparency between untrusted partners and traceability throughout production processes. The advantage of using blockchain technology in the supply chain is that it provides an open, immutable, global, online ledger for transactions, which includes a verification mechanism.

Recently, various start-ups (Chronicle, Everledger, Skuchain, Blockverify, ubirch, Provenance etc.) and large corporate players (IBM, Microsoft, Walmart, Maersk, BHP Billiton, etc.) have begun to run proof-of-concept studies, committing significant R&D resources to building new platforms and fostering international collaborations.

Strategy: Pharma first

In mid 2016, when modum.io began operations, only a few working blockchain infrastructures were available. modum.io opted to use blockchains with proven industry applications. This decision allows the modum team to focus on the development of the business case and to be able to stay relatively neutral or “agnostic” with respect to the growing portfolio of blockchain solutions.

modum.io chose the pharma industry as its first business case because this sector requires highly automated and cost-effective logistics solutions, which guarantee data integrity. As the pharma industry has one of the highest standards for product safety, security, and stability, it is the ideal candidate to act as a “blockchain-enabler”; having successfully proven a viable blockchain solution with the highest requirements, scaling into other verticals is feasible.

Strategy: Blockchain agnosticism

The general maturity of the Ethereum network and development stage of Solidity validated modum.io’s choice to use Ethereum for its pilots or proof-of-concepts. While Ethereum remains one of the most cutting-edge blockchains with great developer and commercial interest, modum.io will stay open to other options for blockchain use in this rapidly changing market.

In particular, requirements from our clients for permissioned blockchains or systems with low or no transaction fees call for substantial flexibility and resources from modum.io in order to truly become and remain blockchain agnostic. From a risk-perspective, social and technical uncertainties of blockchain infrastructures (governance, scalability, interoperability), make blockchain agnosticism an essential foundation of modum’s business strategy in order to be able to provide the best infrastructure to every customer.

Regulatory driven first application

EU GDP regulation recently changed

The first product of modum.io offers an efficient system to comply with recently tightened regulatory requirements for the transport of medicinal products for human use in the European Union. Chapter nine of the Good Distribution Practice regulation (GDP 2013/C 343/01) now requires proof that shipped medicinal products have not been exposed to conditions (particularly temperature) that may have compromised their quality.¹ National regulatory bodies enforce GDP regulations on the over 10,000 wholesale distribution authorization holders in the EU to ensure drug safety, whereby the consequence of non-compliance can lead to licenses being revoked.² It is likely that regulation in the United States (draft chapter 1083: "Good Distribution Practice") will follow in a similar direction.³

To date, pharmaceutical companies meet requirements via expensive, temperature-stabilized trucks and containers from third-party logistics providers (3PLs). For the majority of medicines (which are not temperature sensitive) this is excessive from a cost and regulatory perspective.

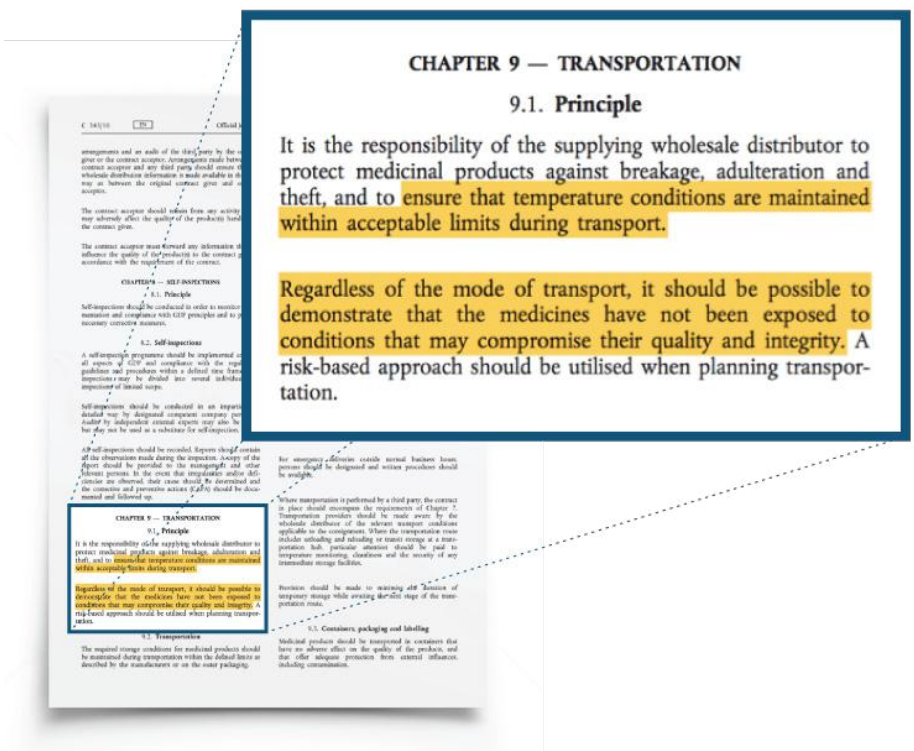


Figure 1: GDP 2013/C 343/01) Regulation.

1. https://ec.europa.eu/health/sites/health/files/files/eudralex/vol-1/2013_c343_01/2013_c343_01_en.pdf

2. estimate based on the list of WDA holders in Germany; <https://www.pharmnet-bund.de/static/content/galleries/downloads/de/am-grosshaendler-namen-stand-201706.pdf>

3. http://www.usp.org/sites/default/files/usp_pdf/EN/USPNF/revisions/c1083.pdf



An efficient solution to meet regulations

modum.io offers a more efficient supply chain solution, which enables companies to prove compliance with GDP regulations using blockchain and Internet-of-Things (IoT) technology. The modum solution allows significant cost savings for the distribution of medicinal products that do not require active cooling. The modum solution is:

1. Designed for pharma standards with a calibrated temperature sensor.
2. Automated to a high degree and fully wireless.
3. Easily integrated with existing customer systems, capable of being rolled out painlessly, with no gateways.
4. Able to provide a high level of data integrity, authenticity, independent verification, auditability, security, and flexible data ownership.
5. A low-cost solution that allows mass use.

How it works

USPs of the modum system



Figure 2: Components of the modum system: dashboard, temperature loggers, and mobile application

modum.io has developed a system with the above design focus, leading to the following features and USPs:

Before shipment occurs, the temperature logger ID, shipment ID, and alarm criteria are fixed within a shipment-specific smart contract. Upon receipt, this smart contract will allow receivers to check that regulations have been met. The evaluation criteria (in this case temperature ranges), cannot be changed retroactively. During the shipment, the temperature is monitored, whereby the data is stored in the internal flash memory of the logger. Using BLE (Bluetooth Low Energy) the shipment does not need to be opened in order to perform the checks. At each change of ownership, data authenticity is certified by the smart contract. The results of the evaluation are immutably stored in a blockchain as a proof-of-existence. Depending on the outcome, the receiver and sender are notified immediately, allowing them to release the product or arrange further corrective and preventative actions. Customers do not need to install additional hardware to use the system, downloading a mobile application is sufficient.

For the customer, the modum system provides:

1. A passive solution that includes a monitoring service with no special packaging required, without the need for expensive, active-temperature controlled logistic services.
2. The proof required by GDP regulations that medical products have not been compromised on shipment level.

Technical details of the modum system

First series

The following describes the state and components of the first series of the modum system planned for production in Q4/2017.

The modum system is designed with a clear design focus on automation and security. It consists of multiple hardware and software components.

- A pharma-qualified temperature logger, which monitors the temperature during the transport. It communicates wirelessly to a mobile application via BLE (Bluetooth Low Energy), alternatively, via NFC (Near Field Communication).
- The dashboard serves for preparation (e.g. setting alarm criteria) and tracking of shipments, data visualization and analytics, and can be used to perform statistical calculations on historical data, e.g. compare different shipments, with export functionality.
- The mobile application can be used to pair the temperature loggers with the respective shipments, initialize shipments and visualize the recorded data.
- The front end (dashboard, temperature logger and mobile application) communicate with back-end's HTTPS server via RestAPI/JSON.
- The back end is for data retrieval, evaluation, verification and storage. It also runs an Ethereum full node executing the respective smart contract code.

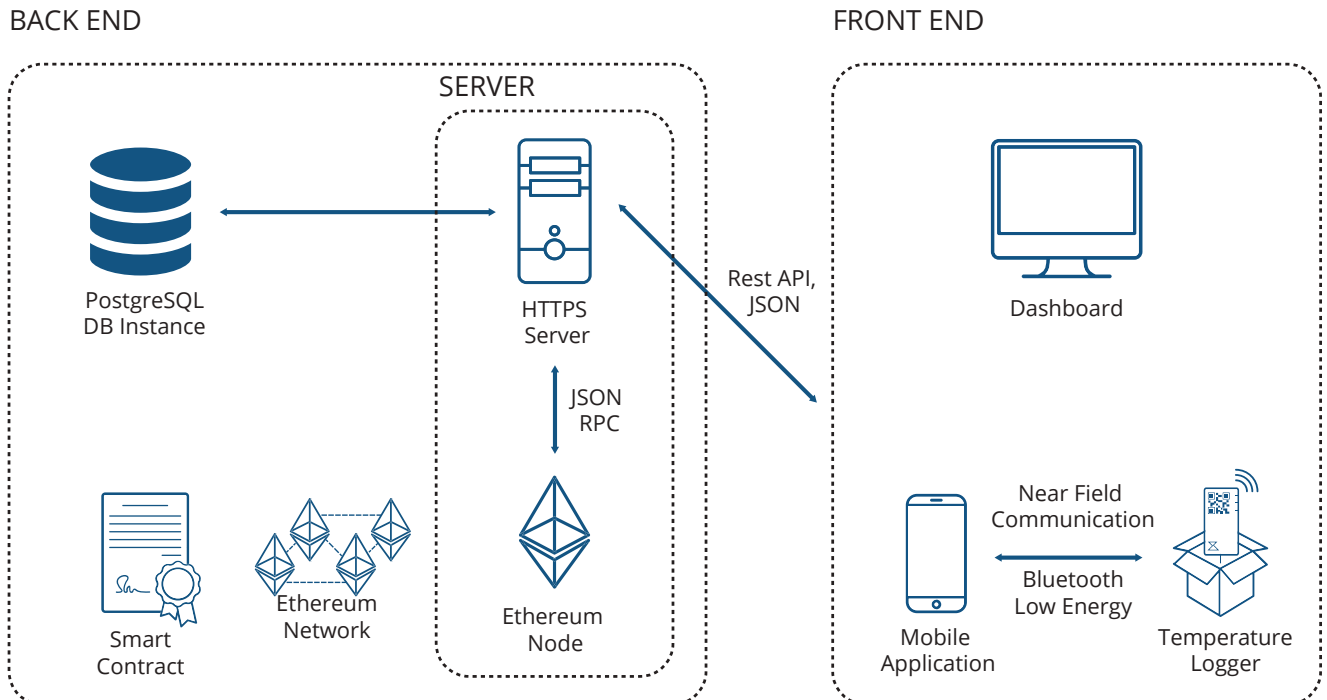


Figure 3: Front end and back end of the modum system

Shipment process

Users will first set the temperature ranges (alarm criteria), measurement intervals etc. using the dashboard. During the packing process, the operator scans the shipment information (e.g. tracking number), receives the serial number of the temperature logger and places it in the corresponding package. This process can be accelerated in an industrial setting, using NFC. In the back-end, a shipment-specific smart contract (already containing specific shipment parameters such as temperature range) is called. The temperature measurement starts either immediately or after a pre-defined time. During transport, the logger can be queried for shipment, current, and recent temperature data. Upon receipt, BLE can be used to retrieve the shipment data, even without opening the package.

Compliance is checked in multiple stages and on multiple levels:

1. The logger itself signals occurrences of deviations to the operator via its three LEDs.
2. The smartphone application displays data and deviations submitted by the logger in a graphical way, even when the phone is not connected to the internet.
3. Through the back-end the data is validated for authenticity and compliance by the shipment-specific smart contract, without the possibility of any party to interfere - whereby all information required for validation is publically accessible.

For all outcomes, the smart contract stores the measurement hash, a yes/no outcome with respect to the pre-set temperature range and a pointer to the actual measurement data (e.g. the PostgreSQL or a customer database) in the blockchain as proof-of-existence. If a deviation has occurred, the sender is notified and can review the corresponding measurement and shipment data.

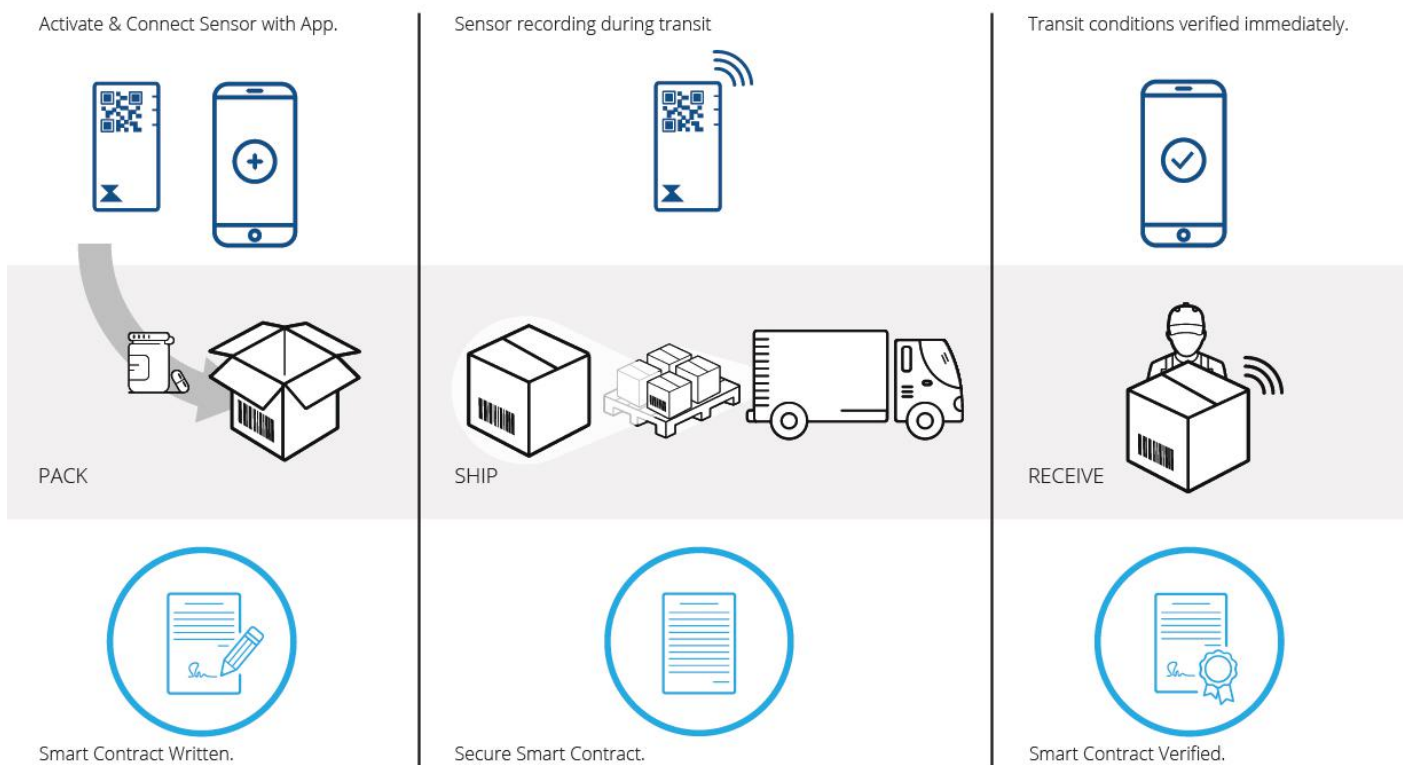


Figure 4: Shipment process of the modum system

modum temperature loggers

The specifications of the modum temperature logger (first series) can be found below:

Device Type	modum.io temperature logger TAG1
External Dimensions (LxWxH)	100 mm x 40 mm x 10 mm
External Display	3 LEDs: Active/Measuring/Warning
Weight	60 g
Warehouse Conditions (stand-by mode)	0 °C to +30 °C
Operating Temperature Range	-10 °C to +70 °C, arbitrary temperature ranges, alerts
Measurement Interval	1 second to 1 week (pre-defined), start after time delay
Temperature Accuracy (calibrated)	±0.45 °C between -40 °C to +70 °C
Temperature calibration valid for	1.5 years
Accelerometer	Range: ±2g – 16g, free fall and motion detection
Memory (RAM)	30 KB
Storage for Measuring Points	50,000 measurements
Protection Class	IP65
Battery Life	6 weeks (active), 1 year (passive, on-shelf)
Reactivation	Possible
Bluetooth Low Energy (BLE)	Bluetooth 5 w/ secure connections
Bluetooth Features	BLE API on BLE GATT layer updating firmware
NFC (Near Field Communication)	For fast initialization / pairing (automation)
Certifications	CE, Temperature calibration, GMP, GAMP5

Specifications subject to change

Table 1: Technical specifications of the modum temperature logger



Figure 5: Rendering of the upcoming series of modum temperature loggers

Security concept

The modum temperature loggers must mitigate various risk- and attack scenarios.⁴ With potentially thousands of loggers in circulation there is a credible risk that the hardware is subjected to physical disassembly, tampering, or manipulation of its firmware and flash memory. The housing itself is tamper-resistant and water-proof. All components with a serial number (e.g. temperature sensor, System-on-a-Chip) are registered in the authorized device database to identify forged, tampered-with, and stolen loggers. The cryptographic co-processor shields its secret keys (it uses to create digital signatures of all measurements, timestamps, etc.) from decapping, probing, and fault attacks. The corresponding public key of every logger is used by the system to guarantee end-to-end data authenticity. Smart contracts used in the modum system are open source and can be verified by anyone.⁵

Furthermore, the modum system provides customers with multiple levels of access control and permits only authorized users of sender- and receiver company to interact with the temperature loggers.

4. See the upcoming security whitepaper at https://modum.io/modum_securitywhitepaper.pdf

5. <https://github.com/modum-io/smartcontract/blob/master/TemperatureMeasurementA2.sol>

Compliance-as-service business model

For the last mile

During modum.io's extensive proof-of-concept phase, pilot projects with several customers have determined that the modum solution delivered its highest value as a last-mile logistics service in the pharma supply chain. As such, modum.io will offer its solution in a "pay-per-shipment" model.

The last mile of the pharma supply chain begins when finished products leave the pharmaceutical production facility and ends when they arrive at the pharmacy or hospital to be administered to the patient. Between producer and pharmacy, the products typically move through a pharmaceutical wholesaler.⁶ In the EU, around 200 million of these shipments occur each year.⁷

Only the beginning for modum.io

Our goal is to utilize the potential of a blockchain-based back-end for supply chains. Most logistics companies have small margins and high competition and therefore little possibilities to innovate if it does not save costs – therefore we focus on providing significant cost reductions for our customers in the pharma supply chain.

Once the blockchain is a proven, cost-saving part of a logistics supply chain, additional use cases will be possible with almost no incremental costs for our customers. Besides the obvious ones as trade finance, trade documents and determination of legal handover, we are able to deliver unique products by adding additional environmental sensors to our hardware. For example, motion sensors to detect whether fragile goods were handled correctly, light detectors to immutably prove whether a parcel

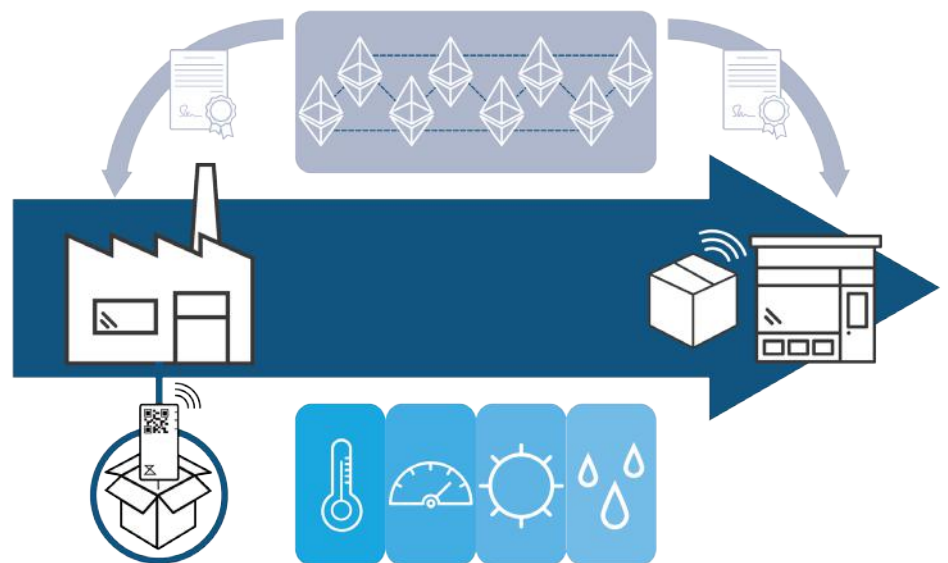


Figure 6: The modum system overview

6. 'Nearly three-quarters of all medicinal [...] are distributed through pharmaceutical full-line wholesalers.' <http://www.girp.eu/files/GIRP-IPF%20Study%202016.pdf>

7. 'Number of minimum daily Wholesaler deliveries to Pharmacies across the EU27' multiplied by 'Number of retail and hospital pharmacies and dispensing doctors' multiplied by working days. http://eprints.lse.ac.uk/51051/1/Kanavos_pharmaceutical_distribution_chain_2007.pdf
<http://www.girp.eu/files/GIRP-IPF%20Study%202016.pdf>

was opened during its journey, and secure such an event with insurance policies. Furthermore, humidity sensors to monitor the condition of raw materials like salts for the pharmaceutical sector or hay for the transport of specialized horse food. Those are just some of the use cases which were already discussed with pilot and potential customers. Certainly, many more use case, which have not been considered will follow.

By extrapolating some of the novel technologies described in this white-paper we expect that Smart Logistics (or Supply Chain 4.0), will yield a role reversal between the “object to be transported” and “carrier”: A “self-dependent shipment” could manage itself, i.e. autonomously optimize for revenue, directly pay its fees to different service providers and cost centers.

Experienced team

The modum team believes that technology is the answer to the world's most urgent problems. Our highly capable team combines a breadth of competency and experience to serve our clientele and deliver a high-quality solution.

- **Malik El Bay**, has experience in building products in the fast-paced startup environment. With two start-ups under his belt, he leads the team and strategic growth of modum.io.
- **Dr. Stefan Weber**, a physicist with industry and start-up experience. He manages hardware development and compliance.
- **Sacha Uhlmann** has a background in peer-to-peer systems and quality assurance. He leads the system development and is the lead architect of modum.
- **Simon Dössegger**, a mechanical engineer who already exited his last start-up creating autonomous flying drones to GoPro. He leads the product strategy and business development.
- **Andreas Knecht**, is a lead engineer and IoT guru. He is responsible for the hardware and firmware development.
- **Marc Heimgartner, Tim Strasser, Guilherme Sperb Machado, Moritz Schneider and Sebastian Stephan** are the core developers of the modum system.
- **Michael Taylor and Ozan Polat** spearhead the marketing and communications team. They bring marketing experience from major tech- and innovative startup environments.
- **Dr. Thomas Bocek** is the resident blockchain expert, with a PhD in decentralized and peer-to-peer systems.
- **Marc Degen**, a blockchain investor, guides the modum.io team with deep digitalization knowledge.
- **Werner Spörri**, chairman and former investment banker, contributes valuable financial and legal direction.
- **Pascal Degen**, currently engaged as Head of Sterile Packaging at Novar-

tis, brings in-depth manufacturing knowledge from within the pharma sector.

- **Michel Schaer**, founded a Swiss-based pharmaceutical distributor and provides insight regarding pharma wholesale and distribution.

Additionally, the modum.io team regularly consults with our advisors:

- **Prof. Dr. Burkhard Stiller** (Communications Chair, University of Zurich) whose main research interests are in blockchain, IP-based networks, cloud and grid services, and the economics of IP services.
- **Prof. Dr. Erik Hofmann** (Director of the Chair of Logistics Management, University of St. Gallen) who wrote the book Supply Chain Finance and Blockchain Technology.
- **MLaw Benedikt Schuppli**, RA, is a legal counsel who works with the Swiss Fintech company Lykke Corp, which is building a global marketplace based on blockchain technology.
- **Dr. Ing. Heinrich Zetlmayer** (Member of the Board, Lykke Corp) is a Board Member at Lykke Corp and advises on the business aspects of the token sale, being a former IBM top executive in charge of big-scale supply chain implementation programs.

Furthermore, we are working together with external experts, specialists in embedded systems and GDP-compliant transport validation implementations.

Token Sale

modum.io is a company with a real product, commercial traction, and with major partnerships. Its token sale has been carefully crafted to relate to the reliability of our service offering. The primary goal of the token sale is to establish mechanisms for modum.io to efficiently execute its vision: 'to improve supply chain operations with emerging technology' and to align the interest of token holders with the interests of the team. Therefore Lykke Corp. was chosen to advise on the token sale and all related activities.

Token Economics

The modum token (MOD) is a profit share token with voting and profit participation rights. The maximum total supply is 30 million tokens. 20.1 million are offered in the token sale, 0.9 are used to cover the token sale costs and for the bug bounty program, and 9 million MOD are reserved for modum.io, to be vested based on major milestones. Token holders will vote to decide if the milestones are met and release the locked tokens. Locked tokens do not have profit share nor voting rights. Ethereum ERC20 technology was used to build the MOD token. The code of the smart contract and the tokensales application is open source⁸ and has been reviewed by Lykke Corp and Consecom (a Swiss IT Security consultancy).

8. visit: <http://github.com/modum-io>

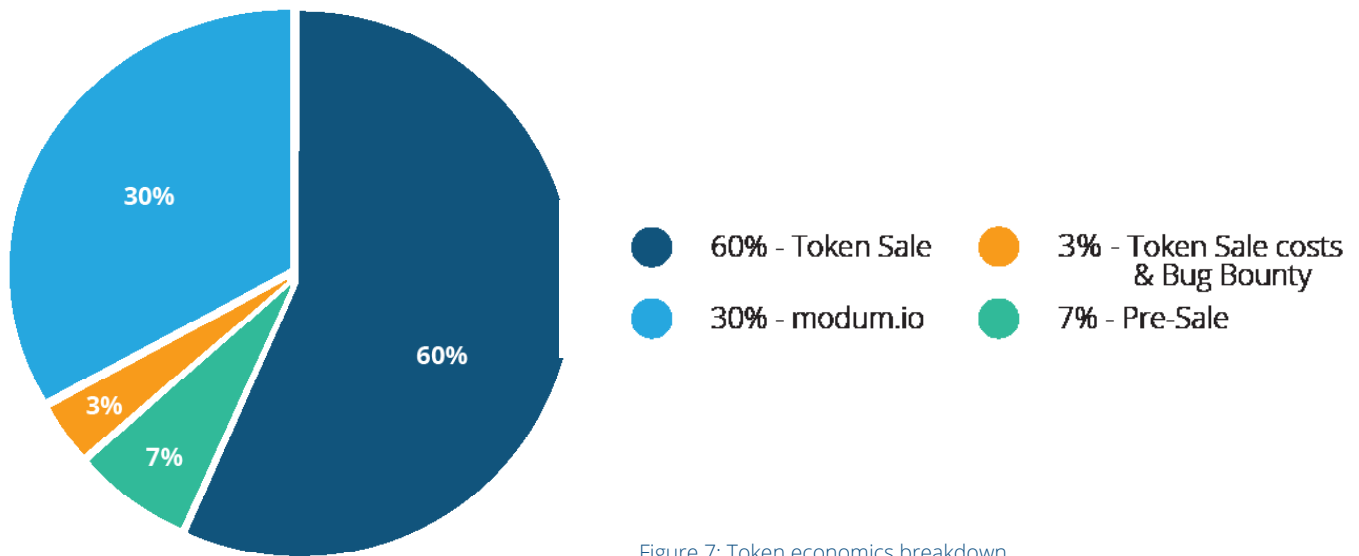


Figure 7: Token economics breakdown

Milestones

The funds collected in the token sale are used to meet predefined milestones in our product roadmap as elaborated below. The mentioned dates are “earliest dates possible” and no voting will take place before the dates mentioned. The milestones provide today’s view of the market needs. Due to the fast-evolving nature of the blockchain ecosystem those milestones are indicative, i.e. if a milestone needs to be changed, prior acceptance of the change is required, therefore an additional voting is conducted. In case of a negative voting, modum.io can reinstate the voting process earliest 90 days after the end of a prior voting period, and no milestones can be skipped by modum.io. We commit to these milestones regardless of the outcome of the token sales and total funds collected.

Milestone 1 – expected earliest October 22nd, 2017:

The objective is to ensure a proper minting and token distribution process to release upon positive voting 900,000 tokens (3% of the maximum MOD supply) to a wallet controlled by modum.io. The distribution is conducted using the first in first out principle. All contributions are consolidated into one list. The timestamp per block is used to define the conversion rate to USD, which is then used to define the conversion rate to MOD tokens. One contribution might be in multiple bonus tiers. This process is supervised by our advisor Lykke Corp. The released tokens are used for our advisors, many helping hands in the making of this tokensale and the bug bounty program.

Milestone 2 – expected earliest Q1/2018:

Objective is to ensure the go-to-market of our first product line including the mass production of our dedicated sensor device and the product ecosystem (application, validation & qualification). At least two environmental sensors are integrated into the hardware platform (temperature and motion) and besides Ethereum at least one of the following blockchains: IOTA, NEO, Fabric, ETC or Rootstock, is supported as blockchain back-end. 3 million tokens are upon positive voting released to a wallet controlled by modum.io.

Milestone 3 – expected earliest Q1/2019:

Objective is to deliver the next sensor generation with real-time interaction (via current or emerging network technologies, like LoRaWAN). At least one additional environmental sensor is integrated (light or humidity) and any two additional blockchain back-ends of the following: IOTA, NEO, Fabric, ETC, Rootstock, Waves, Tezos, EOS or Cosmos, are supported. 3 million tokens are upon positive voting released to a wallet controlled by modum.io.

Milestone 4 – expected earliest Q1/2020:

Objective is to deliver the next sensor generation with a real-time, on-chip blockchain node. An additional environmental sensors (e.g. light or humidity) is integrated and the complete modum software is delivered in a fully decentralized architecture. 3 million tokens are upon positive voting released to a wallet controlled by modum.io.



Figure 8: Roadmap and first milestones

Voting & profit sharing

With the publishing of the annual report modum.io can claim whether or not the present milestone was achieved. With the publishing of the report the start date of the voting period is set. The voting period lasts for two weeks. Every MOD token in circulation has one vote. Locked tokens cannot vote. The default vote is void. The quorum is defined by the number of executed votes within the predefined timeline. A simple majority is needed to decide if the milestone was met. If the milestone was met, the defined number of tokens are released to the modum.io wallet.

The board of modum.io decides and declares the amount of dividends when there is a profit. A payment equivalent to this amount is converted to Ether and sent to the modum smart contract. The modum smart contract evaluates the current holdings and distributes the profits to the token holders in Ether. The voting and profit share smart contract is open source

Early investor incentives

The token pre-sale will be conducted by invitation only. The pre-sale starts in August and comes with a 50% discount on the price of 1 USD per MOD token. The number of tokens sold at 50% discount is hard capped at 2.1 million tokens.

The public token sale starts on 1 September. The first 6 million MOD tokens are sold with a discount of 30% on the price of 1 USD per MOD token. The following 6 million are sold with a discount of 15%. The last 6 million are not discounted and sold for 1 USD per MOD token. Oversubscriptions of a bonus tier get allocated to the following tier. The estimated current bonus tier is visible on the token website. The displayed amount may change due to changing exchange rates and is therefore indicative. Final bonus tier and token allocation is done post transaction. Oversubscriptions of the whole token sale are returned to the investors after the closing of the token sales. (Refund addresses are requested in the token sale app.)

Bug Bounty Program

Modum.io is deeply engaged with the developer community and has maintained a 'code is law' value system while developing its platform. With every major platform release modum.io will open a new phase of its "Bug Bounty Program". Every developer that submits a bug will receive a certain number of points based on the severity of the bug. The severity is calculated according to the OWASP risk rating model based on impact and likelihood.

In the first phase the smart contract of our token sale will be the first item to be checked by the community under the Bug Bounty Program. 3% of the total tokens issued will be held for the bounty program, with 25,000 tokens available for participants who find bugs in the token sale smart contract.

OVERALL RISK SEVERITY					
IMPACT	High	Medium	High	High	
	Medium	Low	Medium	Medium	
	Low	Note	Low	Low	
			High	Medium	Low
LIKELIHOOD					

Buying procedure

To buy MOD tokens, please register on token.modum.io with your email and confirm the Terms of Token Sale. By confirming the Terms you are indicating, among other things, that you are not a resident of a country whose laws and regulations conflict with the purchase of MOD token and/or the participation in the token sale. You will be asked confirm that you are not a resident of the United States or Singapore or resident of a country where American embargoes and sanctions are in force, namely Iran, North Korea, Syria, Sudan, or Cuba. For further details please consult the Terms of Token Sale. After the confirmation of your email address, you will create your wallet for MOD tokens, upload a UTC/JSON Keystore, or the receiving address is entered manually. In the next step the pay-back addresses for possible oversubscription payments can be added and finally a personal BTC and ETH address is generated to deposit the investment amount. An email is sent upon successful confirmation of your payment. The conversion rate to USD is determined at the time of confirmation by official BTC/USD and ETH/USD exchange rates, which are provided by our advisor Lykke. The conversion to modum tokens is done post token sale. Therefore the exact number of tokens distributed per investor is communicated at the time of distribution of the modum token.

Minting of MOD tokens

The MOD tokens are distributed latest 30 days after the token sale is closed. The code for the creation of the tokens is open source⁹. The proper distribution is also the first milestone to be met. All investments are allocated by their confirmation time to the respective bonus tiers. Oversubscriptions of a bonus tier get allocated to the next following tier. At every time, the estimated current bonus tier is visible on the token website. Oversubscriptions of the whole token sale are returned to the investors. Upon sign-off of the distribution, every investor receives an email with their binding number of modum tokens they receive and the date and time of distribution to their token sale wallet. For more information on regulatory and legal aspects, see the Token Terms of Sale Document.

9. visit: <http://github.com/modum-io>

Market segmentation & go to market

Last mile logistics are typically separated into two stages: From producer to wholesaler and from wholesaler to doctors, hospitals and pharmacies. However, mail-order pharmacies now open up a third stage skipping the pharmacy and are directly delivering to the patient.

Producer to wholesaler

Approximately 10% of the 200 million annual shipments occur between pharma producers and wholesalers. These deliveries primarily consist of pallets containing finished products. The bulk of modum.io's potential customers are small and medium-sized enterprise (SME) pharma producers, with an average annual volume of 1,000 to 10,000 shipments.

Wholesaler distribution

90% of the total shipping volume is conducted from a wholesaler to hospitals, doctors, and pharmacies. Wholesalers usually have their own fleet of vehicles and outsource up to half of the shipments to third-party logistics service providers. There are about 750 wholesalers in the EU serving in total more than 180,000 pharmacies and dispensing doctors.¹⁰

Mail-order pharmacies

Mail-order pharmacies are a special case in last-mile logistics – they deliver medicines directly to the end consumer, adding up to 20 million shipments per year within the EU. Their segment is growing quickly, currently 2% of total market revenues¹¹ (the average e-commerce revenue proportion across industries is approximately 8% and growing).¹² The leading mail-order pharmacy in Europe, DocMorris, has 2.5 million clients and an annual turnover exceeding CHF 350 million.¹³

Over 200 million shipments containing medicinal products are sent within the EU each year.

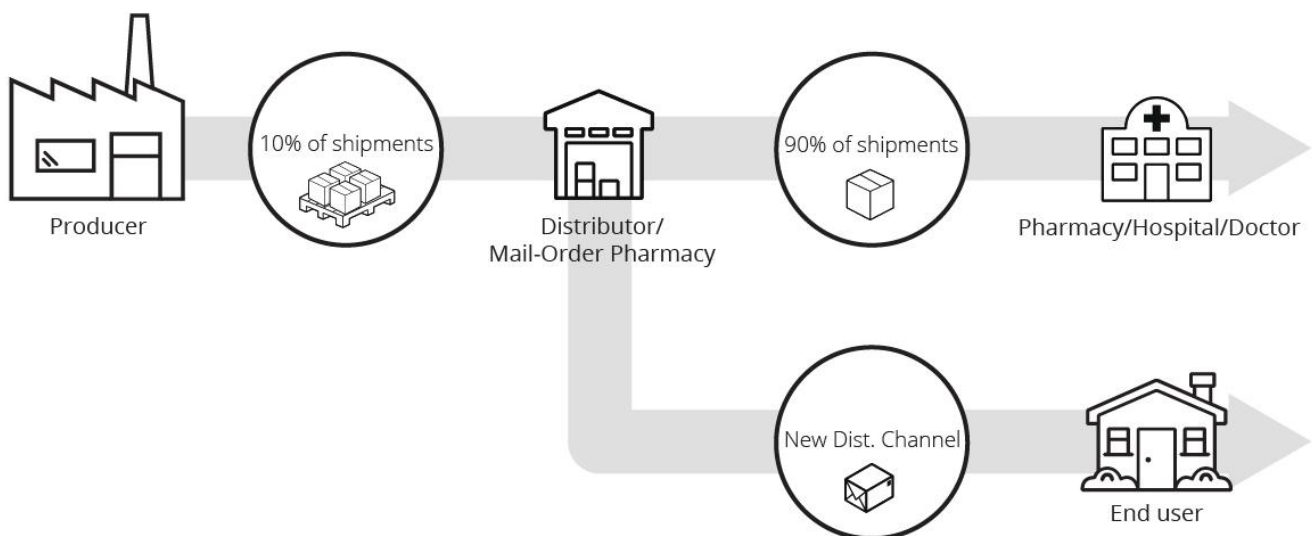


Figure 9: Distribution of medical products overview: Of the 200 million pharmaceutical shipments occurring in the EU each year, 10% occur between producer and distributor and 90% occur between distributor and dispenser. Indicating that the bulk of shipments exist in the last mile between distributor and Pharmacies/Hospitals/Doctors.

10. <http://www.girp.eu/files/GIRP-IPF%20Study%202016.pdf>

11. <http://www.apotheke-adhoc.de/nachrichten/apothekenpraxis/nachricht-detail-apothekenpraxis/versandapotheken-legen-um-30-prozent-zu/?L=1?t=1>

12. <https://www.emarketer.com/Article/Worldwide-Retail-Ecommerce-Sales-Will-Reach-1915-Trillion-This-Year/1014369>

13. <https://www.docmorris.de/service/unternehmen/presse/pressemitteilungen/2016/docmorris-vorreiter-beim-faelschungsschutz>

Mail-order pharmacies must comply with GDP regulations too: “It is in the responsibility of the sending pharmacy to demonstrate that the medicines have not been exposed to conditions that may compromise their quality”. More explicitly, the “sender must check the transport conditions for suitability in each case. Compliance, especially temperature, needs to be verified and documented regularly.”¹⁴

From pilots to market entry

Since its founding in 2016, modum.io has conducted several pilots in each of the last-mile segments in order to receive customer- and user input for developing the system, test different go-to-market strategies, and explore business and pricing models.

For the pilots, modum.io used an off-the-shelf temperature logging device, the TI sensor tag, and developed its own custom firmware to interface with the modum system.¹⁵

Pilot 1.0

The first pilot was conducted in Switzerland in 2016, monitoring shipments from a SME pharma producer to a wholesaler.

Over six weeks, several temperature loggers recorded 10,000 data points and were able to successfully track the temperature of most shipments. The collected feedback indicated necessary improvements in the following areas:

1. Connectivity of the temperature logger with the mobile application should be quicker.
2. Data transfer speed should be improved.
3. A dashboard for data analysis should be created.

The main advantages for SME pharma producers to use the modum system is the wider choice to find a suitable logistic partner and ensure compliance on a shipment level.



Figure 10: Pilot 1

14. https://www.ag.ch/media/kanton_aargau/dgs/dokumente_4/gesundheit_1/gesundheitsversorgung/heilmittel/regeln_versandhandel_2013.pdf

15. http://www.ti.com/ww/en/wireless_connectivity/sensortag2015/index.html?INTC=SensorTag&HQS=sensortag-pr

Pilot 2.0

In its second pilot, modum.io monitored shipments between a wholesaler and several clinics and pharmacies whereby shipment volumes were scaled up by one order of magnitude.

For this pilot, the temperature logger's connectivity and data transfer speed were improved and a dashboard for quality assurance and customer service departments of the wholesalers was introduced and tested. To improve the responsiveness of the read-out process of temperature data was an important learning from pilot 2.0.

Additionally, modum.io monitored a cross-border shipment to validate the technology internationally and between continents.

Paid Pilot 3.0 with 3PL & mail-order pharmacy

A key takeaway from earlier pilots and the market studies was that a direct integration in the processes of a third-party logistics provider already serving high shipping volumes would greatly help modum.io scale because pick-up and hand-over would be handled by the same company.

By using a third-party logistics provider, the shipment process remains the same for the sender: insert the loggers into the respective shipment and transfer the shipment to the 3PL provider. Prior to delivery to the pharmacy or hospital, the 3PL driver will use their proprietary scanning device to check compliance. He can then either release the shipment to the owner, or take corrective and preventive actions in case of any deviations.

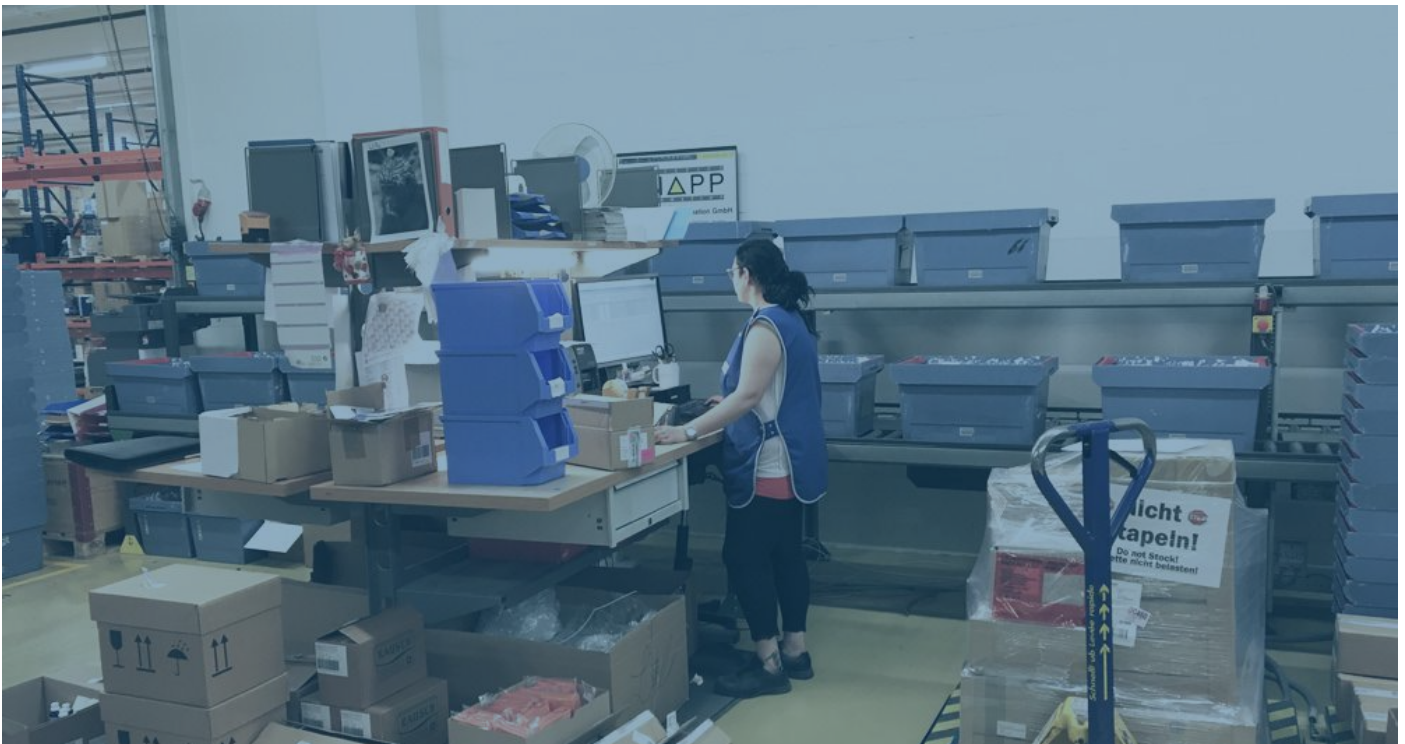


Figure 11: Pilot 2

During the third, paid pilot with the parcel-service market leader in Switzerland, modum.io aimed to prove the suitability for mass use of the modum system. Two phases were conducted: in the first phase, modum implemented and stabilized customer processes; in the second phase, modum.io quantified additional efforts and the duration of the temperature data read-out process. The customer's objective for this pilot was to achieve 95% of all readouts within 30 seconds. modum.io managed an average readout of only eight seconds for 100% of the shipments. In the pilot wrap-up meeting, suitability of the modum system for mass use was confirmed and the client recommended integration of the modum system into the offering of the 3PL.

Business & Pricing Strategy

By using the modum system, depending on market segment and volume, costs per shipment can be reduced by up to 60%. With respect to the 200 million shipments of pharmaceutical products in the EU, a widespread adoption of the modum system or competing services has the potential to reduce industry-wide expenses by approximately 3 billion USD.

The modum.io solution is offered in an easy "pay-per-shipment" model. It has been shown in the market studies and pilots that customers would pay up to 10 USD per shipment. When compared with the use of environmentally-controlled transport solutions, the modum system still significantly reduces overall shipping costs plus further cost reductions if the potential for automation, that comes with the modum system, is taken into account.

Current status

Currently, the modum system is being integrated into the system of the leading last-mile logistics service provider in Switzerland. modum.io is planning to finalize this integration in Q4/2017, using the first series of proprietary temperature loggers. Clients from the wholesaler and mail-order pharmacy segment are lined up. Upon successful completion, official market entry in Switzerland will begin in Q1/2018. Once integration has been established within our first client site, the logistics service provider can approach the SME pharma segment to offer the additional service.

Furthermore, modum.io is in contact with significant customers from within the pharma distribution vertical in the UK, France, Germany, Turkey, and Vietnam.



www.modum.io
Technoparkstrasse 1
CH - 8005 Zurich
info@modum.io