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dHealth Network

Blockchain Infrastructure for the Healthcare Market

dHealth Network Configuration

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[1] The dHealth icon shows a mitochondrion which is an organelle found in all eukaryotic organisms. It generates most of our cell's energy. Due to the fact that its DNA is inherited from the mother, it can be used to trace our ancestry and uncover the evolutionary history of populations. The mitochondrion was chosen because it is a biological equivalent of traceability and power generation.

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1 Purpose

The Decentralized Health (dHealth) Network is the proposition of a distributed and community-owned network for healthcare-related transactions that powers a global data-driven healthcare ecosystem. It is adapted to patients' and industry needs and targets healthcare-related transactions without the noise from other industries.

An open healthcare dedicated network of Supernodes can serve as an alternative solution for permissioned, regulated, and government-controlled infrastructure. It provides the pillars of a real-time and efficient data-transaction healthcare ecosystem with:

1. Native Digital Currency for Asset Transfers
2. Traceability for Transparency and Accessibility
3. Immutability for Safety and Validity
4. Unique Identity
5. Digital Contracts

A blockchain-based token system is predestined to align incentives among ecosystem participants and allows for the secure and transparent transfer of assets. Making data accessible in a decentralized system reduces the vulnerability that comes with big monolithic data silos. Traceability leads to accountability and trust. For the tracking and tracing of goods in the healthcare system blockchain offers a unique opportunity where partners do not want to share infrastructure or use intermediaries. Immutability prevents fraud and a unique identifier can be used by all stakeholders in the healthcare ecosystem to increase trust and safety. Digital contracts can be used to streamline and automate processes, hence, increasing the effectiveness of transactions in the healthcare system.

As a community-owned and distributed platform for health-related transactions and data-access the dHealth Network puts the individual at its center. Its disruptive potential lies in breaking existing data monopolies and the empowerment of a global data-driven healthcare system.

2 Industry Background

After the financial sector, healthcare is perfectly positioned to be the next area of adoption for blockchain technology due to its fragmentation, legion of intermediaries, and inefficient processes. Currently, blockchain-based healthcare applications rely on public chains that have serious performance problems or on consortium chains that lack native currencies for transactions and offer limited transparency and trust.

2.1 Market Size

In 2019 it was predicted that the global healthcare market is rallying towards USD 10 trillion by 2021.[1] It is not clear yet what the impact of the Covid-19 pandemic will be, however, the importance of healthcare has become even more obvious, accelerating innovation and favoring digitization.

Even before the pandemic digital health was one of the fastest-growing sectors in healthcare. Its data-driven nature poses many challenges and most processes around

data acquisition and data protection have remained unchanged for many years. Large corporations dominate the playing field, accumulating massive amounts of data.

In healthcare, tremendous amounts of data are generated by medical documentation, regulatory requirements, and patient care.[2] Precision medicine and the general trend of digitization in healthcare lead to a constant rise of data gathered at the individual user's or patient's level.[3,4] Another driving force in this massive growth of data is the individual himself, e.g., when using fitness or wellness apps. According to PwC, the global connected health market is worth 61 billion USD in 2020 with an annual growth rate of 33%.[5] The global digital health market is worth 693.4 billion USD by 2026.[6] Pharma and MedTech logistics as well as health insurance and invoicing are prone to use blockchain and digital contracts to streamline their business models as well as their payment processes.

2.2   Challenges

Considering the huge potential and the flawed system, it is time to rethink how to approach data-driven business models in healthcare and the backend infrastructure used to facilitate data exchanges.

The dHealth Network addresses the key issues plaguing healthcare that prevent the availability of data to improve processes and treatments: lack of transparency, monopolization, fragmentation of data leading to siloes, and inefficiencies in accessing data by all healthcare stakeholders.

2.2.1   Patients

Health data should first and foremost improve patient outcomes. Current business models in digital health revolve around centralized storage of health data where patients have no control over how their data is being used. This has led to countless data breaches and companies being acquired solely for the value of data they collected.

Usually, most individuals are not interested in their health-related data, unless they are sick. For them, tokens can be used as incentives to make their data shareable.

The introduction of blockchain infrastructure as a backend enables business cases that focus on transparency and fair incentives to share data. dHealth Foundation believes in a future where patients grant access to their health data directly, regaining control over their digital data. The dHealth Network will play a vital role as a trustless facilitator, allowing the patient to participate directly in the value creation of "digital health data".

2.2.2   Industry, Researchers, and healthcare providers

Access to health-related data is vital for the development of new cures and treatments, patients' safety, and faster access that equals faster time to market. However, most health data passes through multiple vendors before it becomes available for research, therefore, increasing the costs, development time, and risk of tampering with the data. Access to health data can be facilitated through apps that

utilize dHealth Network as a trustless backend to connect patients and healthcare providers without a middleman.

Researchers must rely on the integrity of data and transparency in times of the replication crisis and cases where data has been engineered and research subjects excluded from the sample in order to reach significance levels. A healthcare dedicated blockchain infrastructure can guarantee the immutability of the data and can trace its origin. Moreover, administrative costs of clinical trials could be reduced by streamlining processes based on digital contracts and making the compensation of participants easier.

The healthcare industry has the opportunity to use the dHealth Network as infrastructure for their use cases such as securing supply chain processes or streamlining payment processes. Having access to field-tested infrastructure can jumpstart innovation without dragging critical resources from other projects.

2.2.3   Payers, Regulators & Governments

Real-world data allows payers to predict the cost-effectiveness and regulators to control the safety of new treatments, whereas governments can steer their health-related efforts on a population level. Unfortunately, that data is difficult to get and usually outdated when available.

Digital contracts can help to streamline administrative processes like reimbursement, claims management, payments, and prior authorization. In countries where there is little or no reimbursement infrastructure, the dHealth Network can provide an alternative and trustless infrastructure for claims management and reimbursement. Assets can be transferred to the rightful recipients and their impact can be measured at the same time.

Prevention programs and adherence programs are just two examples of incentive-based use cases that can be launched on the dHealth Network. Faster and direct payouts, fewer fees, and more transparency allow payers to launch effective programs with high retention rates.

Additionally, a shared blockchain infrastructure can facilitate complex multi-party scenarios that require approval from different stakeholders. Whereas these processes are impossible to audit by all parties when using a centralized system, building them on dHealth Network will create an immutable audit trail that assures all parties and expedites the approval.

3   Solution: A Healthcare Dedicated Network

On the basis of the dHealth Network, interested parties can build their use-cases. The network's value-proposition beyond being the first healthcare-dedicated blockchain consists of the network components that enable the ecosystem partners to benefit from each other.

3.1 Network Components

The network components that are currently implemented or scheduled for release comprise:

1. Wallet
2. Decentralized Identity (targeted for Q4 2021)
3. User (Patient-) controlled data repository (targeted for Q3 2021)
4. Payment & Asset Transfer
    a. Network Currency
    b. Utility Tokens
    c. Stablecoin (targeted for 2022)
5. Automated Market Maker for Network Currency
6. Certificates & Registry
7. Tracking & Tracing
8. Auditable transactions
9. Digital Contracts (targeted for Q4 2021)

It is a unique value-proposition to a healthcare ecosystem.

3.2 Technology

The dHealth Network is a domain-specific blockchain based on NEM's next core engine "Symbol" (https://symbolplatform.com/). For further information it is referred to the **Symbol Documentation.**[7] It is optimized for healthcare-related transactions and designed for scalability and openness. Decentralization is essential for the network and Supernodes are the guarantors for it. The dHealth Network launched 29 March 2021 with a limited number of Supernodes operated by partners that share the dHealth Foundation's vision of an equitable healthcare system.

The blockchain layer provides a trustless backend service that has built-in redundancy and immutability. Every Supernode in the network provides API endpoints that can be called by applications to perform functions on the blockchain.

dHealth Network comes with functionality such as aggregated transactions and cross-chain swaps. These technological advances will allow the network to provide the health information infrastructure of the future that is interoperable with other blockchains. dHealth Network is open to third-party developers to create their applications.

3.3 Consensus

dHealth Network utilizes Symbol's Proof-of-Stake Plus mechanism. The generation of a subsequent block is stochastically assigned to a coin-holding Supernode of the blockchain weighed by its importance. This importance is derived from the eligible network accounts' importance that delegate harvesting to a Supernode.

The importance comes from a combination of factors relating to the tokens in a network account and its activity:

- Stake: The total amount of DHP in the account.
- Transactions: The total amount of fees paid by an account.
- Nodes: The number of times an account is a beneficiary of a block.

For detailed information about the consens and calculation of the importance score see, it is referred to **Symbol's Technical Documentation.**[8]

The dHealth Network creates one block every 30 seconds. Hence, 2'880 blocks per day and 1'051'200 every year.

3.3   Nodes & Supernodes

Nodes can be considered servers of a decentralized network that are performing specific tasks. The dHealth Network consists of Nodes with different functionalities as described in this chapter. Supernodes are high-performance blockchain nodes that form the backbone of the dHealth blockchain network.

The dHealth Network is open to anybody who wants to run a Node. However, for network stability and accessibility, there will be a core network of maximum 100 high performing Supernodes. Supernodes preferably interact with each other. The Supernodes are spread out geographically and responsible for synchronizing the network.

Supernodes function as Validator, Harvesting, and Voting Nodes. Although all Supernodes must act as Validator Nodes, the operators do not need to open the Supernode to harvesting, e.g., due to regulatory reasons.

Operators of high performing Supernodes can create custom Namespaces at no additional costs. A Namespace (similar to URL on the internet) allows operators to create a unique on-chain place for their business and their assets on the dHealth Network.

3.4.1   Validator Nodes

Validator Nodes function as access nodes or API gateways to the network, i.e. as nodes that permit to read the chain. Validator Nodes neither create blocks, nor take part in the finalization. They are essential for system integrations, provide a partial transaction cache, websocket endpoints, and REST APIs.

Validator nodes are also responsible for collecting partial transactions, which are only broadcasted when they have received all necessary signatures.

There is no limit to stand-alone Validator Nodes because the more access points the network offers the better it is for those who run applications that interact with the dHealth Network. They are read-only nodes and do not require a minimum balance. However, partners that run a Supernode must provide high throughput and bandwidth through appropriate technical infrastructure.

3.4.2   Harvesting Nodes

In the context of the Symbol Protocol, the process of creating new blocks is called harvesting. A Supernode that participates in the block generation process is rewarded with the transaction fees added in the block and the staking reward (see 4.2). Partners who run a node have the opportunity to earn DHP that can be used for their own application, e.g. as payment for transaction fees. The probability of an account to harvest a new block is determined by its importance.

A key determinant of the importance is the DHP balance of the Supernode's account. Any dHealth Network account holding at least 10'000 DHP can delegate its balance for harvesting to improve the Supernode's importance (see 4.3). One single Harvesting Node cannot exceed 5% of the overall importance involved in the harvesting.

3.4.3 Voting Nodes (Finalization Nodes)

Voting Nodes do not create blocks but are essential to the finalization by providing the finalization voting protocol. Supernodes do not necessarily have to activate Voting Node functionality.

The finalization voting protocol requires participants - with a minimum balance of 100'000 DHP - to vote for a *set of blocks* that are to be *finalized*. Finalized blocks will *never* be rolled back.

4   Mosaics/Tokens

dHealth Foundation builds on NEM technology, therefore, tokens on the dHealth Platform are called Mosaics and have a divisibility of 6.

4.1   Digital Health Point (DHP)

The native currency of the network is the Digital Heath Point (DHP). DHP is a utility and payment token compliant with the Swiss Financial Market Supervisory Authority (FINMA) regulations for crypto currencies. Transaction fees on the dHealth Network have to be paid in DHP.

A total of 1 billion (1'000'000'000) DHP was created to facilitate transactions. Half of it will be locked and released as staking rewards. An additional 1 billion will be created as staking rewards.

The value of the capped utility and payment token is based on the size of the user base, the number of quality partners, and how often the tokens change hands (velocity). A growing network leads to increased DHP demand and value. The staking model promotes that a substantial amount of DHP will be locked in Harvesting Node's accounts. Inflation will be caused by the gradual release of the tokens reserved for the staking reward. The DHP will be exposed to market volatility once it is traded on crypto exchanges.
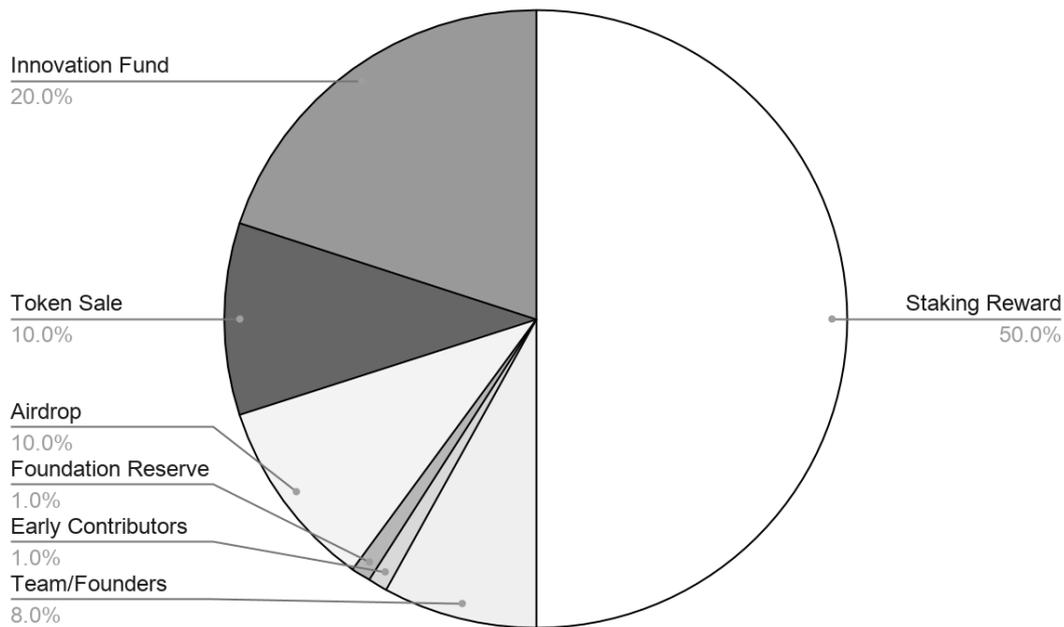
4.1.1   Transaction fee

Transaction fees generated on the dHealth Network must be paid in DHP. It will be divided according to their importance among the accounts participating in the Delegated Harvesting (see 4.3). Dynamic pricing will apply to determine the **transaction fee**.[9]

4.1.2   DHP Distribution

A total of 2 billion (2'000'000'000) DHP will be the circulating supply on the dHealth Network. Half of it will be created as Staking Rewards during 10 epochs or 12.5 million blocks and distributed to eligible harvesting accounts (see Figure 1). Besides, 20% is reserved for the Innovation Fund to initiate and facilitate the implementation of dHealth Network use cases. With the launch of applications using the DHP in 2020, it can already be used as a payment token in real-world use cases.

Figure 1. DHP distribution

An Automated Market Maker (AMM) and the listing on crypto exchanges gives the DHP an external reference value. The DHP can be used as a means of asset transfer as well as payment for the transaction fees on the dHealth Network.

A total of 10% DHP will be distributed through AMM and exchanges in a token sale. To increase the initial user base and as an appreciation of the NEM Foundation's support 10% of the DHP supply will be airdropped onto the NEM community. The founders' and team reward amounts to 8% (160 million). As a reserve, 1% of DHP (20 million) will remain with the Foundation, e.g to run Voting Nodes. Roughly 1% of the total token supply was given to early contributors. These DHP tokens constitute 30% of the total DHP supply as the circulating supply at the start of the dHealth Network.

4.2   Inflation and Staking Reward

The maximum DHP supply is immutable and cannot be increased. The dHealth Network draws the Staking Reward from the 50% initial DHP supply (see Table 1). The initial Community funds will be released over the same period of 10 years. Five percent of each block reward goes to the Community Fund and will be used to support projects utilizing the dHealth Network (see Figure 2).

Rewards and network fees will be allocated according to the importance of the Supernodes.

Harvesting Nodes distribute the rewards to those accounts that have delegated their funds to the Harvesting Nodes for staking, however, Harvesting Nodes can ask for a levy from those wallets. The staking model promotes that a substantial amount of DHP will be locked in Harvesting Node's accounts.

Staking Rewards are granted to active Harvesting Nodes since the network launch.

Table 1. Inflation Schedule

Epoch	Block Start	Block End	DHP Reward	Innovation Fund	Circulating Supply	Days	DHP/block
		0	0	0	600,000,000	0	0
1	1	1,250,000	500,000,000	40,000,000	1,140,000,000	434	400
2	1,250,001	2,500,000	250,000,000	40,000,000	1,430,000,000	868	200
3	2,500,001	3,750,000	125,000,000	40,000,000	1,595,000,000	1,302	100
4	3,750,001	5,000,000	62,500,000	40,000,000	1,697,500,000	1,736	50
5	5,000,001	6,250,000	31,250,000	40,000,000	1,768,750,000	2,170	25
6	6,250,001	7,500,000	15,625,000	40,000,000	1,824,375,000	2,604	12.5
7	7,500,001	8,750,000	7,812,500	40,000,000	1,872,187,500	3,038	6.25
8	8,750,001	10,000,000	3,906,250	40,000,000	1,916,093,750	3,472	3.125
9	10,000,001	11,250,000	1,953,125	40,000,000	1,958,046,875	3,906	1.5625
10	11,250,001	12,500,000	1,953,125	40,000,000	2,000,000,000	4,340	1.5625

For the first 1.25 million blocks (Epoch 1), 500 million DHP have been allocated (see Table 1), i.e. the reward is 400 DHP per block. The reward will be cut in half after 1.25 million blocks have been created. Halving will continue until Epoch 9. The remaining Staking Reward will be given away in Epoch 10.

There will be no more Block Rewards stemming from Staking Rewards after Epoch 10. Block rewards from network fees will continue as long as the dHealth Network is operational.

The initial supply of DHP from the innovation fund will be released over a period of 10 Epochs. In Table 1 it is displayed without the network fees adding to the fund, because those are already part of the circulating supply.

4.3   Tokenomics

The dHealth Network is a self-sustaining economic ecosystem involving DHP token holders, Supernode operators, and organizations that are applying use-cases. In this way, it's similar to many decentralized blockchains, but there are important differences that make it easier for anyone to earn rewards.

As indicated in Figure 2, an initial DHP token distribution is achieved by allocating DHP via Airdrop to the NEM community, DHP sale, and early supporters as well as team members. The DHP holders can sell and buy DHP via centralized exchanges and a decentralized Automated Market Maker (AMM).

Supernodes secure and enable the dHealth Network and its use cases in which individuals and organizations holding DHP are participating. Supernodes receive Block Rewards for creating new blocks and transaction fees and distribute it to the DHP holders that staked on the Supernode. Supernode operators can deduct a fee from the rewards and fees.

Figure 2. Ecosystem and DHP flow
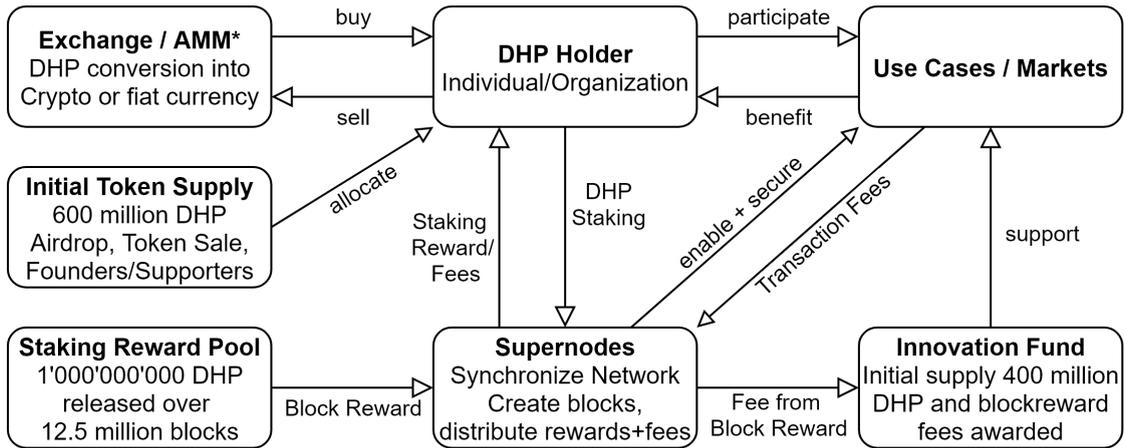
* Automated Market Maker

The Innovation Fund has an initial supply of 400 million DHP and is also fed by fees from the Block Reward. A maximum of 40 million DHP is allocated per epoch to support Use Cases that generate transactions on the dHealth Network.

4.4   Delegated Harvesting

Any dHealth Network account holding at least 2'000 DHP can participate in the harvesting process by delegating its importance to the account of a Harvesting Node. The maximum balance of a harvesting account is 20 million DHP.

Figure 3. Example of reward distribution
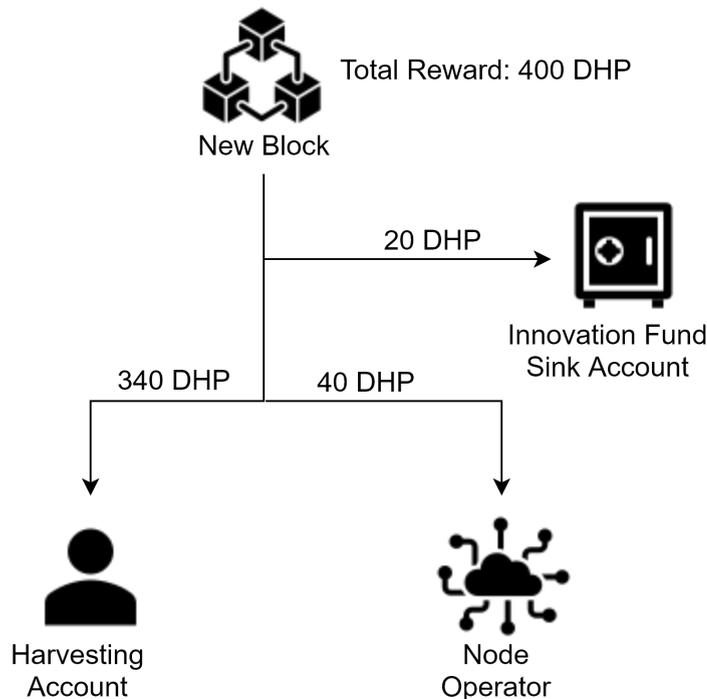
Of the rewards per block, 5% will go to the network sink account of the innovation fund. The remainder of the reward will be divided between the operator of the Harvesting Node and the Harvesting account that delegated its importance to the Node.

The default setting for allocating the reward is 10% to the node operator and 85% to the account (see Figure 3).

In a network of Harvesting Nodes, the delegation of importance by DHP account holders is essential. First, node operators can increase their network importance without having to own DHP at all. Secondly, network accounts can participate in the staking reward without running a Harvesting Node themselves.

Any account balance that has been delegated for harvesting cannot participate in DHP transactions during that time.

4.5   Acquiring DHP

DHP will be made available to ecosystem partners through the community fund or through Harvesting. DHP for use-cases can be acquired through selected exchanges or an AMM.

5   Organization

5.1   Foundation

The HIT Foundation (currently in the process to be renamed into dHealth Foundation) is a foundation established under the laws of Switzerland and registered in the commercial register of the state of Zug (CHE-382.156.242); its legal domicile is in Zug.

The Foundation's responsibilities are:
- Token creation
- Release of network protocol
- ecosystem growth
- custodianship of the Innovation Fund

Another purpose of the Foundation, on a global scale, is the facilitation, promotion, and support of applications running on the open dHealth Network. All code is open sourced under the Apache 2.0 license.

5.2   Network

The dHealth Network is decentralized and community-driven. The interest of the participants lies in the execution of healthcare related use-cases.

5.3   Innovation Fund

dHealth Foundation has reserved 20% of the total token supply for strategic projects that will expand and strengthen the dHealth ecosystem. The funds will be released throughout 10 Epochs (see Table 1. Inflation Schedule). The innovation fund is to be used for the support of projects that have a positive impact on ecosystem growth. The

foundation, therefore, initiates Innovation Hubs around the world that are responsible to evaluate and approve the funding of projects in their geographical region. Project proposals can be submitted by anyone who pays 250 DHP (non-refundable) to the innovation fund.

6 Roadmap and Milestones

In November 2017 the HIT Foundation was formed and approved by the Swiss authorities in March 2018. In December 2020 HIT Foundation applied at the Swiss Federal Foundation Supervisory (Eidgenössische Stiftungsaufsicht) to be renamed into dHealth Foundation. The Foundation and its token are compliant with the Swiss Financial Market Supervisory Authority (FINMA) regulations since May 2018.

Table 2. Timeline

3/2021	Launch of dHealth Network
4/2021	Migration of users from NEM NIS1 to dHealth Network
5/2021	Automated Market Making
6/2021	Listing of DHP payment tokens at centralized exchanges
Q3/2021	User (Patient-) controlled data repository integration
Q4 2021	Digital Contracts
2022	Stablecoin integration

The Mainnet of the dHealth Network was launched 29 March 2021 with the harvesting of the Nemesis Block (see **http://explorer.dhealth.cloud/blocks/1**).

7 Outlook

As an alternative solution for permissioned, authority-controlled healthcare infrastructure, the dHealth Network provides the pillars of a real-time and efficient data-transaction platform for the healthcare ecosystem. It is centered around the individual user but, at the same time, facilitates B2B exchange.

As an open system, it will be available globally, but with the network-of-networks capability, it can also interact with regional and even permission-based networks. Adoption will be fast in regions where there is little or no infrastructure for the settlement of healthcare-related transactions. Countries that already have such infrastructures can take advantage of a shared blockchain infrastructure that can facilitate complex multi-party scenarios that involve different stakeholders.

The native currency of the network DHP will be used as a secondary currency for a global healthcare system, thus making healthcare services more accessible, transparent, and equitable. To settle payments without the volatility of the network's DHP, in the future stable coins can be established on the dHealth Network.

8   Legal Disclaimer

This document does not constitute nor implies a prospectus of any sort. No wording contained herein should be construed as a solicitation for investment. Accordingly, this whitepaper does not pertain in any way to an offering of securities in any jurisdiction worldwide whatsoever. Rather, this whitepaper constitutes a description of the functionality of the dHealth Network and the development and distribution of the dHealth Blockchain.

9   References

1. Deloitte (2019). Global health care outlook: Shaping the future. https://www2.deloitte.com/global/en/pages/life-sciences-and-healthcare/articles/global-health-care-sector-outlook.html (Accessed 4 Nov 2019)

2. Raghupathi W.: Data Mining in Health Care. In Healthcare Informatics: Improving Efficiency and Productivity. Edited by Kudyba S. Taylor & Francis; 2010:211–223.

3. Andreu-Perez J., Poon C.C., Merrifield R.D., Wong S.T., Yang G.Z. Big data for health IEEE J. Biomed. Health Inform., 19 (4) (2015), pp. 1193-1208

4. Personalized Health and Care 2020, Framework for Action, National Information Board, HM Government, UK: (2014). Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/384650/NIB_Report.pdf (retrieved 2017-10-04).

5. PwC (2016). The value of patient data. http://pwc.blogs.com/health_matters/2016/05/the-value-of-patient-data.html (retrieved 2017-10-04).

6. Health Europa https://www.healtheuropa.eu/digital-health-market-worth-more-than-693-4bn-by-2026/101709/ (retrieved 2020-09-10).

7. NEM Developer Center. https://docs.symbolplatform.com/ (retrieved 2020-11-27).

8. Importance Score. https://docs.symbolplatform.com/concepts/consensus-algorithm.html

9. Transaction Fee. https://docs.symbolplatform.com/concepts/fees.html#transaction-fee

Appendix: Network Genesis Parameters

Topic	Parameters		
Token Creation	DHP	Type	Currency+Harvest
		Supply	1'000'000'000
		Divisibility	6
		Supply Mutability	Immutable
	Custom Mosaic Creation	Supernode Operator (Free)	
		Network Accounts (Paid)	
Block Generation / Consensus	blockGenerationTargetTime	30 seconds	
	minHarvesterBalance	10'000 DHP	
	maxHarvesterBalance	20'000'000 DHP	
	minVoterBalance	100'000 DHP	
	networkType	104 - MAIN_NET	
	beneficiaryPercentage	10%	
Inflation	totalInflatedSupply	1'000'000'000	
	inflationDuration	12'500'000 blocks = 4'340 days	
	harvesterReward	95%	
	neworkFeeSinkReward	5%	
	Inflation Rate 1-1'250'000 blocks	400 DHP / block	
	1'250'001 - 2'500'000	200 DHP / block	
	2'500'001 - 3'750'000	100 DHP / block	
	3'750'001 - 5'000'000	50 DHP / block	
	5'000'001 - 6'250'000	25 DHP / block	
	6'250'001 - 7'500'000	12.5 DHP / block	
	7'500'001 - 8'750'000	6.25 DHP / block	
	8'750'001 - 10'000'000	3.125 DHP / block	
	10'000'001 - 12'500'000	1.5625 DHP / block	
Fees	minFeeMultiplier	100	
	defaultDynamicFeeMultiplier	100	
	transactionSelectionStrategy	maximize-fee	
	rootNamespaceRentalFeePerBlock	0.001	
	mosaicRentalFee	10000	