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bloodchain

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BloodChain is a circulation system for value exchange to be used by the community of blood donors and all who want to support it, participate in it and use it.

BloodChain is the first Open Social Blood Bank

Introduction

The purpose of this paper is to thoroughly explain a new conceptual framework to be used within the blood donorship. Through the utilization of recent technological innovations, we have created a model with the ability to overcome the majority of the blood donation's biggest constraints and propose various measures that will significantly improve the efficiency of blood donorship.

The project aims to build a BloodChain cooperation network for a new blood donation platform. The beneficiaries will be all stakeholders registered in the BloodChain network. The platform will be focused on cooperation with public healthcare and blood collection organisations and units, as well as private organizations who care about the interests of their clients and widely understood stakeholders, including patients, blood donors and organizations that support blood donation. The objective of BloodChain is to unite current and potential blood donors as well as all who want to support the idea of voluntary blood donation. Within the cooperation network, both donors and supporters will be motivated to participate in blood donation activities and they will be rewarded for such activity through services directed to the network (medical examinations, dedicated diets, gift cards, access to sport and recreation centers, insurance under special conditions and other incentives). Community members will have the possibility to collect benefits that can be used or passed to another organization or person. Thus they will be able to help twofold.

The **Open Social Blood Bank** concept is a metaphor that describes the BloodChain donors network available 24/7/365 to donate blood by required type, when and where is needed. All BloodChain community members together constitute the social blood bank. The community is open for all who want to support it, participate in it and use it.

BloodChain will be based on Shared Economy¹ and the technology that supports it in the best way, i.e. blockchain.

Target groups:

- blood donors,
- the needy,
- blood collecting, processing and delivering organizations,
- healthcare, hospitals,
- donors' foundations and organizations.

It is expected that the value of the blood market is going to reach USD 13.3 billion by 2025², up from USD 8.10 billion in 2017³. This is the market of our clients. Although we do not know exactly how much financial resources are allocated to promote and motivate donors, we do know that without donors our clients will not be able to fulfill all their orders. We know that blood demand will increase, and this will be accompanied by a decrease in size of the group of potential best donors. In the future our clients will have to use expensive replacements, which will exert negative impact on the costs of services and profitability of the business activity undertaken.

Our goals are:

- to offer an attractive incentive scheme to blood donors
- to ensure blood availability for all the needy
- to increase availability of rare blood types
- to provide effective support for the less than 21 day shelf-life inventory strategy
- to provide a verifiable and effective incentive system for the blood/tissue market.
- The service is to enable organizations existing thanks to blood donors to ensure that the needed amount of blood is supplied to the growing human blood market (ageing of society)
- to provide healthcare with a continuous and need-efficient supply of human blood at prices that will allow to perform all needed medical procedures
- to determine the cost-effective blood donation promotion system
- to reduce cost of blood storage and management

¹ https://en.wikipedia.org/wiki/Sharing_economy

² <https://www.grandviewresearch.com/press-release/global-blood-collection-market>

³ <https://www.marketsandmarkets.com/Market-Reports/blood-collection-market-39733117.html>

Expected Benefits:

- **100% cost-effective blood donation promotion system:** All blood promotion costs are inherently and accurately allocated to donors and supporters requested activities.
- **25% blood storage cost reduction in 15 years:** Usually blood gathered as a result of blood donation is stored and preserved for later use in blood transfusion. As the BloodChain social donors network supplies continuously and efficiently all needed blood demands, blood storage in large quantities as we know it today will be unnecessary.
- **50% shorten blood shelf-life. Toward the <21 days blood shelf-life inventory strategy.** In the course of studies was proved that after even 21 days, the blood cells have degraded. According to other analysis a transfusion of long stored RBC could cause negative side effects. In fact a inventory management approach based on FIFO (first-in-first-out) favors transfusion of 'old' blood. Bloodchain can deliver blood when it is needed on demand, it reduces necessity of long term blood storage.

Business Case

Summary

The Analysis of both the European and American blood donation market has allowed us to identify following key problems encountered in both markets:

Objective problems:

- **current blood shortage** – especially during summer season and for rare blood types
- **future blood shortage** – decrease in size of the population of donors accompanied by an increase in size of the population of the blood needy⁴
- high level of rejection of potential donors (15%)⁵
- insufficient level of optimization and management of blood inventory⁶

Subjective problems:

- failure to inform and bring together the blood needy and the donors
- low awareness of the state of blood donation among potential donors and recipients
- failure of society to perceive blood donation as social activity

Thus it was obvious to build a system which encounters those failures and focuses on the needs of the blood recipients trying to optimally satisfy those through the offers of the blood donors - considering local factors, location of blood collection stations, current inventory and localisation by app (and/or website) of donors and recipients. This system, based on data obtained from blood donors and from the blood needy, will optimise the use of the donors' potentials, anticipate inventories for future needs (like summer season),

⁴ The size of the population of the blood needy grows in relation to the population of potential donors' age group.

⁵ Polish Supreme Audit Office (NIK) Report: OPERATION OF BLOOD DONATION AND HEMOTHERAPY SYSTEM [FUNKCJONOWANIE SYSTEMU KRWIODAWSTWA I KRWIOLECZNICTWA]: LOP-4101-15-00/2013, Reg. No. 167/2014/P/13/166/LOP. (<https://www.nik.gov.pl/plik/id,7750,vp,9713.pdf>)
(<https://www.nik.gov.pl/aktualnosci/nik-o-systemie-krwiodawstwa-i-krwiolecznictwa.html>)

⁶ Routine blood storage is 42 days or 6 weeks for stored packed red blood cells, which prevents Blood Banks to store whole blood normally used for transfusion longer than 42 days.

manage efficiently current inventory levels, respond to sudden rises in demand through direct donor motivation, and secure cases like rare blood group availability.

The platform is to gather blood donors and blood donation supporters into a cohesive community that will have access to products and services supporting blood donation under special dedicated offers (doctors specializing in nutrition, hematologists, fit food products, sports and recreation centers, non-public healthcare clinics, health and life insurance, and others).

The system must be open to cooperation not only with other public platforms to allow for the exchange of data on needs and inventory, but also with private platforms with regard to offering dietary services, medical advice and coaching advice and responding to sudden needs of blood donors and the blood needy. The whole sector, based on a systematic and continuous supply of blood and other tissues, will be able to motivate donors in an effective and verifiable manner.

An important part of the ecosystem is the support and promotion of social and technological innovations in the field of blood donation as part of broad partnership developed between academic centers, private and public institutions, public benefit organizations and foundations.

Reasons for Doing this Project (Social Need)

Launching of the project is justified by the possibility to satisfy the described social need:

access to blood as the most important medicine,

through implementation of the aforementioned solution.

There are five factors that currently limit the possibility to fully satisfy this need.

1. Factors influencing the rise in demand for blood and blood components
2. Objective factors influencing decreased blood supply
3. Subjective factors influencing decreased blood supply
4. Problems of the blood needy
5. Short shelf life of red blood cells

Possibility to mitigate negative impact of factors 2, 3, 4, enhances the conviction that the solution for the described social need can be implemented in full.

Factors influencing the rise in demand for blood and blood components

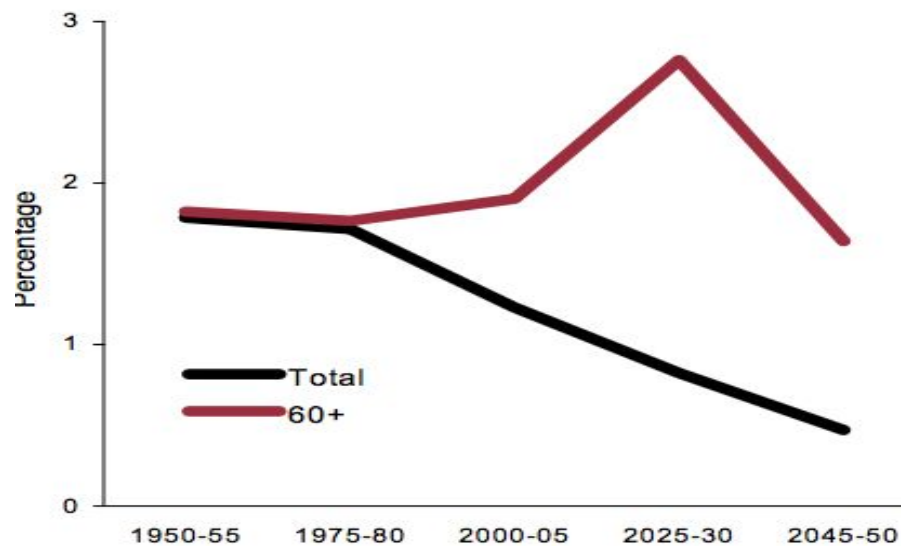
- **development in medicine** that allows rescuing people from the very beginning of their life – even at the time of fetal life – until old age
- **ageing of society**

- increased incidence of cancers
- increased effectiveness of the medical rescue system
- improved accessibility to medical services

Geriatric Epidemiology

In 1950, the world was populated by 205 million people aged 60 and older, and this global population figure is now 500 million. Around 2020, the number of elderly people in the world will reach 1 billion, and until 2025, it will further increase to 1.2 billion. We are aging at a tremendous rate. Between 2025 and 2030, the percentage of people aged above 60 will increase 3.5-fold with respect to the general population⁷⁸.

Figure 9. Average annual growth rate of total population and population aged 60 or over: world, 1950-2050



An even more rapid growth is expected in the group of very advanced-aged people (aged 80 and older). According to forecasts, between 1950 to 2025, the number of people in this age group will increase 8 to 10 times. Aging process will continue⁹ due to fact that the

⁷ World Population Ageing: 1950-2050

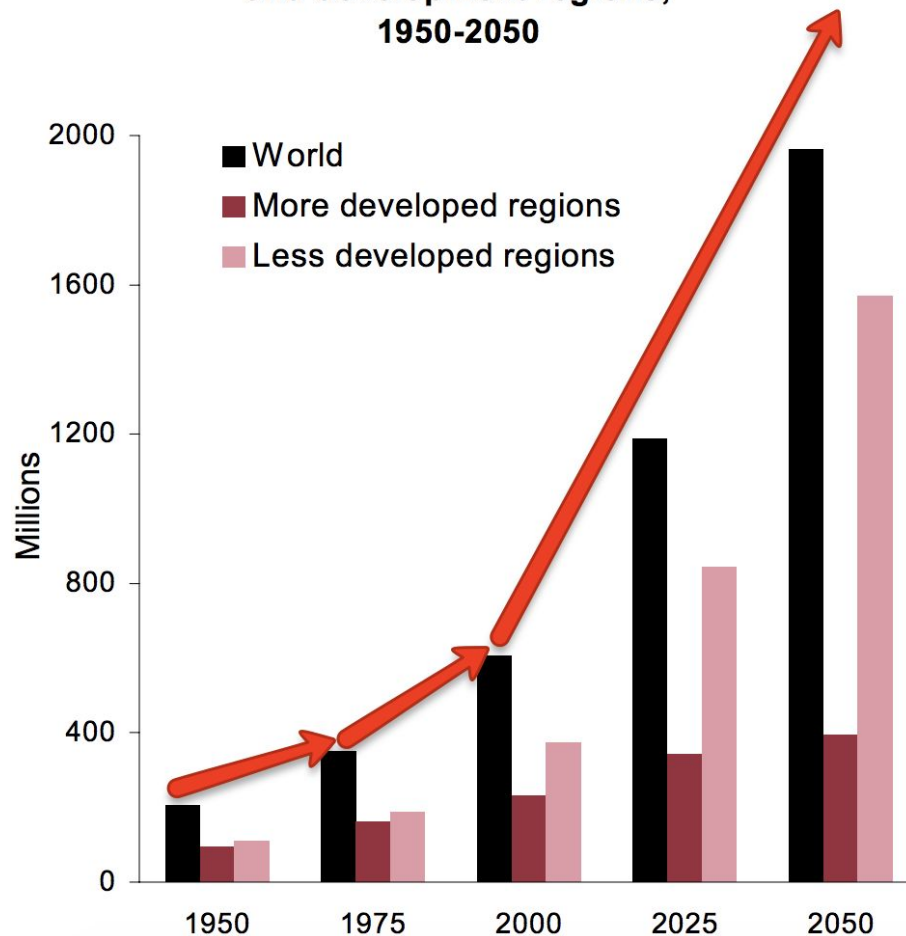
<http://www.un.org/esa/population/publications/worldageing19502050>,
The 2015 Ageing Report, EUROPEAN ECONOMY 3|2015

⁸ https://link.springer.com/chapter/10.1007/978-3-319-44084-2_1

⁹ <https://www.theguardian.com/science/2016/oct/05/human-lifespan-has-hit-its-natural-limit-research-suggests>

ceiling for human lifespan appears to be stuck at around 115 years¹⁰ and an increase of effectiveness of the medical rescue system.

Figure 8. Population aged 60 or over: world and development regions, 1950-2050



Main points: ageing of society

- The number of older persons has tripled over the last 50 years; it will more than triple again over the next 50 years
- People aged over 65 use over 76% of blood¹¹
- People aged under 30 use only 10% of blood
- Population of potential donors aged 18-50 decreases in inverse proportion to the increase in the population of the elderly.

¹⁰ <http://www.sens.org/research/aging-as-weve-known-it>

¹¹ WHO Blood safety and availability, Fact sheet (Reviewed June 2017)
<http://www.who.int/mediacentre/factsheets/fs279/en/>

- It is expected that by 2026 blood demand will rise above 26%

CONCLUSION: *The dwindling group of young donors and the ageing of society have a direct impact on the decreasing group of regular donors that now represents only 50% of all donors.*

Objective factors influencing decreased blood supply

- 15% of donors cannot give blood because their hemoglobin level, blood pressure or levels of other blood components are outside of the required range¹²
- lack of adequate incentives for the generation of 15-17 year olds, i.e. future potential donors
- because blood demand and blood supplies vary, there is not enough blood especially during the summer months
- because receipt of blood is not harmonized with blood demand, surplus blood – accounting for approximately 2% of blood inventory – is discarded¹³

Subjective factors influencing decreased blood supply

- fear of venipuncture and drawing blood
- lack of time
- lack of awareness about the need for blood donation
- fear of weakening the body
- lack of knowledge about how often and when the donor can safely give blood
- blood donation is often considered “useful craziness”, just like veganism,
- lack of consistent information about specific people who need help – research has shown that blood donors are more willing to give blood in connection with a specific matter or cause and for a specific person

Problems of the blood needy (necessitous)

- the needy do not know how to seek help¹⁴
- the needy are not aware of the number or location of potential donors, and they do not know whether such donors are able to help
- the needy are not sure whether there will be enough blood for them
- the needy do not know that life-saving operations are postponed because, among others, of the lack of blood
- the needy are not aware that there will be less blood in the future

¹² Polish Supreme Audit Office (NIK) Report No. LOP-4101-15-00/2013

¹³ Polish Supreme Audit Office (NIK) Report No. LOP-4101-15-00/2013

¹⁴ <http://umm.edu/about/blood-drives/reasons-people-dont-give>

Short shelf life of red blood cells

Routine blood storage is 42 days or 6 weeks for stored packed red blood cells (also called "BRC"), by far the most commonly transfused blood product, and involves refrigeration but usually not freezing. There has been increasing controversy about whether a given product unit's age is a factor in transfusion efficacy, specifically on whether "older" blood directly or indirectly increases risks of complications¹⁵. Study published in the journal *Anesthesia&Analgesia* has found that after even 21 days, the membranes of stored blood cells have stiffened, apparently the result of damage over time¹⁶. According to analysis was proof fact that transfusion of long stored RBC could cause negative side effects¹⁷. The Fact a first-in-first-out inventory management approach is the standard presently leads to transfuse only 'old' RBC¹⁸.

CONCLUSION: *Transfusion of older RBCs significantly increased the risk of postoperative complications.*

Data on blood donation

- on average, blood is actively donated by 3% of the population¹⁹
- the 18-25 year-old age group give blood least often, and the contribution of this group in donations is shrinking²⁰
- regular donors account for about 50% of all donors²¹
- regular donors are in the 35-55 age group²²

¹⁵ https://en.wikipedia.org/wiki/Blood_bank

¹⁶ For decades, the Food and Drug Administration has limited storage of refrigerated red blood cells to 42 days. But it has been clear for some time that stored blood degrades in various ways long before that six-week limit, and some research suggests that the changes may be harmful to patients who receive older blood.

<https://well.blogs.nytimes.com/2013/03/11/the-shelf-life-of-donor-blood/>

¹⁷ https://journals.lww.com/anesthesia-analgesia/Abstract/publishahead/Transfusion_of_Older_Red_Blood_Cells_Increases_the.97242.aspx

¹⁸ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5515544/>

¹⁹ The collection, testing and use of blood and blood components in Europe

²⁰ According to WHO data, the 18-25 year-old age group accounts for 19% of all donors. In Poland, the group has shrunk from 61.1% in 2010 to 38.8% in 2013 (source: Polish Supreme Audit Office (NIK) Report No. LOP-4101-15-00/2013). In the EU, this age group accounts, on average, for 23% of all donors.

²¹ The collection, testing and use of blood and blood components in Europe

²² People in the 35-55 year-old age group are donors who outgrew their previous 18-24 year-old age and continue to give blood.

Major risks and opportunities

Major Risks

- R1:** Lack of interest on the part of active donors. Cause – the current model is sufficient in their perception.
- R2:** Lack of interest on the part of recipients. Cause – the current model is sufficient in their perception.
- R3:** Emergence of a strong competitor in the market with greater resources for product promotion.
- R4:** Change in the law preventing activity within the scope of facilitating and incentive blood donation.
- R5:** Invention of cheap artificial blood.
- R6:** Recipients and donors giving untrue information in order to donate blood and gain tokens – loss of trust.
- R7:** Low availability of programmers who can write software for the purpose of blockchain can significantly delay implementations of the system and/or raise production costs.
- R8:** Lack of interest on the part of healthcare institutions, NGOs, blood banks.
- R9:** Donors will want to gain benefits as quickly as possible and this will reduce accuracy of donation distribution with respect to demand. Donation not corresponding to the request.

Responses to risks

- R1:** Raising donors' awareness by promotion and marketing campaign
- R2:** Raising recipients' awareness by promotion and marketing by promotion and marketing campaign
- R3:** Connecting with other parties, monetization of tokens.
- R4:** Cessation of prohibited or restricted activities.
- R5:** Supporting the project of cheap blood invention and including cheap blood resources in the system.
- R6:** Restrictive policy of token disposal after having obtained high reputation, and proportional decline in reputation after disposal of tokens. In practice, this results in **one year** of systematic blood donation.
- R7:** Establishing strong cooperation with a party having blockchain-related programming competencies.
- R8:** Ensuring that the system is handed over to blood donors only with the reputation system.

R9. Introducing additional tokens/reputation to cater to requested needs. Rare blood groups, emergencies, a reserve being collected. Introducing additional tokens/reputation for standby donors (reserve).

Opportunities

S1: Interest in the solution exceeding the expected level of interest by over 1% in the first year or in subsequent years.

S2. Serious epidemics, catastrophes, natural disasters, wars.

S3. Increased rate of civilization's ageing process, prolongation of life, more effective treatment of old-age diseases, advances in geriatrics.

S4. Increased incidence of cancer causing a greater number of surgeries.

S5. Large interest on the part of national and international institutions responsible for blood donation.

S6. Interest in cooperation on the part of a large partner operating in the social media market.

S7. Interest in cooperation on the part of a large partner operating in the market of medical services/products.

S8. Interest in cooperation on the part of a large partner operating in the market of insurance services.

Backup plan

P1. If risks 1-6 cannot be avoided/reduced, the operation of the organization may change so that the organization becomes a consulting company whose activity will consist in engaging the community of blood donors and managing a demand-driven blood supply. The main service offered by the organization would be consulting and implementation of blood supply chain for national blood donation systems based on DDOM (Demand Driven Operating Model). Market entry as an expert/consulting/implementation company for e-medical services.

P2. Creation of a blockchain-based community as a demonstrator of a new model of operation of NGO-type organizations.

P3. Creation of a company of a technical expertise in the implementation of blockchain technology in the health service.

Project Brief

Project Definition

Background

- current and future blood deficit
- no system allowing for exchange of blood for additional benefits
- no system for organizing the donor and recipient community
- low participation of donors aged under 30
- ineffectiveness of 15% of potential donations because of an elevated heart rate, inadequate hemoglobin levels or levels of other blood components
- ageing society
- blood remains an indispensable medicine
- the older the patient, the higher the likelihood of necessary blood treatment
- increasing incidence of cancers
- ineffective synchronization of blood demand and supply - blood supply chain not existing and/or dispersed
- no exchange of information between donors and recipients

Project objectives

- to offer an attractive incentive system to blood donors
- to ensure blood availability for all necessitous
- to increase availability of rare blood types
- to provide effective support for the less than 21 day shelf-life inventory strategy
- to appropriately match donors with the need based on Kell antigen system
- to provide a verifiable and effective incentive system for all in need of blood
- the service is to enable organizations to ensure that a needed amount of blood is supplied to the growing human blood market (ageing of society)
- to provide healthcare with a continuous and need-efficient supply of human blood at affordable prices that will allow to perform all needed medical procedures
- to keep blood availability at optimum levels, securing availability to cover 100% needs in the future
- to ensure recipients' safety in terms of their current and future needs
- to make recipients certain they are well-cared for and give them a sense of security by using a system informing about availability and donor response statuses
- to reduce a number of rejected donors (15% of donors)

- to minimize disposal of blood inventory (5% of donated blood) due to expiry of utilization date
- to reduce blood donation promotion/advertisement cost
- to reduce blood storage and management cost
- to cover 25% of global blood market in 15 years, which means we expect BloodChain to be used by individuals and companies to match blood supply and demand for every 4th blood donation transaction globally by 2032. BLOOD tokens in circulation will represent the respective share of the global blood market.

Desired outcomes

- every blood needy person receives blood on time.
- reduced blood deficit
- greater regularity of donors' donations
- activation of young potential donors (14)
- controlled blood supply when needs increase
- prevention of blood destruction and waste
- provision of anticipatory models to determine future blood supply
- anticipation of future increases in blood requirement
- adequate and effective rewarding of donors
- a verifiable incentive system for donors with potential application for other areas of citizens' public activity

Expected Benefits

- **100% cost-effective blood donation promotion system:** All blood promotion costs are inherently and accurately allocated to donors and supporters requested activities.
- **25% blood storage cost reduction in 15 years:** Usually blood gathered as a result of blood donation is stored and preserved for later use in blood transfusion. As the BloodChain social donors network supplies continuously and efficiently all needed blood demands, theoretically blood storage will be obsolete.
- **50% shorten blood shelf-life. Toward the <21 days blood shelf-life inventory strategy.** In the course of studies was profit that after even 21 days, the blood cells have degraded. According to other analysis a transfusion of long stored RBC could cause negative side effects. In fact a inventory management approach based on FIFO (first-in-first-out) favores transfusion of 'old' blood. Bloodchain can deliver blood when it is needed on demand, it reduces necessity of long term blood storage.

Associated outcomes

- promoting a new blood donation platform based on engagement of all system users
- changing blood donation perception by marketing blood donation attractiveness
- ensuring greater understanding of blood deficit problem and bringing it on to people's agenda
- controlling the amount of blood utilized and intended for further processing by pharmaceutical companies
- defining a new market of consumers – blood donors
- creating a price-balanced blood market and an alternative for products that may replace blood (e.g. artificial blood)
- an incentives model applicable for all other tissues.

Project scope and exclusions

- system for donors and recipients intended for use on mobile devices, including location and basic blood and life parameters.
- system is not a health services portal. It is independent from health services.
- system is capable of integrating with the health services system, but it is not an extension of the health services system.
- system's application is limited to local blood donation; however, where possible, it also enables foreigners to donate and search for blood if they are in a location where blood donation system is different than their indigenous one.
- system supports blood collection events organized by foundations and non-governmental organizations.
- it may be needed to arrange blood collection for an injured group – collection arranged by an organization registered in the system

Constraints and assumptions

- territorial and legislative limitation of the system's application corresponding to the scope of activities of national blood donation systems
- system does not guarantee 100% success with regard to timely collection of an expected amount of blood for the recipient

Stakeholders

- blood donors
- blood recipients
- people supporting blood donation (who cannot or are not willing to donate blood for any reason)
- people treated with blood but not directly involved in public blood donation system
- healthcare – governmental organizations
- healthcare – non-governmental organizations – associations, foundations
- commercial organizations involved in the sector of medical services and products
- people interested in a healthy lifestyle
- chronically ill
- insurance companies
- organizations and logistics companies
- IT and data storage services providers, trusted service providers
- blood banks
- Red-Cross
- pharmaceutical companies
- NGO

Interfaces

- medical sector (public and private)
- non-governmental organizations
- funds for new technologies (investors)
- sector of portable devices with readers for reading blood and body parameters
- new social media
- insurance sector
- sector of non-monetary transactions – non-currency transaction systems based on barter, flow of services, exchange of services, sharing
- sector of incentive systems

Economic model

Market

Donors

- EU donors 16 000 000²³
- US donors: 9 500 000²⁴
- Total: 25 500 000

Supporters

Diabetics are a potential strong group supporting blood donation. They can be blood donors in many countries, but not in Poland.

- EU diabetics: 60 000 000²⁵
- US diabetics: 29 000 000²⁶
- Total: 89 000 000

Number of donations globally

- EU yearly: 18 000 000²⁷
- US yearly: 13 600 000²⁸
- Total yearly: 31 600 000

According to WHO, in 2016, there were **112.5** million donations in the world²⁹.

²³ https://ec.europa.eu/health/blood_tissues_organ/eurobarometers/eb822_en and <http://www.euro.who.int/en/health-topics/Health-systems/blood-safety/data-and-statistics>

²⁴ <http://www.redcrossblood.org/learn-about-blood/blood-facts-and-statistics>

²⁵ <http://www.euro.who.int/en/health-topics/noncommunicable-diseases/diabetes/data-and-statistics>

²⁶ <https://www.cdc.gov/features/diabetesfactsheet/>

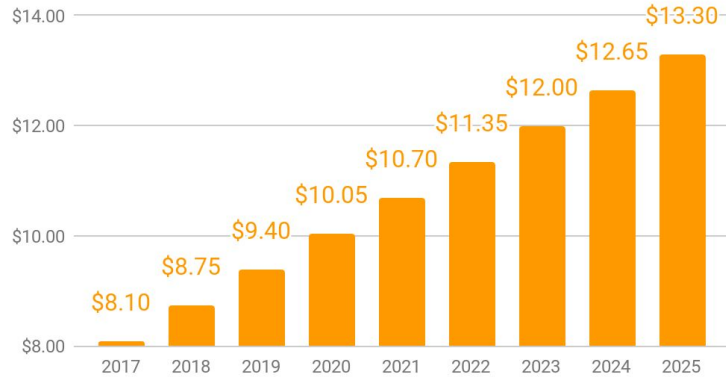
²⁷ <https://www.edqm.eu/sites/default/files/report-blood-and-blood-components-2014.pdf>

²⁸ <http://www.redcrossblood.org/learn-about-blood/blood-facts-and-statistics>

²⁹ <http://www.who.int/mediacentre/factsheets/fs279/en/>

Market of blood and blood products

Figure 2. Blood collection market growth



It is expected that the value of the blood market is going to reach USD 13.3 billion by 2025³⁰, up from USD 8.10 billion in 2017³¹, with an accumulated annual growth rate of 5.3% in the forecast period. Factors such as increasing incidence of both communicable and noncommunicable diseases, growing number of surgical procedures and increasing number of injuries and accidents cause an increase in the market. The risk associated with blood transfusion in underdeveloped regions could delay the growth of the blood market in the forecast period.³²

Health promotion Market

Health promotion enables people to increase control over their own health. It covers a wide range of social and environmental interventions that are designed to benefit and protect individual people's health and quality of life by addressing and preventing the root causes of ill health, not just focusing on treatment and cure³³.

Main groups of parties

- donors (**DON**)
 - they donate blood
- BloodChain network supporters (**SUP**)
 - they carry out reward tasks (e.g. sharing BLM content in social networks).
- partners (**PAR**)

³⁰ <https://www.grandviewresearch.com/press-release/global-blood-collection-market>

³¹ <https://www.grandviewresearch.com/press-release/global-blood-collection-market>

³² Blood Collection Market Worth \$13.3 Billion By 2025 | CAGR: 6.1%

³³ <http://www.who.int/features/qa/health-promotion/en/>

- they direct their products to DON and SUP and profit from high conversion of the profiled offer.
 - they advertise their products and services on BLM platform.
- foundations, associations, other parties that include blood donation promotion in their statutory/program purposes do not sell services into our network (**NGO**)
- BloodChain application (**BLM**)
- trust service providers (**TSP**)
 - service providers (computing nodes)
 - sensitive data storage
 - personal data storage
 - keeping VPN
 - providers of trust services in cross-border transactions described in eIDAS Regulation (EU) No. 910/2014
- medical facilities: blood collection facilities, hospitals, blood banks (**MED**)
- investors, people involved in project development (**INV**)

Model description

*Reputation (**REPUT**): internal unit in BloodChain application layer. It has no unit-of-exchange character. Reputation can be obtained or lost as a result of a user's activity. Reputation cannot be sold, bought or transferred.*

Access to discounts on offers directed to the network, access to dedicated services for people with a high reputation depends on the user's reputation level.

*Token: **BLOOD** (BloodChain Token). BLOOD tokens are characterized by features of a unit of settlement and they are obtained for contributing value to a cooperative structure referred to as Decentralized Cooperation (DC). Tokens operate both within BloodChain ecosystem and external market – they can be sold, bought or transferred.*

BLOOD tokens are issued on Ethereum blockchain. The tokens are distributed from BLM address to addresses of other parties within the DC as a result of blockchain smart contracts implementation.

Quantitative token distribution model

The token distribution model assumes the division of tokens into following tranches:

- **Developers.** This tranche is intended for people who actively build the system. It will be a kind of a bonus for the effort taken to build the solution, and a reward if the project is successful.

- **Investors.** This tranche is intended for initial investors whose funds will be used for the development of the platform.
- **Blood donors.** This is the largest tranche, aimed at motivating donors to donate blood. It is expected that with increase in the number of donors, the number of tokens issued per donation will be systematically reduced. The aim of this is to motivate donors to contribute to the development of the platform at the earliest stage.

The relationship between the different tranches will be determined during preparations for the ICO.

MVP model

Granting reputation/distributing tokens

- ***Sharing blood group information***

For sharing his blood group information, the donor (DON) obtains 100 reputation points (data saved in BLM application layer) and 100 BLOOD tokens (data saved in the portfolio on Ethereum based on smart contract).

- ***Donating blood***

For each properly donated 450 ml of blood, the donor (DON) obtains 1000 reputation points (data saved in BLM application layer) and 1000 BLOOD tokens (data saved in the portfolio on Ethereum based on smart contract).

- ***Sharing content***

For sharing BLM content through social networking sites, the BLM user, not only donors – referred to as SUP in the model – obtains 1 reputation point (data saved in BLM application layer) and 1 BLOOD token (data saved in the portfolio on Ethereum based on smart contract).

- ***Community work***

For work for the benefit of the BLM community, each BLM user, not only each DON – referred to as INV in the model – obtains tokens (data saved in the portfolio on Ethereum) per one hour of work. Tokens are issued from a specifically designated pool as part of token distribution process. For the work, only tokens, and not reputation points, are obtained.

- **Community-oriented investments**

For financial contribution for the benefit of the BLM community, each BLM user, not only each DON – referred to as INV in the model – obtains BLOOD tokens (data saved in the portfolio on Ethereum) in accordance with a determined conversion factor [see details in the attached monetization model].

- **Blood donation incentivization/promotion**

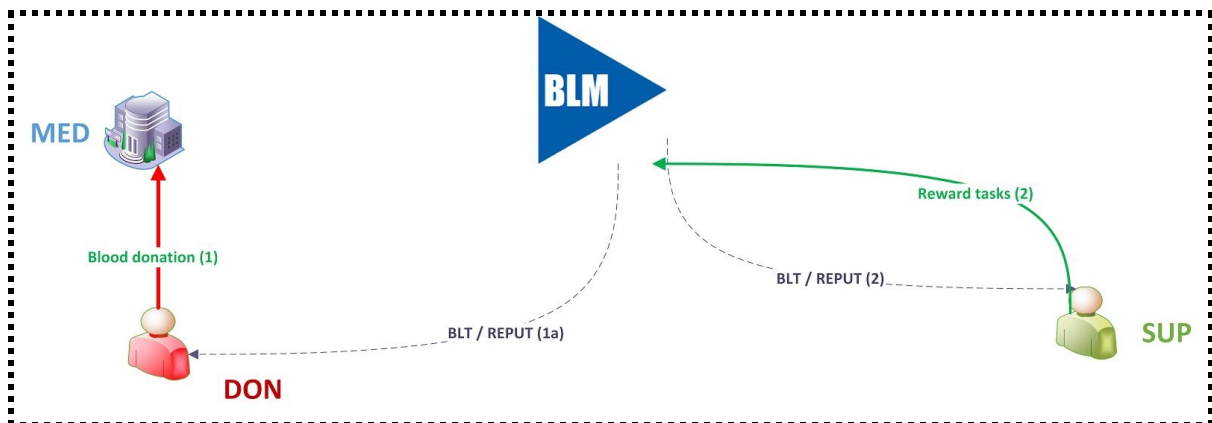
In order to test the model and for the purpose of blood donation incentivization, foundations, associations, other parties that include blood donation promotion in their statutory/program purposes – referred to as NGO in the model – obtain tokens from BLM (data saved in the portfolio on Ethereum) in accordance with individual rules and needs.

- **Community-oriented services**

For provision of services for the benefit of the BLM community, service providers – referred to as TSP in the model – obtain BLOOD tokens (data saved in the portfolio on Ethereum) in accordance with a determined conversion factor [see details in the attached monetization model].

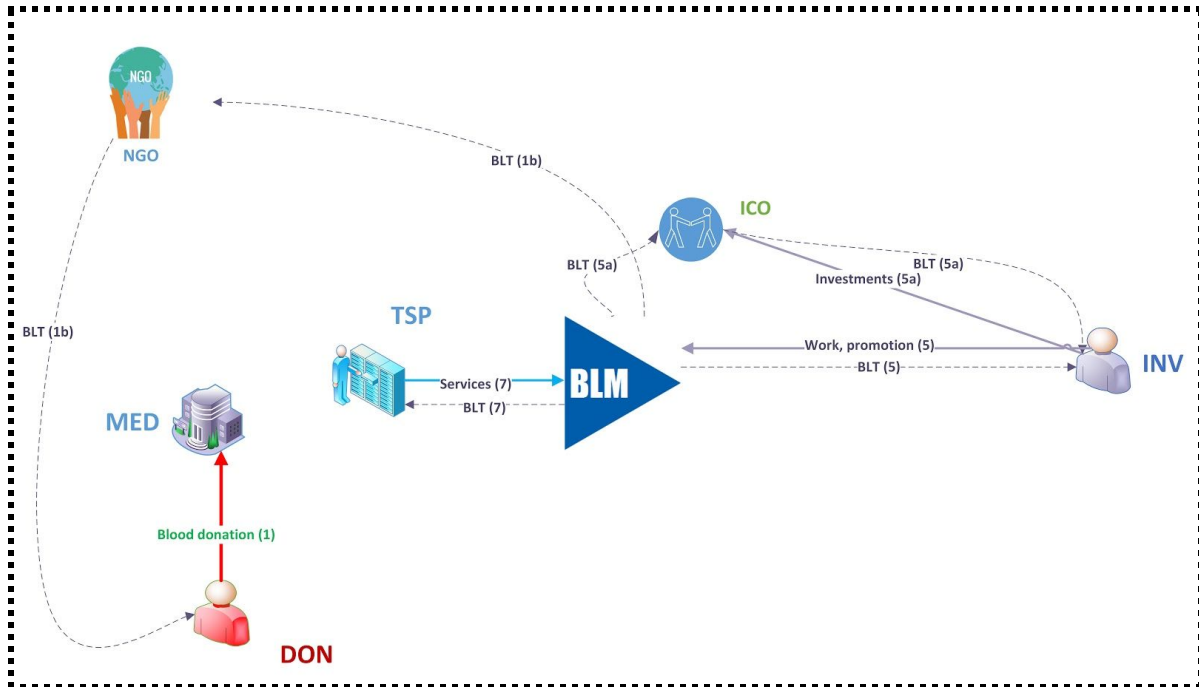
Therefore, at the initial stage, **reputation and tokens** are obtained:

- by DON from BLM as an incentive to donate 450 ml of blood to MED (1a), and properness of each such donation (1) will be verified by BLM.
- by SUP from BLM for fulfillment of reward tasks (2).



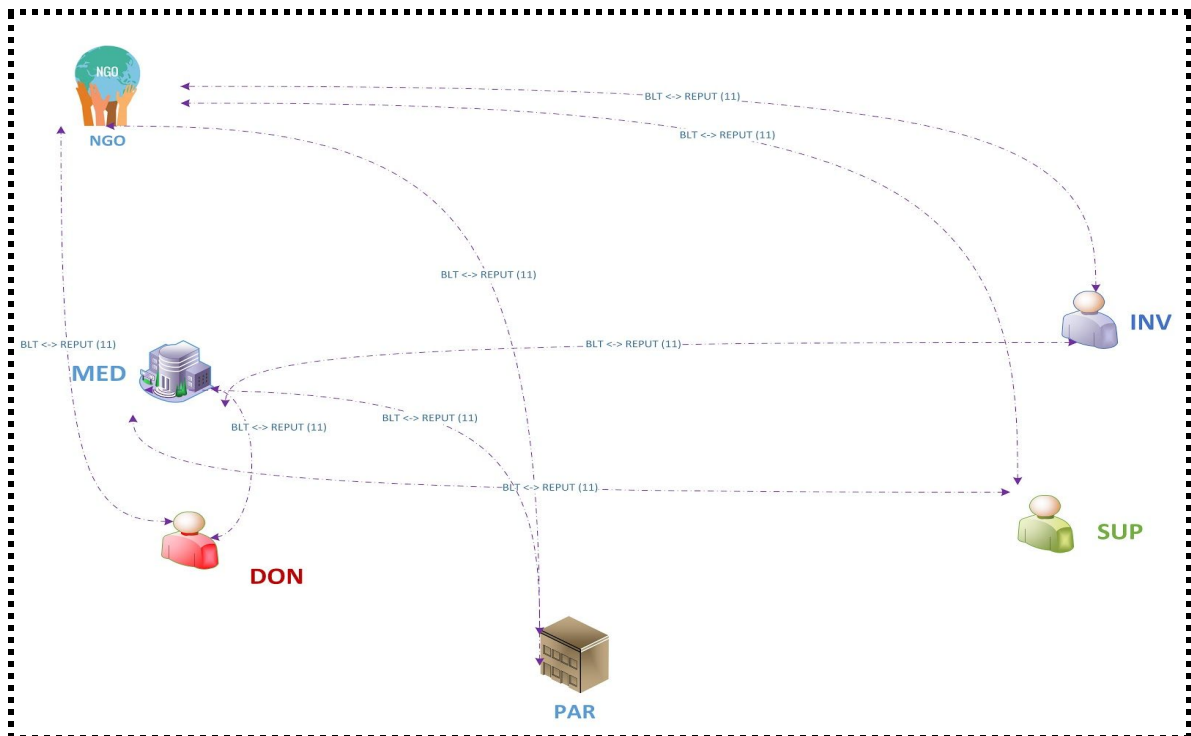
Tokens without reputation are obtained:

- by NGO from BLM (1b) as part of “test packages” in order to test the platform and create an additional incentive for DON (1b), simultaneously encouraging DON to donate 450 ml of blood to MED (1).
- by INV from BLM for work for the benefit of the DC or promotion of the DC (5) and for investments in the form of financial resources contributed by them (e.g. in an ICO) (5a).
- by TSP from BLM for services provided for the benefit of the DC (7).



Furthermore, **tokens without reputation** can be issued:

- by any user (DON, SUP, PAR, INV) for the benefit of NGO and MED. Issue of tokens into NGO and MED raises the issuers' reputation (11). In contrast, tokens cannot be given to other users.



Limits

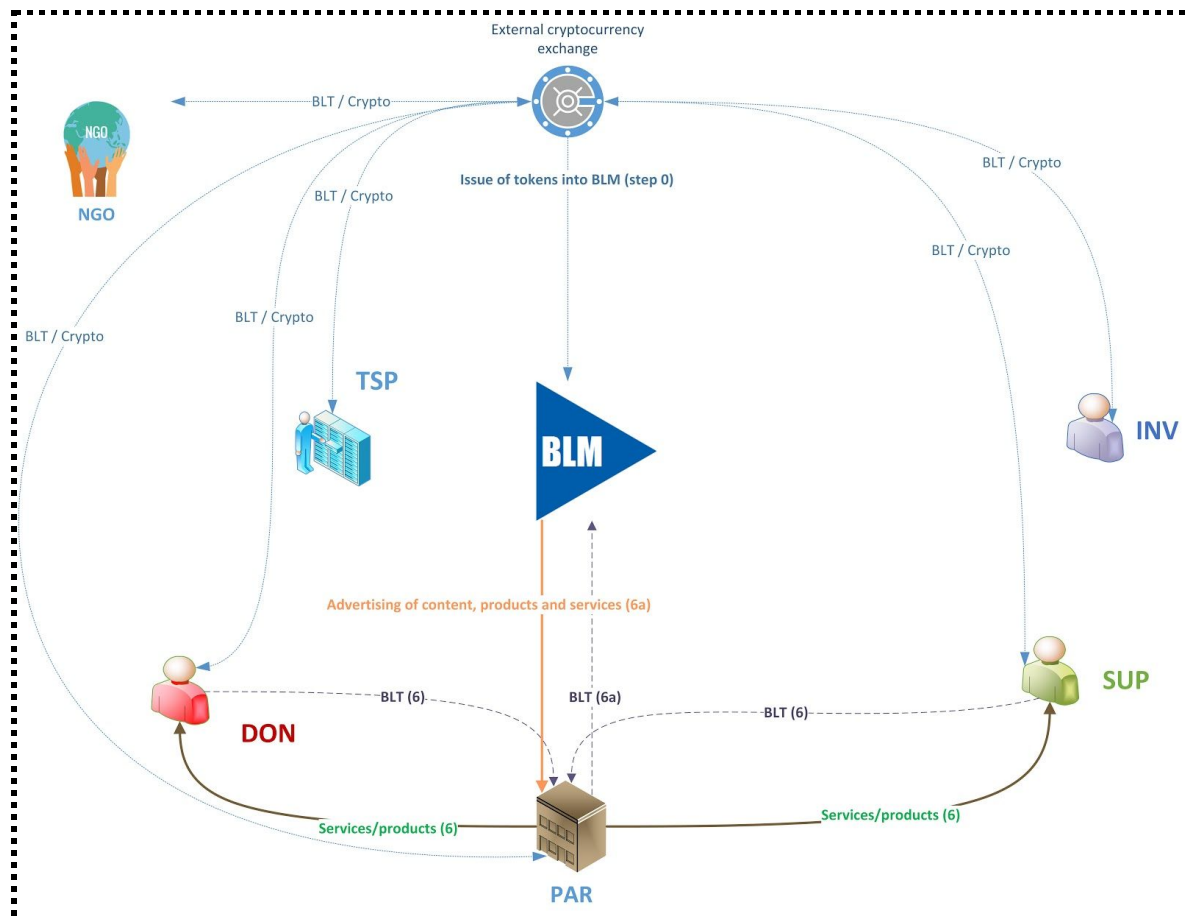
In order to limit the process of “marketization” of BLOOD, possible use of tokens obtained in connection with blood donation by DON is limited to the level of reputation in the system. After donating blood, DON obtains an appropriate number of tokens that can, however, be “unlocked” only (condition under smart contract) after 4000 reputation points (3000 for women) have been obtained. Once the reputation points have been obtained, BLOOD tokens are “unlocked” and DON is entitled to use or sell them. This allows to minimize the risk of the DC being accessed by unfair DON who are driven only by profit. Sale of tokens causes loss of reputation in BLM application layer (private blockchain). The loss is proportional to the sold tokens, which acts as an encouragement to carry out more tasks and thus obtain a reputation level releasing token disposal options. In practice, this mechanism allows to eliminate the risk (Risk No. R6) of giving untrue information/concealing information to obtain benefits from the sale of tokens. Lack of activity (failure to participate in the system, failure to donate blood, failure to share) results in loss of reputation.

Trade

BLOOD can be exchanged for goods or services offered by PAR (6) (offer addressed to DON and SUP).

In turn, PAR may use the obtained BLOOD tokens in exchange for advertising their own content, products and services on BLM platform (6a).

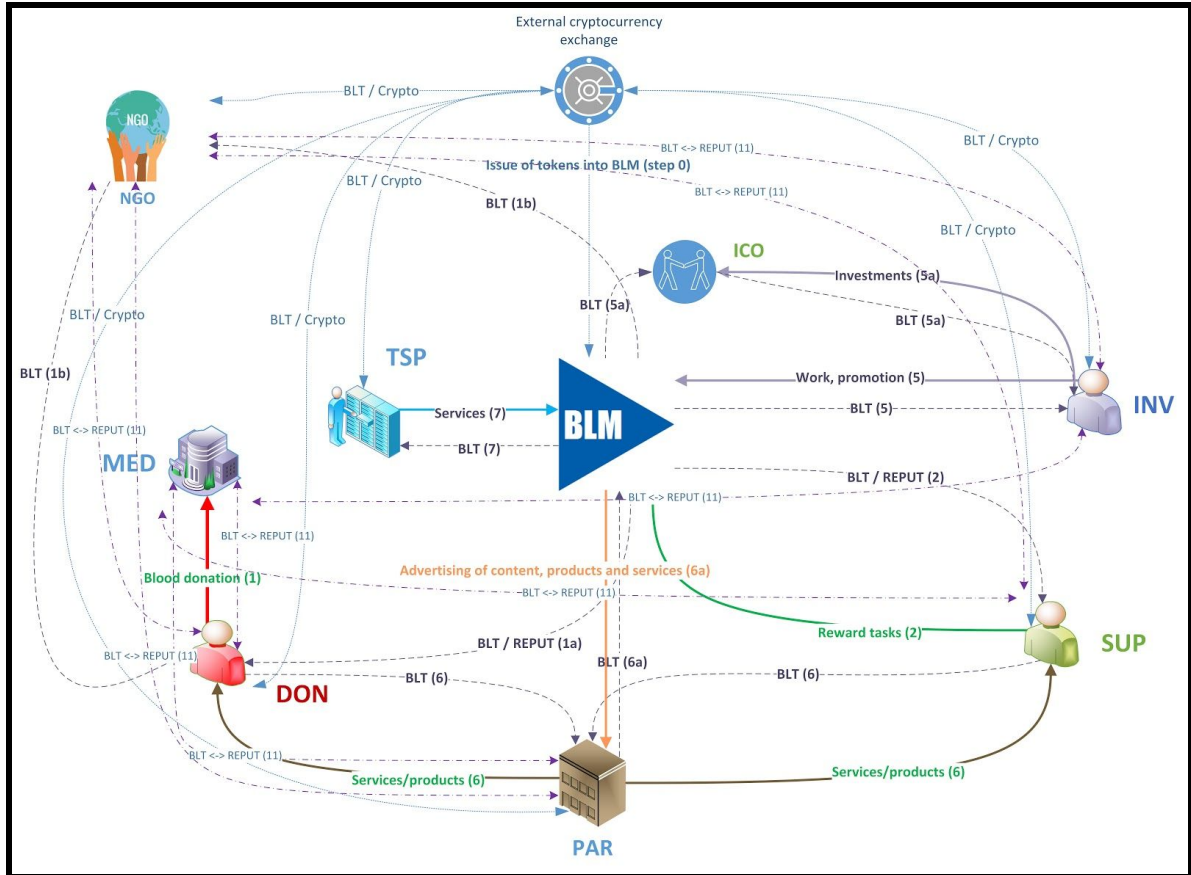
BLOOD tokens are also the object of trade on an external cryptocurrency exchange; therefore, each subject (DON, SUP, PAR, NGO, TSP and INV) within the DC may sell/purchase them on the market at their current market price.



In the MVP model, apart from the transfer of tokens through BLM to DON and SUP and the establishment of a cycle of values between DON, SUP and PAR, the objective is to get NGOs interested in the platform through initial distribution of “test packages” of tokens, which will enable NGOs to test the platform and meet their statutory/program purposes. If this objective is achieved and NGOs express continued interest in this form of donor motivation, NGOs will be able to purchase tokens on the exchange, thus giving tokens a market value.

This is the basic mechanism of value creation in the MVP model. Tokens are issued into the cycle in this manner until the cycle becomes “saturated” with tokens and the market mechanism starts to operate – see the FULL model.

Graphic presentation of the MVP model



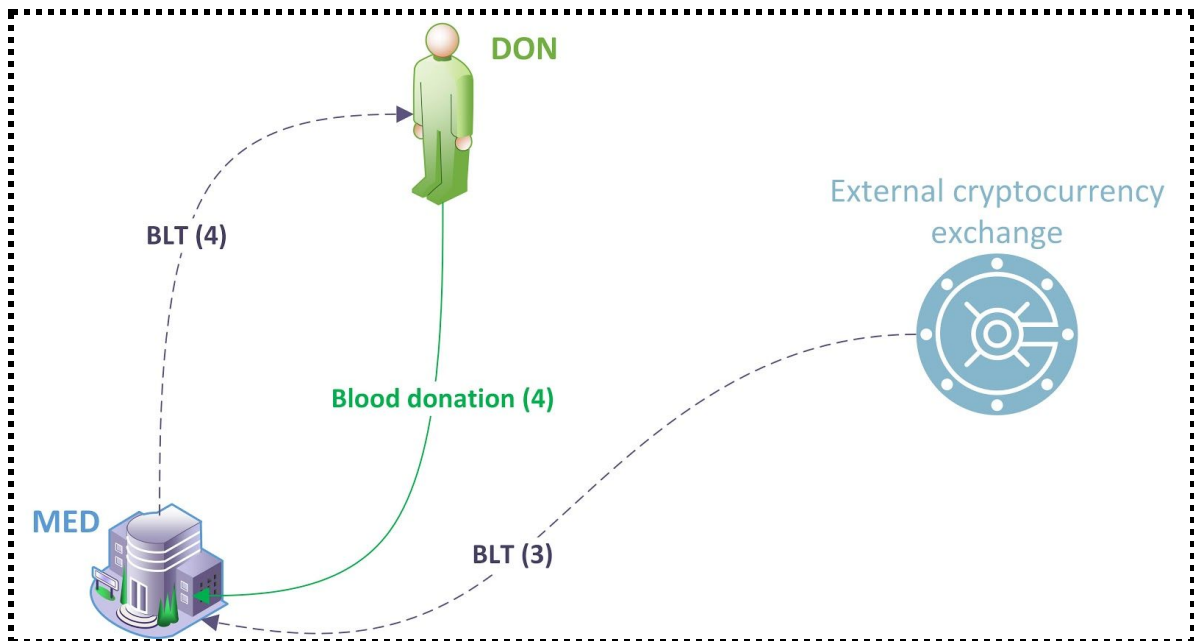
BloodChain model 1.0

Introduction of MED into trade

Launching a full market mechanism is understood as emergence of requirement for BLOOD on the part of MED – MED will start to buy BLOOD on cryptocurrency exchanges (3) to then transfer it to DON through BLM platform (“test packages” may also be distributed among MED for the purpose of testing the platform). By buying tokens, MED will buy incentives to donate blood. Next, by offering tokens purchased through MED platform, MED will create an incentive with specified parameters (location, group, time,

criteria for quality) for DON. DON will be able to use the incentive and donate blood at a blood collection facility. Effectiveness of blood donation by DON and fulfillment of the conditions of an incentive created by MED will be confirmed by BLM platform, which will “release” the incentive to relevant DON as a reward.

Emergence of requirement on the part of MED depends on MED's interest, and MED will become interested when a DON base, sufficiently large for MED to direct their incentives to specific donors, is created. When MED become interested, BLM will stop to transfer tokens as an internal incentive – this step is subject to a decision by the DC (decision-making mechanism – see below). Once the issue of new tokens through BLM has been blocked, BLM application does not generate new tokens in the process of creation of incentives for DON. DON are still motivated to donate blood by incentives in the form of tokens; however, at this stage tokens are already obtained from MED (4) and not generated by BLM. BLM retains its ability to “supplement” the cycle with additional tokens if a need arises [to determine whether the mechanism for issuing new tokens is automatic on the basis of fulfillment of specific conditions or decision made by members of the DC].

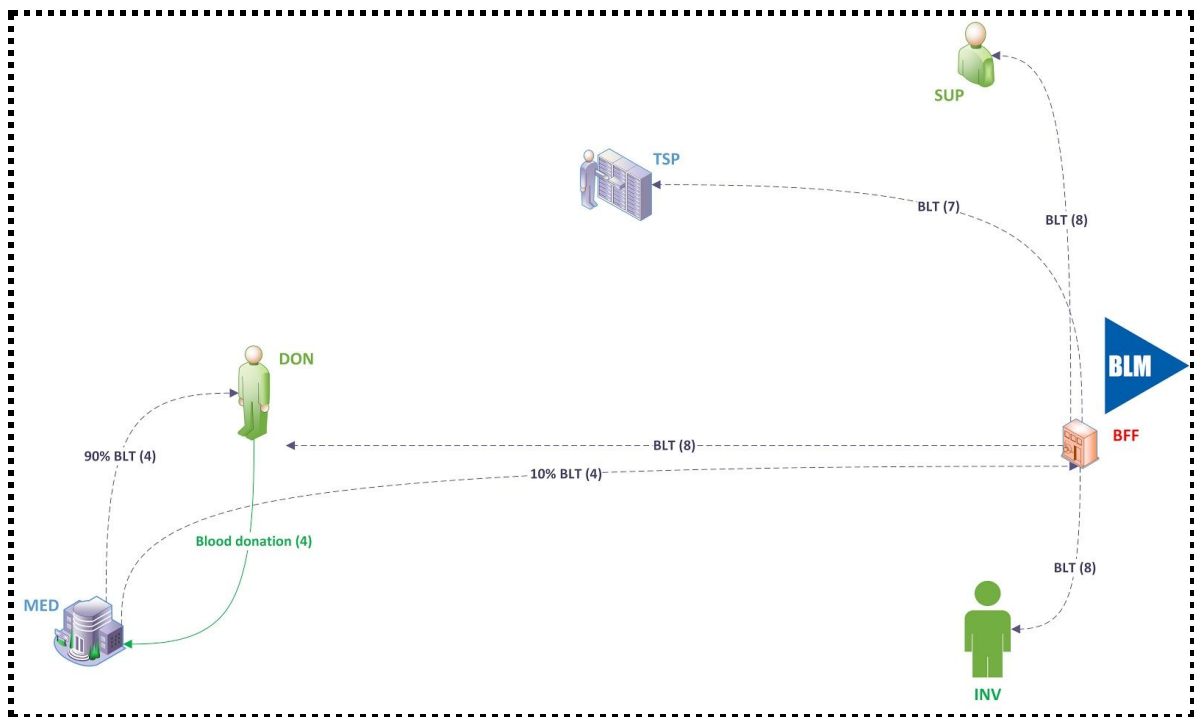


Blodon Foundation Fund (BFF)

As part of transaction consisting in transfer of BLOOD through MED to DON in exchange for the donated blood, part of the total amount of transferred tokens (10%) is transferred to BLM Blodon Foundation Fund (4). If payment is made with reputation, tokens will be contributed to the BFF.

BFF is created for the purposes of:

1. settlement with infrastructure service providers (TSP) (7) with the use of BLOOD tokens (TSP) (7) (in the full version of the model)
2. surpluses create Blodon Foundation's special-purpose fund for:
 - development of BloodChain open standard (donor/supporters/needly network)
 - blood donation promotion
 - research and development of new social technologies for blood donation and health service
 - foundation's operating costs
 - charity (1% of the BFF will be regularly spent for blood related charities worldwide)



Trade

In the full model:

- MED and NGOs buy BLOOD tokens on an external exchange at the market price.
- DON obtain BLOOD tokens from MED and NGO and may exchange tokens at PAR for services and products or sell them on an external cryptocurrency exchange or donate them to NGO thus helping twofold.
- SUP obtain BLOOD tokens from BLM for reward tasks and may exchange tokens at PAR for services and products or sell them on an external cryptocurrency exchange or donate them to NGO thus helping twofold.

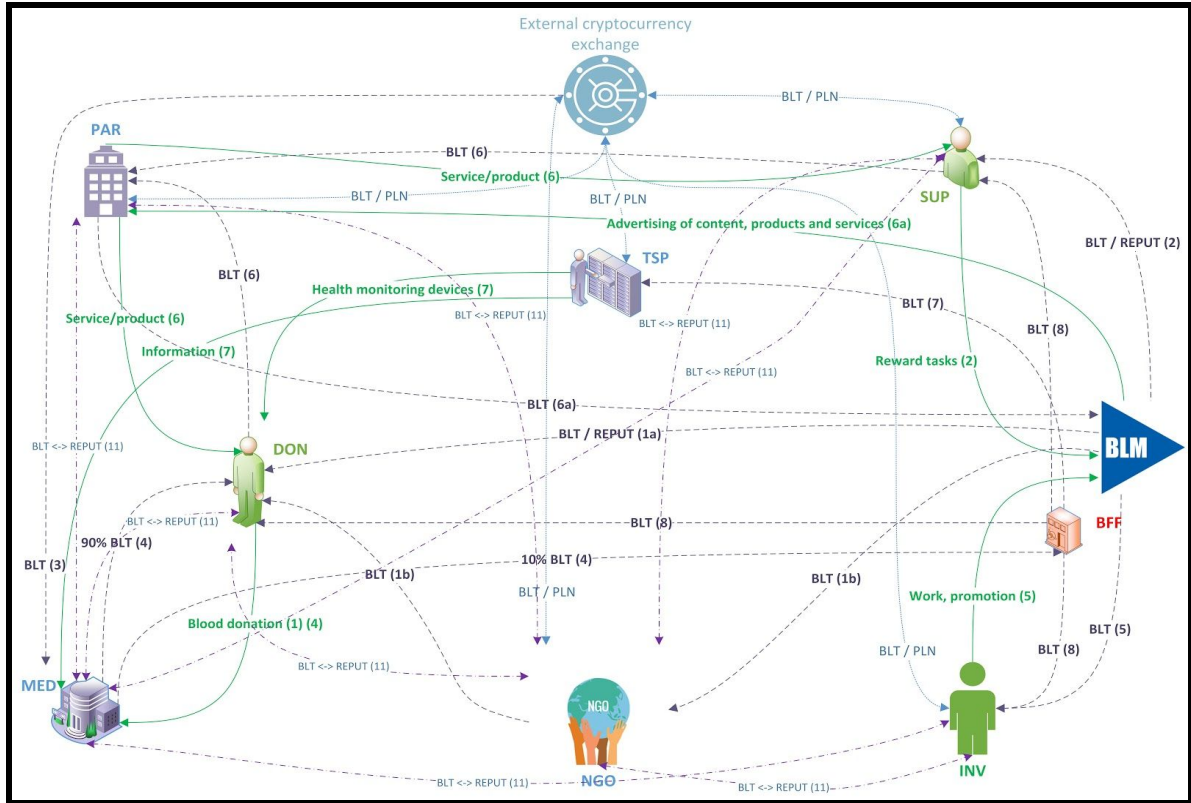
- PAR obtain BLOOD tokens from DON and SUP and may sell these tokens on an external cryptocurrency exchange or exchange them for advertising on BLM platform (website or mobile application).
- TSP obtain BLOOD tokens from FT in exchange for services provided for the DC (DON information management, support of monitoring devices) and may sell them at the market price on a cryptocurrency exchange.
- INV either obtain tokens from BLM at the initial stage of project development, in exchange for supporting the project by working for its benefit and promoting it, or buy tokens (in an ICO or from other parties from the DC on a cryptocurrency exchange) assuming future increase in their value, with an intent to resell them with profit. They may sell tokens on a cryptocurrency exchange at any time at the market price.

In the full model, the market mechanism within the DC relies on MED creating demand for BLOOD tokens. MED is willing to purchase BLOOD because in this way MED can further motivate donors and adjust their current blood demand to the DC's resources.

MED may offer tokens purchased on the market to DON depending on current blood demand: if at a particular time in a specified geographical area there is an increased demand for specific blood group, MED is able to offer particular DON a greater number of tokens, thereby additionally motivating particular DON to donate blood. This increases the effectiveness of blood donation platform as the resources of needed blood groups are increased and the surplus inventory of more common blood groups are decreased.

Individuals can also contribute the need for blood donation without the need to hold any tokens. They can simply create an account and share the need through their social profile. In this way, they will gain 0.0001 token, supplying the network with information about the demand.

Graphic presentation of the FULL model



Decision-making mechanism

Depending on the result of the underlying hypothesis test for the MVP model:

- Option A) Users prefer reputation as the main motivation,
- Option B) Users prefer tokens as the main motivation,

any reputation (A) or token (B) owner will be entitled to make decisions concerning the DC, for example:

- under Option A, decisions on changes to the rules of granting the reputation or decreasing it due to lack of activity;
- under Option B, decisions on “supplementing” the cycle with new BLOOD tokens (for example, in connection with the market entry of a new country) or determining a percent of resources transferred to the FT or division of FT surpluses.

The weight of a member's vote cast during the DC's decision-making process depends on the proportion of reputation points (A) or tokens (B) held by the member in relation to the remaining reputation points (A) or (B) tokens.

Contribution to the system

- DON
 - volunteering blood donation
 - constant sharing of information on health status (e.g. through the use of health monitoring devices provided by TSP) with MED
- SUP
 - DC promotion
- PAR
 - offering services and products to SUP and DON in exchange for tokens, additional incentivization of blood donation
- NGO
 - purchasing tokens in order to fulfill an organization's own statutory/program purposes
 - MED (blood collection facilities (RCKiK), blood banks)
 - blood collection and storage
 - reporting blood demand
- TSP
 - authentication of donors and supporters
 - PoV verification
 - storage and management of the system's information layer, sharing information with MED
 - provision and ongoing support of health monitoring devices for donors
- BLM
 - creating and maintaining the application infrastructure
 - DC promotion
 - coordinating the parties, informing them about the system's possibilities
 - TSP settlement
 - system management
 - taking decisions within the DC
- INV
 - financial resources for project implementation (ICO)
 - time, knowledge, energy
 - DC promotion
- BLODON - Software Development Company responsible for delivering first versions of open software network Bloodchain
- BFF (Blodon Foundation Found) - Foundation governing network open standard and surpluses by BFF's special-purpose fund for:
 - development of BloodChain open standard (donor/supporters/needly network)

- blood donation promotion
- research and development of new social technologies for blood donation and health service
- foundation's operating costs
- charity (1% of the BFF will be regularly spent for blood related charities worldwide)
- BloodChain - Blockchain based network of cooperation

Benefits from participation in the system

- DON
 - blood donation on a voluntary basis, social usefulness
 - certainty that the collected blood corresponds to the actual demand (it is less likely that surplus inventory will be sold to pharmaceutical companies)
 - obtaining honorary distinctions, boosting reputation (gamification elements)
 - additional benefits offered by partners (swimming pool, gym passes, Multisport, discounts on health-promoting products and services, etc.)
 - possibility of exchanging the obtained BLOOD tokens for other cryptocurrencies on the exchange
- SUP
 - sense of participation in a socially useful project
 - obtaining honorary distinctions, boosting reputation (gamification elements)
 - additional benefits offered by partners (swimming pool, gym passes, Multisport, discounts on health-promoting products and services, etc.)
 - possibility of exchanging the obtained BLOOD for other cryptocurrencies on the exchange
- PAR
 - increased sales through exchange of services and products for BLOOD obtained from DON with possibility of further resale
 - reputation resulting from widely understood support for blood donation initiatives and donors
 - promotion of content, products and services
 - acquisition of potential clients
 - possibility of exchanging the obtained BLOOD tokens for other cryptocurrencies on the exchange
- NGO
 - fulfillment of an organization's own statutory/program purposes (blood donation promotion)
- MED

benefits for blood collection facilities:

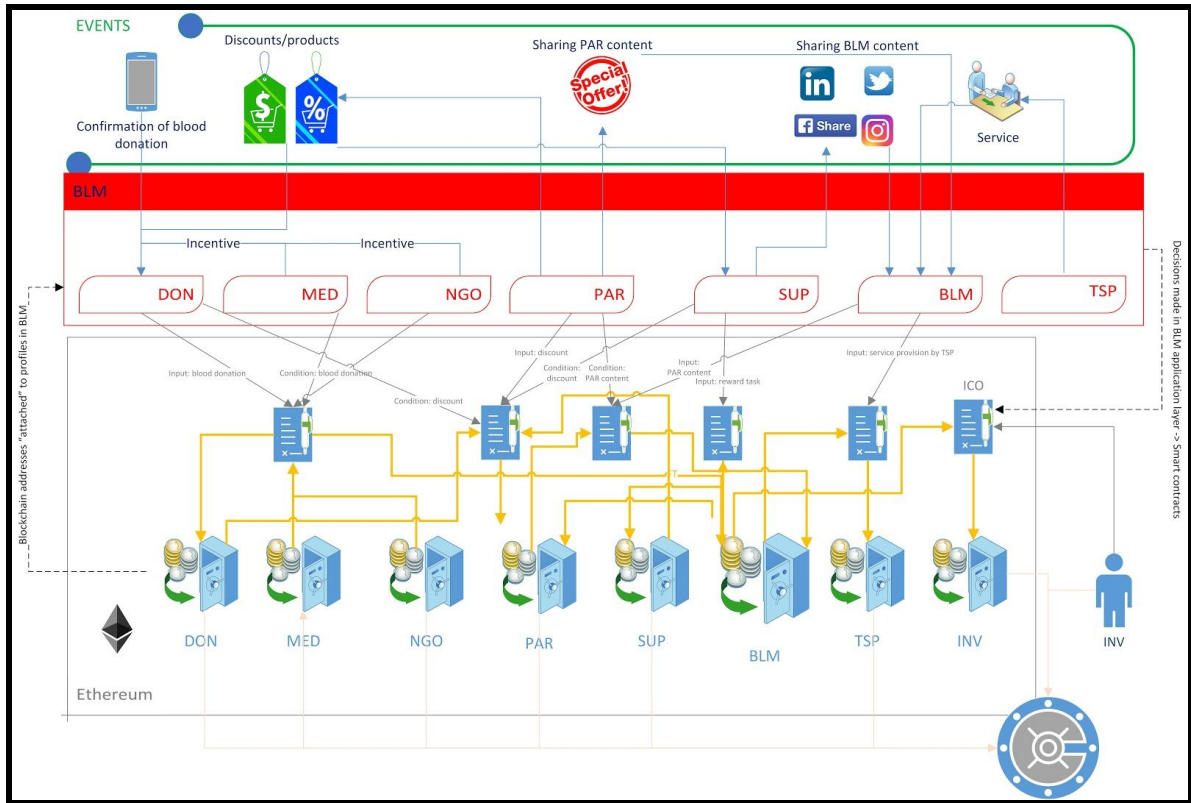
- shortened process of donor verification
- credibility of donors – the system rewards regular healthy donors and permanently rejects donors who fail to meet the requirements
- availability of full history of donations
- possibility of activating blood donors by blood group depending on current needs and availability of rare blood groups thanks to access to specific donors
- no need for storage of surplus inventory

benefits for hospitals:

- increased availability of rare blood groups
- full history of donors
- credibility of donors – the system rewards regular healthy donors and permanently rejects donors who fail to meet the requirements
- TSP
 - remuneration (in BLOOD tokens) for authentication and other ICT services for donors or supporters
 - possibility of exchanging the obtained BLOOD tokens for other cryptocurrencies on the exchange
- BLM
 - improving an inefficiently operating blood donation system by ensuring a better match of blood supply and demand
 - minimizing waste by monitoring blood donors' health
- INV
 - division of transaction fund surpluses in proportion to the owned BLOOD tokens
 - possibility of exchanging BLOOD tokens received as part of investment or for work contribution for other cryptocurrencies on the exchange

Ethereum – smart contracts – BloodChain relationship

BLM application layer is the starting point for implementation of the model outlined above. The application users' profiles are dependent on user category: DON, MED, NGO, SUP, TSP. From the profile view, it is possible to “attach” – in Ethereum network – an address from which/to which tokens will be transferred during the execution of smart contracts.



Example scenarios based on smart contracts

1. MED or NGO create an incentive to donate blood in accordance with specified parameters (location, group, time) by posting relevant information in BLM application. Within the application, the information is transferred to potential DON who express readiness to donate. In parallel with this, a smart contract is created in Ethereum, which “locks” tokens offered as an incentive to MED's and NGO's addresses “attached” to BLM, and “releases” these tokens if the information (input) confirming proper blood donation is received from BLM application. The confirmation PoB ([Proof of Blood](#)) is an automated process after blood has been donated by DON . At the time of receipt of such confirmation (input) from BLM, the contract is executed and DON receives tokens, which were previously offered as an incentive to donate, at the address “attached” to the application.
2. BLM rewards SUP for carrying out reward tasks. Smart contract, which is created on Ethereum, “releases” an appropriate number of tokens to appropriate SUP after the confirmation (input) that the task has been carried out is received from the BLM application. Each reward task is carried out on the SUP account on BLM platform,

e.g. sharing BLM content on a social networking site on SUP account. BLM platform records the confirmation that the task has been carried out, the corresponding input is transferred to the smart contract and SUP is rewarded by transfer to the address “attached” on BLM platform.

3. BLM rewards TSP for providing services for the benefit of BLM. Smart contract, which is created on Ethereum, “releases” an appropriate number of tokens to appropriate TSP after the information (input) confirming that the service has been provided is received from the BLM application. BLM platform records the confirmation that the service has been provided, the corresponding input is transferred to the smart contract and TSP is rewarded by transfer to the address “attached” on BLM platform.

Before implementing a system based on smart contracts, it is planned to have the contracts audited by an external independent entity specializing in this type of activity.

Token distribution model

Details of the token distribution model:

https://docs.google.com/spreadsheets/d/1vHTrzuy5VaLR_T7uGitp41SN1omBmhX4qZwjE97-be4/edit?usp=sharing

What is BloodChain token (BLOOD)

BloodChain token is the first cryptographically-secure token that transparently rewards blood donors and blood donation supporters who make contributions that benefit the community. Blodon team strongly believes in building a distributed blood donation network that will fall into the hands of the donors and supporters resulting in the disruption of the existing fractionated, ineffective and non-holistic blood donation incentive schemes. Blodon strives to create the blood donors and supporters community by rewarding people who provide valuable contributions with new token. Through this reward system, we see a rise in a secure and distributed token that will be able to reach a broad market, including a vast number of people who have yet to participate in any distributed sharing economy.

A “BLOOD” refers to one individual BloodChain token and because it is an ERC20 token, it is configured to be used globally by all individuals and its value is derived from the exchange with Ether. The symbol ‘B’ has been chosen to represent a BLOOD.

Token distribution roadmap

BLOOD tokens will be issued following the 2 mechanisms:

- 1) Token creation
- 2) Proof of Blood

Token creation

As of November 15, 2017 the following steps have been planned:

Step 1. The total amount of 99,000,000,000 (ninety nine billion) BLOOD will be created by BloodChain Foundation

Step 2. 14,000,000,000 (fourteen billion) BLOOD will be distributed as part of pre-sale phase. Pre-sale arrangements will take place based on individual agreements with workers, partners and investors

Step 3. Public token sale event will take place, further called ICO, where 65,000,000,000 (sixty five billion) BLOOD will be sold to general public

20,000,000,000 (twenty billion) BLOOD will be kept by blodon company

Around 2,000,000,000 (two billion) BLOOD tokens is expected to be issued based on Proof of Blood smart contract mechanism.

Pre-sale

Planned pre-sale period:

Month XX, 2018 – Month YY, 2018

Price:

\$0,00005 or 0,000000154 ETH (considering \$330 USD/ETH exchange rate)

Hard-capped pre-sale supply:

14,000,000,000 (fourteen billion) BLOOD = 713,529 USD

Funds allocation:

1. Creation of MVP – establishing a team of front and backend developers, programming and launching the first version of the software
2. Marketing – advertising the project, presentation of the project on conferences and meetups
3. Advisory – building a team of project advisors, blood donation enthusiasts
4. ICO – preparation and launch of public token sale
5. Legal fees

ICO

Planned ICO period:

Month Z, 2018 – Month Q, 2018

Price:

\$0,00008 or 0,000000257 ETH (considering \$330 USD/ETH exchange rate)

Hard-capped ICO supply:

65,000,000,000 (fourteen billion) BLOOD = 5,521,356 USD

Funds allocation:

1. Creation of full version of the software
2. Marketing – global communication campaign for acquiring users and partners
3. Administration – covering costs of the first nodes
4. Maintenance

Proof of Blood

In addition to the 99,000,000,000 of BLOOD created, new tokens will be created by the smart contract for the value brought to the distributed network. Every time a donor will donate blood and input this information into BloodChain smart contract the donor will be rewarded with newly minted BLOOD. The Proof of Blood mechanism is designed to incentivize donors for joining and using the BloodChain platform as well as to incentivize supporters to share information about BloodChain via their social networks.

Main activities to be rewarded by the Proof of Blood mechanism:

- blood donation
- share of blood type
- share of BloodChain content in social networks

Each of the above activities will be rewarded with different amount of new tokens. Rewarding mechanism is of exponentially decreasing nature – the amount of tokens issues as a reward decreases after a certain threshold by 50%.

Blood donation

First BloodChain blood donors will be rewarded with 1000BLOOD for donating 450ml of blood. The reward will decrease after every 900,000 donations, so that 900,001 donation will be rewarded with 500BLOOD instead of 1000BLOOD, and 1,800,001 with 250BLOOD and so forth.

Share of blood type

Every blood donor will have a possibility to share their blood type with the network. This information will be shared anonymously and will be accessible by those in need of blood. First blood type information shares will be rewarded with 100BLOOD. The reward will

decrease after every 900,000 donors share their blood type with BloodChain, so that 900,001 donor will be rewarded with 50BLOOD instead of 100BLOOD, and 1,800,001 with 25BLOOD and so forth.

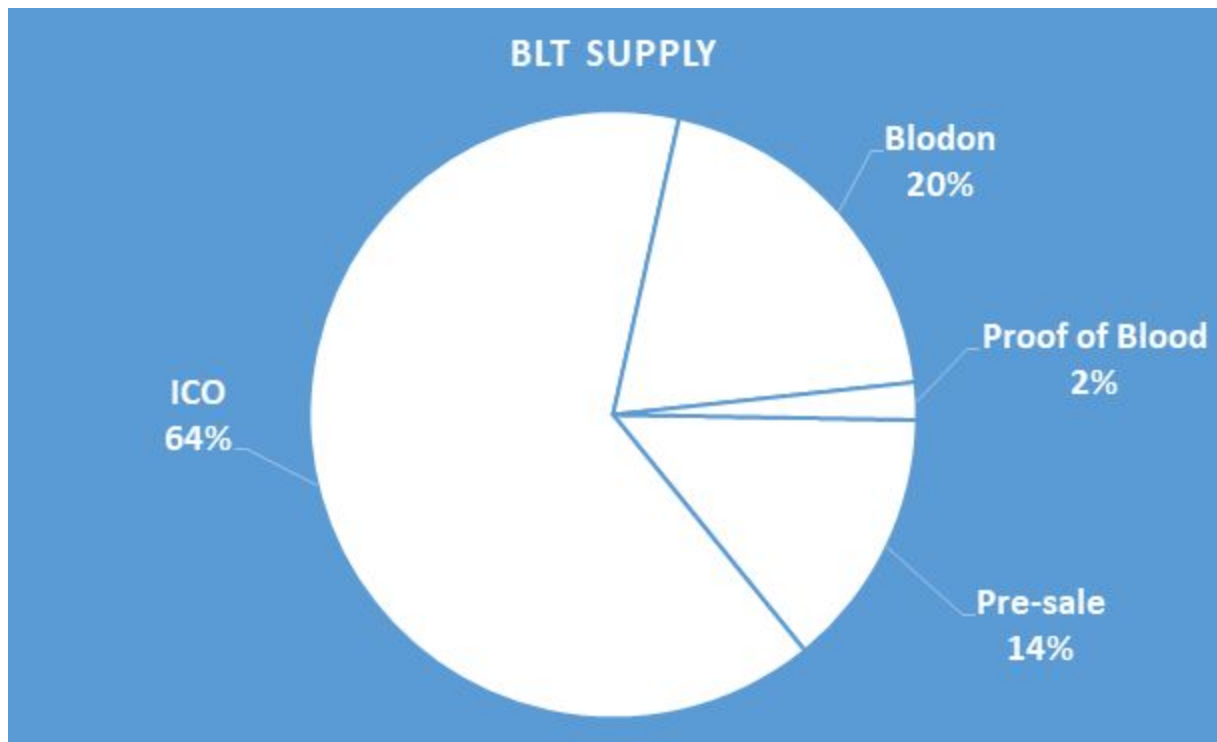
Share of BloodChain content in social networks

In order to increase users' participation in spreading the information about the BloodChain platform, platform users (not necessarily donors) will be rewarded with 1BLOOD for each confirmed sharing of BloodChain content via social networks, such as Facebook, Instagram, LinkedIn etc.. The reward will decrease after every 4, 450,000 information shares, so that 4, 450,001 share will be rewarded with 0,5BLOOD instead of 1BLOOD, and 8,900,001 with 0,25BLOOD and so forth.

The above exponentially decreasing mechanism is designed to outweigh the expected BLOOD market price increase as well to incentivize first users of the platform. Proof of Blood mechanism is will ultimately stop issuing new tokens. By that time the BloodChain ecosystem is expected to generate enough demand to reward the above activities with tokens on a market basis.

Total supply

The total BLOOD supply is planned and estimated to be as follows:



Fundamental BLOOD price

It must be understood that the meaning of BLOOD token and its value for different participants in the BloodChain ecosystem may vary and therefore the price to be yet determined by the market. The market price will be driven primarily by transactional (users buying tokens to access to the platform functions) as well as speculative demand. At the same time, fundamental price of the token may not be influenced by its market valuations.

In the below calculation we present an estimation based on some conservative assumptions. The calculation shows the potential of the network and therefore the future value of its tokens. 112,500,000 donations take place worldwide annually. The global blood market is worth \$7,650,000,000 currently, with its expected growth to \$9,900,000,000 in 2021, which gives a 29% 5-year growth rate. Using this rate, we estimate the market to grow to \$16,306,000,000 in 2032.

BloodChain's goal is to cover 25% of global blood market in 15 years, which means we expect BloodChain to be used by individuals and companies to match blood supply and demand for every 4th blood donation transaction globally by 2032. BLOOD tokens in circulation will represent the respective share of the global blood market. Based on the above assumptions we expect 1 BLOOD to be valued \$0,04036 which gives almost 80,000% return on investment if tokens purchased during pre-sale and 47,000% if during ICO.

An alternative more conservative valuation is based on an assumption that an act of blood donation via BloodChain will be priced based on a 5% valuation of the current price of 450ml of blood and will be equal \$8,5 for an effective (meeting criteria of time, location and blood type) blood donation. If rewarded by 1000 BLOOD, it gives a market price of \$0,00008 for 1 BLOOD and therefore 16,500% return on investment if tokens purchased during pre-sale and 9,900% if during ICO.

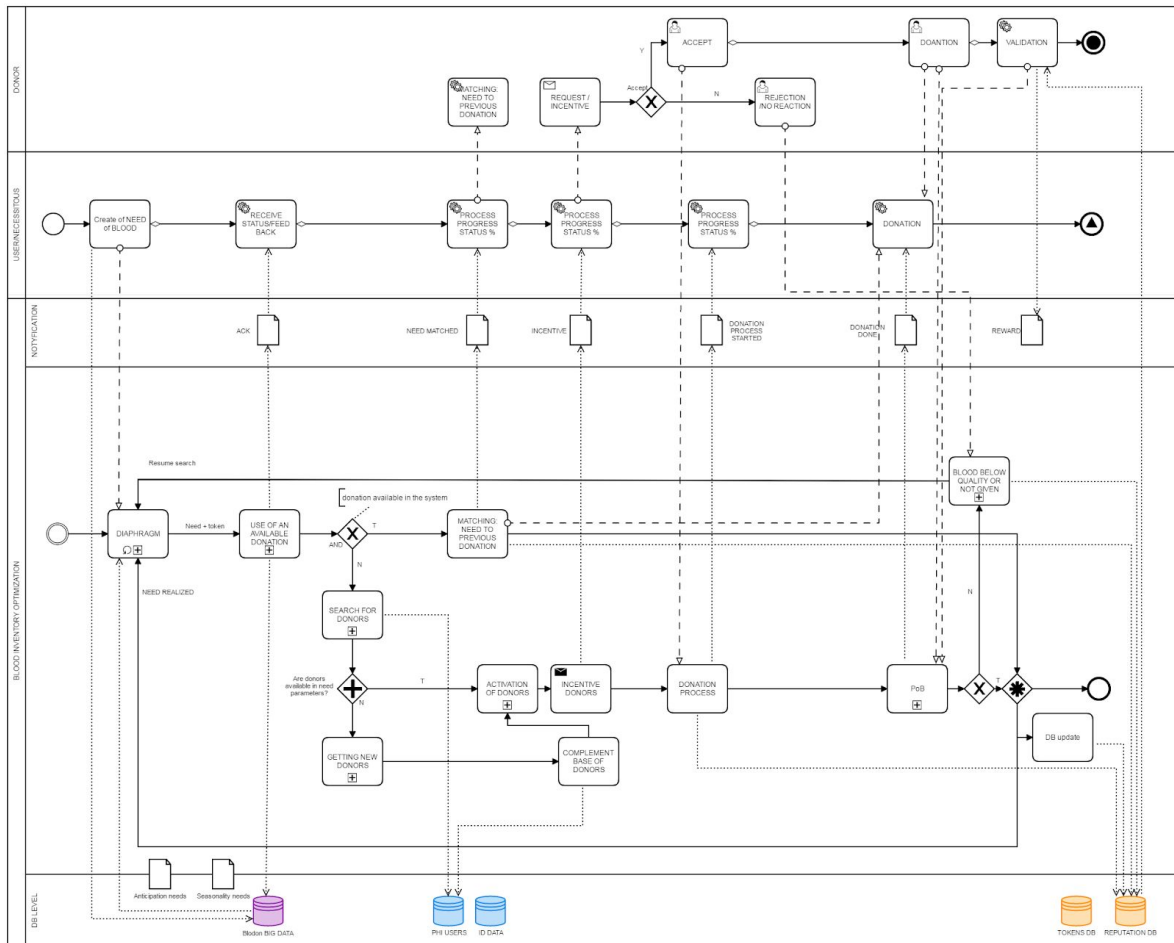
	Planned or estimated token price		Profit in %, entering each phase	Profit in %, entering during pre-sale
<i>Phase 1</i>	\$0,00005	USD, pre-sale price, 40% discount	0%	0%

<i>Phase 2</i>	\$0,00008	USD, ICO price	67%	67%
<i>Phase 3</i>	\$0,00849	USD, target conservative valuation based on an assumption of \$8,5 for 450ml of blood	9900%	16567%
<i>Phase 4</i>	\$0,04036	USD, optimistic valuation based on an assumption of 25% market share in 15 years	375%	79092%

Blood inventory optimization

Blood Diaphragm Vessel

High-level BloodChain donation process



The concept of the membrane

The diaphragm vessel (membrane) changes its shape, adjusting to new conditions and current situation. The diaphragm is continuous, not static in a long run. It is not enough to design the membrane and leave it alone. Although the diaphragm has a specific intelligence - it can adapt and its operations like any type of creature depends on the

quality of the information being fed, and more specifically the data. The low quality of input causes the automat to condemn the low accuracy of the adjustment. For this reason, the quality of what we provide at the entrance to our blood transfusion is very important.

What affects the diaphragm vessel

- **Current needs** → reported by all kinds of recipients who either as institutions or as interested or as recipients will reach out for our help. The need for it must be maintained. This is very obvious, and very important assumption - we always deliver, to all pieces of blood demand. Our intention is to serve every need of life in the form of blood. Therefore, our actions must be multilevel and sublimated, if previous rounds have not succeeded. Our system won't give up until delivery takes place. This is our value proposition, unique in its design.
- **Seasonality needs** → Seasonality refers to a repetitive pattern of demand (needs) that manifests itself at constant intervals with increased or decreased intensity. Theoretically, we know seasons in need of blood, but we know them more often in the form of opinions rather than facts that we can describe mathematically. In addition, seasons can occur at the same time and not occur at all. For example, we can have a high summer season generally in Poland and hypothetically a much smaller high season at the same time in Ostrołęka. The ability to describe this phenomenon will enable us to meet the needs in a timely and intelligent manner.
- **Anticipation needs** → this is used for classical forecasting, which as a method has already been severely compromised or even corrupted. Finding causal relationships and assuming that the past is repeated in the future is a naive and oversimplified naive approach. So we will be in a position to correlate and use the vastness of invisible at first sight patterns from Big Data are the accumulation of blood some time before visible and evident symptoms of the first need.

Diaphragm or diaphragms

Surely it's the latter. These membranes will create many of a kind. There are many reasons for such a phenomenon. The basic thing is that we do not generally talk about blood, but about blood groups. In addition, the geographical distances are significant and bypassing the infirmity of the public system, without the teleports, the provision of blood needs at distances even beyond the borders of the states will be somewhat hindered.

Examples of membranes:

- diaphragm ORh- all over Poland (macro management aspect) with a size of 1000000 I
- diaphragm on ORh- in the Silesian voivodeship with a size of 234000 I
- membrane on ORh- for the period 01.01-13.03.2018 in the Sroda Slaska district (assuming that the separation of such period is significant) of the size 2300 I

Project stages

First stage: BloodChain MVP

The first project stage will involve construction of the MVP environment demonstrating key features of the platform:

- In exchange for web tokens, organizations will be able to offer their services and products at special prices for cooperation networks.
- Public organizations and NGOs will receive starter packages (web service tokens) that will allow them to test the operation of the incentive system.
- Donors will obtain tokens for donating.
- Blood donations will be verified.
- Supporters will receive tokens for sharing the content promoted by the network (blood donation needs, information about blood donation...).
- In exchange for tokens, public organizations and NGOs will be able to activate blood donors or supporters into donating blood of specific groups in a specified place and time, or request sharing the content supporting blood donation.
- To test the research hypotheses, MVP will examine several types of motivation schemes.
- Tokens vs reputation – which is a stronger incentive?
- Will the loss of reputation after sale of tokens motivate people to rebuild their reputation? Won't the not-selling users feel like they are treated unequally as compared to the users who sell and still retain their reputation? - Usefulness: responding to the needs of different users in different contexts.
- Best point-scoring options.
- Won't the creation of an elite group with the highest reputation, to which exclusive network services will be addressed, reduce the reputation of users with lower reputation, especially in the option in which reputation is reduced after sale of tokens?
- Will people with high reputation effectively introduce new donors?

Second stage: BloodChain 1.0

On the basis of data collected by MVP, the full network will supplement the cycle in a way that is most efficient in terms of motivation of donors, supporters and the cooperating and supported units. Description of the target model can be found in the section: Bloodchain model 1.0.

System Architecture

System Architecture Requirements

Because the system is to process health information, its architecture must take into account the increased quality attributes, especially in terms of data security and privacy. In addition, due to regulations on sensitive data, it is necessary to ensure that the system has properties that will allow audit by external entities and provides the possibility to implement appropriate procedures related to data access control.

Irrespective of the issue related to the processing of information on health status, the project involves requirements associated with the use of public blockchain and token technology, which entails the need to implement relevant directives, relating to both AML (anti-money laundering) and KYC (know your customer).

Furthermore, the main assumption of the system consists in its decentralized nature.

This means that the system must be resistant to a widely understood failure of one of its elements or compromise of any user's or administrator's private keys.

Introduction to architecture

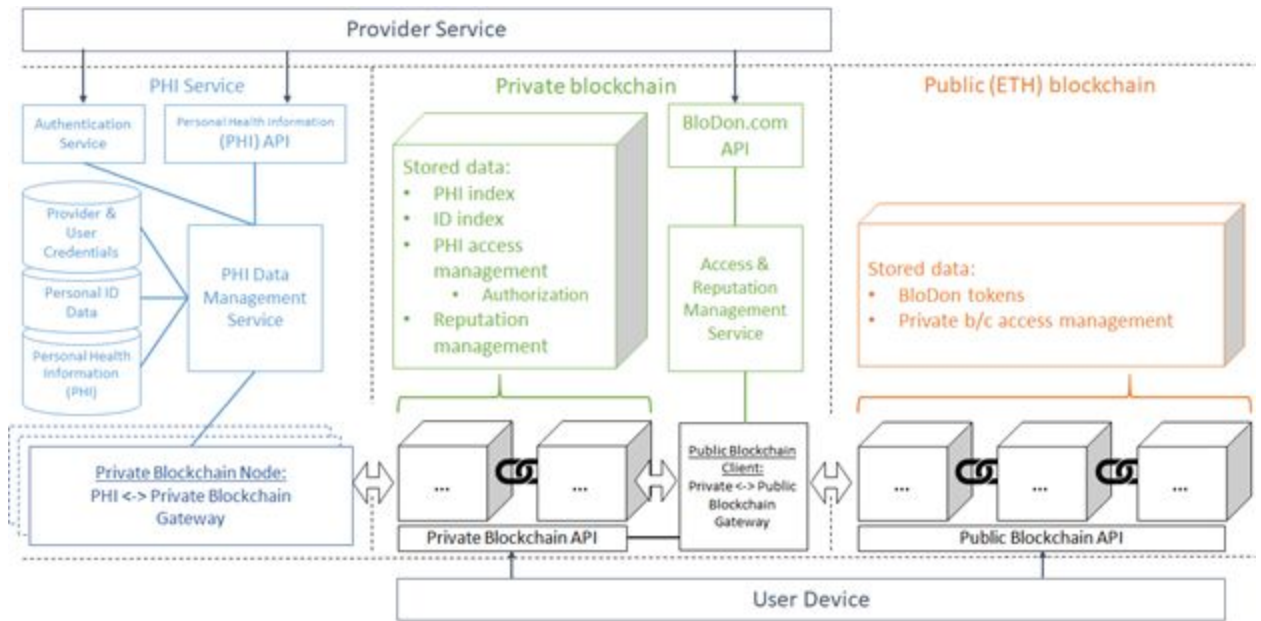
The system has been divided into three information processing layers:

1. Public (ETH) blockchain
2. Private blockchain
3. PHI service

Each layer will be discussed in the following subsections. It is assumed that no health or personal information is or will be stored directly in public blockchain, and private blockchain will store only those data that are necessary for the system's operation (e.g. information about blood donation date).

In addition, it is planned to develop a mobile client (user device) for the user and a web application (provider service) for business users of the system.

Below is an architecture diagram, presented only for illustration purposes. It has been drawn up without considering the issues related to isolation of specific microservices (for SOA architecture), and ignores a number of extra-functional requirements, such as the ones pertaining to encryption of transmitted data.



Public (ETH) blockchain

Because of high costs and limited scalability of public blockchain, only two roles have been assumed:

- The first role is the management of BloodChain Tokens using the smart contract. It will be especially important to implement additional business rules regulating the possibility of exchanging such tokens between network users. Therefore, it will be more of an extension of the ERC20 standard rather than its pure implementation.
- The second, but equally critical role is the management of access to private blockchain. It is assumed there will be no centralized data access management. Anyone holding a private key to the account in public blockchain will be able to use private blockchain after the automatic registration process is initiated. Of course, second party involvement will be necessary in connection with storage of sensitive data; however, it is not expected that third party involvement will be necessary to fully activate donor account through the data processing center.

Public blockchain will rely on Ethereum network. It is assumed that public blockchain should not contain any user-identifiable information.

Access API will be implemented with the use of standard solutions offered by software for Ethereum network.

Private blockchain

The role of private blockchain will be much wider than the role of its public counterpart. Private blockchain will not, however, process any sensitive data (except blood donation date). Limiting the number of nodes only to trusted medical record-keeping units will allow to significantly lower the cost of supporting this blockchain. The following functionalities are planned for this blockchain:

- Indexing of identification data and health information – the information included will serve only as an indicator of data storage location. It may indicate, in particular, the API server address together with access path to resource. An index may include simple information on the nature of data together with an optional date of event associated with this, e.g.:
 - Index to the location where blood group information is stored
 - Index to the location where first name and last name information is stored
 - Blood donation date, index to the location where information on this process is stored
- Managing authorization to access health information – in view of the system's decentralized nature, authorization-related entries (credentials confirming that a person holding a specific key is entitled to access a specified resource) will be fully manageable in private blockchain. Assuming that a private key is a sufficient and only user authentication tool – i.e. a tool confirming that a user is who they claim to be, access to data will be limited to the resources that have been created and assigned to the key. This means that the system should not be used for managing access to any data that are not part of BloodChain system.
- Reputation management, which lacks the value-transfer nature, will be processed in private blockchain.

After verification is conducted to determine what elements/modules will best fit the project, private blockchain will be based on one of the following technologies:

- a) Hyperledger (<https://www.hyperledger.org/industries/healthcare>)
- b) Quorum (<https://github.com/jpmorganchase/quorum>)
- c) Enterprise Service Chain (<https://adshares.net/assets/docs/ESC.pdf>)

It is expected that the following modules will need to be developed:

- Client of public blockchain – gateway between private and public blockchain maintained by independent nodes, the purpose of which is to make data from public blockchain available for private blockchain-managing applications.
- User authorization management module
- Reputation management module
- API for management modules
- API for private blockchain – provision of access to private blockchain for authorized parties and applications

PHI service

Identification data and health information will be collected in the same way as they are collected today in medical records kept by healthcare entities.

It is proposed to develop, for the purposes of MVP, a reference example implementation of a solution allowing for collection of basic donor data and blood donation process data. The solution, however, will not satisfy scalability or reliability requirements, and as for safety – it will only provide an example implementation of authentication and authorization mechanisms with the use of blockchain technology.

The following modules are planned:

- Client of private blockchain – gateway between PHI service and private blockchain. It is supported by nodes held by an entity being an administrator of such information. The client's main objective will be to read data from private blockchain in a way that ensures confidence in the data.
- Health information management module – it is being considered whether to use an HL7 FHIR server as a reference model for exchange of health information.
- Authentication service – based on trust in the user key as a primary authentication tool.

Mobile Client

It is an application that runs on Android and optionally – for MVP – on iPhone, that will enable the user, through API to public and private blockchain, to gain access to reading messages and health information, introduce changes in health information, manage access to health information, and preview reputation. An option to transfer tokens will also be provided (not in MVP).

Web Client

This is a web server which, through access of the management system to API, gives access to services to business customers, e.g.:

- Creating incentives to donate blood
- Sending messages
- Example implementation of health information browser

Data security

BloodChain application presumes that security complies with OWASP Application Security Verification Standard 3.0. Depending on the module and data stored in the system, each of the elements will meet an appropriate ASVS 3.0 level.

- Mobile application – Level 1
- BloodChain website – Level 2
- Server/application for verification of donations, participants – Level 1 (no public access, only in the mobile application <> BloodChain portal <> wallet combination)

Design of the environment structure entails development of an authentication (i.e. verification whether a user is really who they claim to be) and authorization (whether a person is entitled to perform certain actions or access the data) system. This approach ensures that sensitive data will never be linked to a person, but only to a unique generated hash verified for a person.

Main security aspects

Increased data security, privacy and full auditable system

Because the BloodChain is to process health information, its architecture must take into account the increased quality attributes, especially in terms of data security and privacy. In addition, due to regulations on sensitive data, it is necessary to ensure that the system has properties that will allow audit by external entities and provides the possibility to implement appropriate procedures related to data access control.

Strong consistency

BloodChain is based on blockchain database which can also be directly shared among all relevant authorities and still maintains a strong consistency (ACID).

High resistance for failure or compromise

Irrespective of the issue related to the processing of information on health status, the project involves requirements associated with the use of public blockchain and token technology, which entails the need to implement relevant directives, relating to both AML (anti-money laundering) and KYC (know your customer). This means that the system must be resistant to a widely understood failure of one of its elements or compromise of any user's or administrator's private keys.

Information security and privacy

Depending on the input and output options chosen, a full information security risk assessment, as well as a privacy impact assessment, should be performed:

- **A security risk assessment** which will look at threats and vulnerabilities to the system in terms of the classical security triad of CIA - confidentiality, integrity and availability;
- **A privacy impact assessment** which will seek to specifically focus on ensuring that all elements in the workflow of the **bloodchain** have been addressed in terms of the fulfilment of data protection rules. The security risk assessment and the privacy impact assessment are tools to achieve privacy by design. The outcomes would be a prioritised list of privacy targets and security risks, as well as the recommended protection measures and security controls to be implemented.

Security control and resilience requirements

The defining feature of the bloodchain explored above - that it is available over the public Internet - introduces attack vectors and an attack surface. In addition to the above, the web service has a number of additional requirements for security controls and resiliency measures to counter threats coming mainly from the web technologies and the public Internet.

To protect the confidentiality and integrity of the bloodchain, it would - for example - have to be protected against unauthorised access to its infrastructure and the data held therein, of course both for individual files and for a largescale intrusion and potential data theft or modification of multiple or all records. Data breaches are a growing threat area³⁴, and the fact that these could be caused by web-application vulnerabilities constitutes a major risk³⁵

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Baseline security measures

Based on the outcome of the security risk assessment and the privacy impact assessment, specific controls would have to be implemented.

As a baseline, the general preventive, detective and response mechanisms that would be implemented for the all bloodchain levels, public and private blockchains and also for PHI service in terms of people, processes and technology. There should be a strong separation between the public and private blockchains and also for PHI service to prevent data leakage. Additionally, in the event of a major incident where an intrusion into the public blockchain infrastructure is successful, the impact should be prevented from escalating by implementing a strong separation, so that the public blockchain cannot be exploited to further compromise the PHI service. This would include defining restricted one-way access from the PHI service to the private blockchain for transferring data extracts; the implementation of a DMZ and firewalls; and monitoring and intrusiondetection mechanisms. For the front end of services, the development of the interface must be carefully designed according to best practice to manage the risk of attacks and reduce any potential impact. This could, for example, include the best practice as defined by OWASP (the Open Web Application Security Project). The front end of service should be carefully monitored and regularly undergo security testing, such as vulnerability scanning and penetration testing, to ensure the early detection of attack vectors which could be deployed for malicious activities.

Proof of Blood (PoB): blood donation verification

³⁴According to the ENISA Threat Landscape Report, data breach data increased by 25% in Q4 2014 in comparison with the same period in the previous year.

³⁵According to the OWASP (Open Web Application Security Project) Top 10 Privacy Risks 2014, the number one risk is web application vulnerabilities.

https://www.owasp.org/index.php/OWASP_Top_10_Privacy_Risks_Project#tab=Top_10_Privacy_Risks

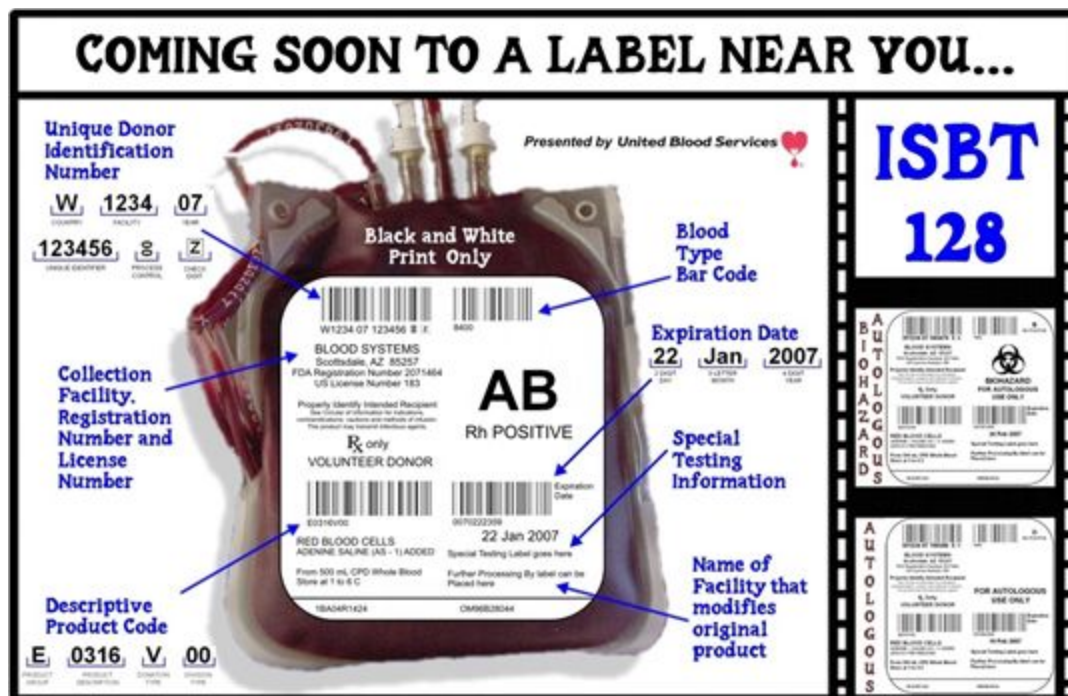
³⁶http://www.nytimes.com/2015/07/10/us/office-of-personnel-management-hackers-got-data-of-millions.html?_r=0

³⁷http://www.datatilsynet.dk/fileadmin/user_upload/dokumenter/On-line_hoeringssvar_-_Nyhed_16_6-03/Datatilsynets_udtal_else_hackcase.pdf

Verification based on a photo of blood bag marking (according to the ISBT 128 standard). If the photo is made correctly, it will allow automatic reading of at least the following:

- Unique donation number (barcode + optional OCR of the text);
- Blood group (barcode + optional OCR of the text);
- Blood component code (barcode + optional OCR of the text);

Donation date (OCR of the text).



https://openi.nlm.nih.gov/detailedresult.php?img=PMC3046378_JPI-2-3-g007&req=4

Donor data are not present there, but the uniqueness of these four data and the requirement of compatibility between the provided blood group and the donor blood group gives us a well-founded basis to conclude that blood has been properly donated.

When the information about time/date/place/blood group is added in conjunction with the information about the donor's last donation, it is extremely difficult to falsify the donation. PoB falsification would require providing false location data.

Additionally, with the system's scale, we will be able to retroactively validate past notifications (e.g. the more donors in the system, the more registered unique donation numbers and the greater likelihood to detect any false numbers that may be submitted). The combination of donor history data, blood group information, unique code and location data on the blood bag confronted with the beacon information gives a group of elements that significantly impede falsification of donations. In order to falsify the donation, a falsifier

would have to set up a KYC validated account in the system, falsify the beacon signal, generate a correct unique donation code corresponding to the donation location, and do this 3 times a year for women or four times a year for men to be able to use the possibility of disposal of 3000 tokens earned this way after one year, which would also entail losing the possibility of disposal of more tokens for the next 3 or 4 donations. In addition, at their first donation, every new blood donor will need authorization granted by the donor with reputation of at least 3000. Authorization will be performed using a beacon.

Private BlockChain data:

1. Last donation
2. Donor ID
3. Reputation level

Blood-bag data:

1. Donation date
2. Blood group and Rh factor
3. Facility ID
4. Unique donation ID
5. Donation time

Cell data:

1. Time
2. Date
3. Donor ID in the app

Beacon data:

1. Donor ID

Data in the health information system

1. Blood group and Rh factor

If all 1-13 match, and the first donation is authorized by the donor with reputation of at least 3000, the contract is closed under Proof of Blood (PoB).

Beacon authorization

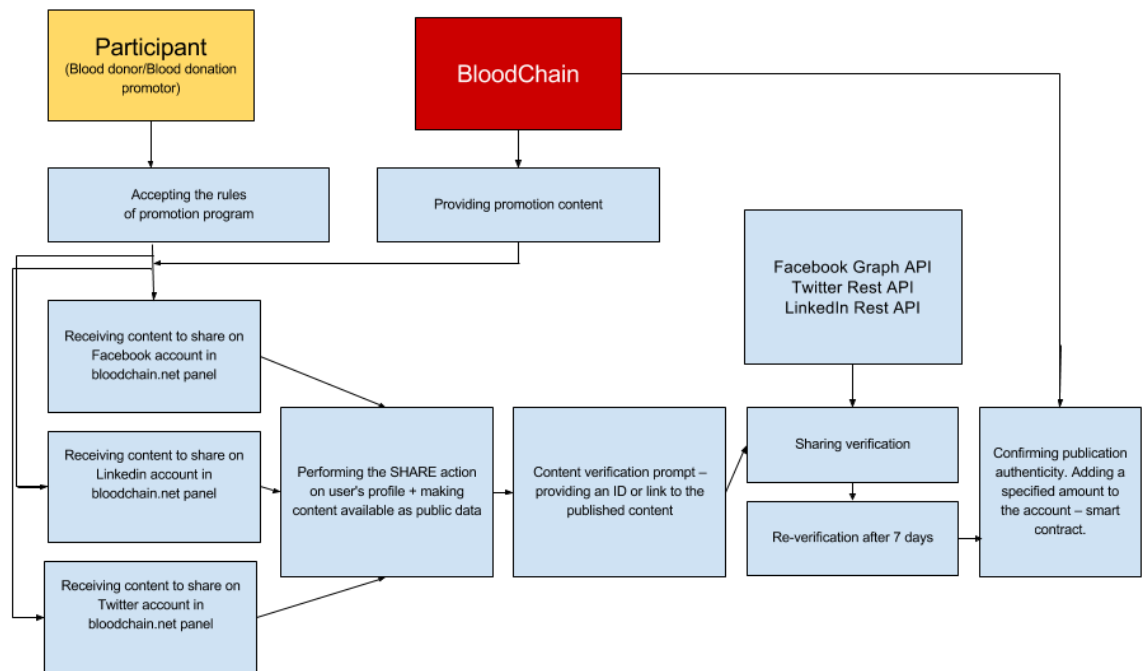
The second considered method of authentication of the user's presence at a blood donation center is the use of beacon technology. Beacons are small devices that work over several years with no power and transmit a low-power Bluetooth signal. This signal could be received by a mobile device which could then use it to prove that the user was present in a specified time and location near specific beacon.

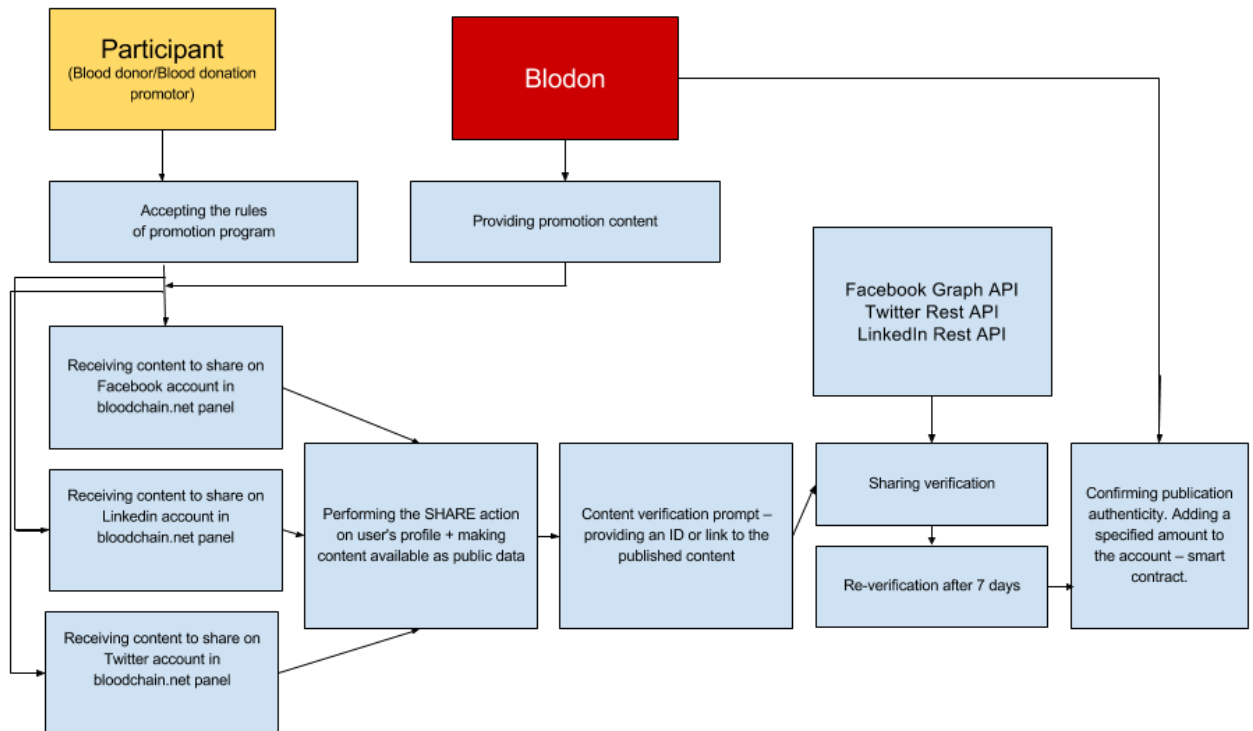
At present, it is being considered to use a solution offered by the following companies:

- Estimote Polska Sp z o.o.: <https://estimote.com/>

- Kontakt.io, Inc. <https://kontakt.io/>

Content sharing verification algorithm





Shared content verification mechanism will be an independently-developed promotion method for BloodChain concept and system. Participants who accept the rules of promotion of our messages will obtain specific amounts of tokens through the smart contract.

They will be required to share the message on their profile in a selected social network (Facebook, LinkedIn, Twitter, and more in the future), chose public post visibility (available for people not connected to the posting parties) and keep the post visible for at least 7 days (parameterized option).

In connection with possible misuse on the part of participants (e.g. setting up fictitious accounts), the following security mechanisms will be implemented:

- a) “One social network account” rule – as a result of first sharing, ID of the participant's social network account profile is saved at the participant's account. This ID will be verified at each subsequent share.

- b) Unique ID – verification of uniqueness of the participant's social network account ID within the scope of the entire BloodChain system.
- c) Possibility to make granting of tokens dependent on the number of likes (shares) a post gets from user's friends.
- d) Verification of a unique ID assigned to a participant's wallet/account in BloodChain

Cooperation with the environment

- medical sector (public and private)
- non-governmental organizations
- funds for new technologies (investors)
- sector of portable devices with readers for reading blood and body parameters
- new social media
- insurance sector
- sector of non-monetary transactions – non-currency transaction systems based on barter, flow of services, exchange of services, sharing

Team

Sebastian Zaremba – Project Leader

Over 17 years of experience in management of global IT projects. Certified project manager Prince2 Practitioner, IBM associate PM, ITIL expert, UX PM executive, authorization of access to EU Secret data. Professionally linked to the European Agency for the operational management of Large-Scale IT Systems in the area of freedom, security and justice. Most recent project: New Visa Information System (VIS) for the European Union. Member of the BC and cryptocurrency stream at the Polish Ministry of Digital Affairs [Ministerstwo Cyfryzacji].

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Aleksander Sosnowski – Inventory Optimization Expert

Over 14 years of experience in management of global organizations and logistics processes. Certified [EJlog – Supply Chain / Logistics Manager \(Supervisory Level\)](#), [CSCP – Certified Supply Chain Professional](#), [CDDP – Certified Demand Driven Planner](#)

<https://pl.linkedin.com/in/aleksandersosnowski>

Radek Ługowicz – Web Dev Expert

Manager, programmer, originator and organizer of the project potrzebna.krew.pl. IT specialist by education (programmer, project manager). For 11 years, owner of netmachina website-developing company. Long-time blood donor and blood donation promoter.

<https://pl.linkedin.com/in/radosław-lugowicz-7b8687>

Anton Bubiel – Economy and Auditing Expert

Economist (PhD from Warsaw School of Economics) and an enthusiast of cryptocurrencies and blockchain technology. Professionally, a consultant and project manager, 6 years of experience in implementation, optimization and auditing (Certified Internal Auditor) of business processes. Member of the BC and cryptocurrency stream at the Polish Ministry of Digital Affairs. <https://www.linkedin.com/in/antonbubiel/>

Adrian Tkacz – System Architecture Expert

Software engineer with over 10 years of experience in IT projects for healthcare. He holds medical and computer science education and experience in management of cloud-based

programming projects. Worked on a number of POCs on the use of Ethereum. Stock market investor for 20 years; (medical) ICO investor for one year.

<https://www.linkedin.com/in/atkacz/>

Partners

- **BioInfoBank** is a non-for-profit research and development (R&D) organization.
- **Tiqdiet**: Program for modern nutritionists and coaches
- for developing menu plans and modern Customer communication
- **PotrzebnaKrew.pl** – Application motivating people to donate blood, but to a much narrower extent. Support in the field of promotion of the project in social media.
- **BC and cryptocurrency stream at the Polish Ministry of Digital Affairs**
- **Red Code sp.k.** Medical solutions integrator: <http://www.redcode.red/>
- **Coinfirm Blockchain Lab** - AML services provider <https://amlt.coinfirm.io/>
- **IMAS International** - market and public opinion research institute
<http://imas.pl/en>