WHITEPAPER

Disclaimer: This version of the DAIN White Paper is released as a discussion paper and with informational purposes only. This white paper remains a work in progress and is subject to change without notice.

Just as electricity and the Internet transformed everything, artificial intelligence (AI) and blockchain will disrupt every industry in the coming years.

To lead this transformation, we are building DAIN, a decentralized, geographically dispersed network specialized in AI problems and governed through blockchain.

DAIN is a new generation artificial intelligence platform enabling the efficient utilization of the computing resources of any device to solve complex computational problems.

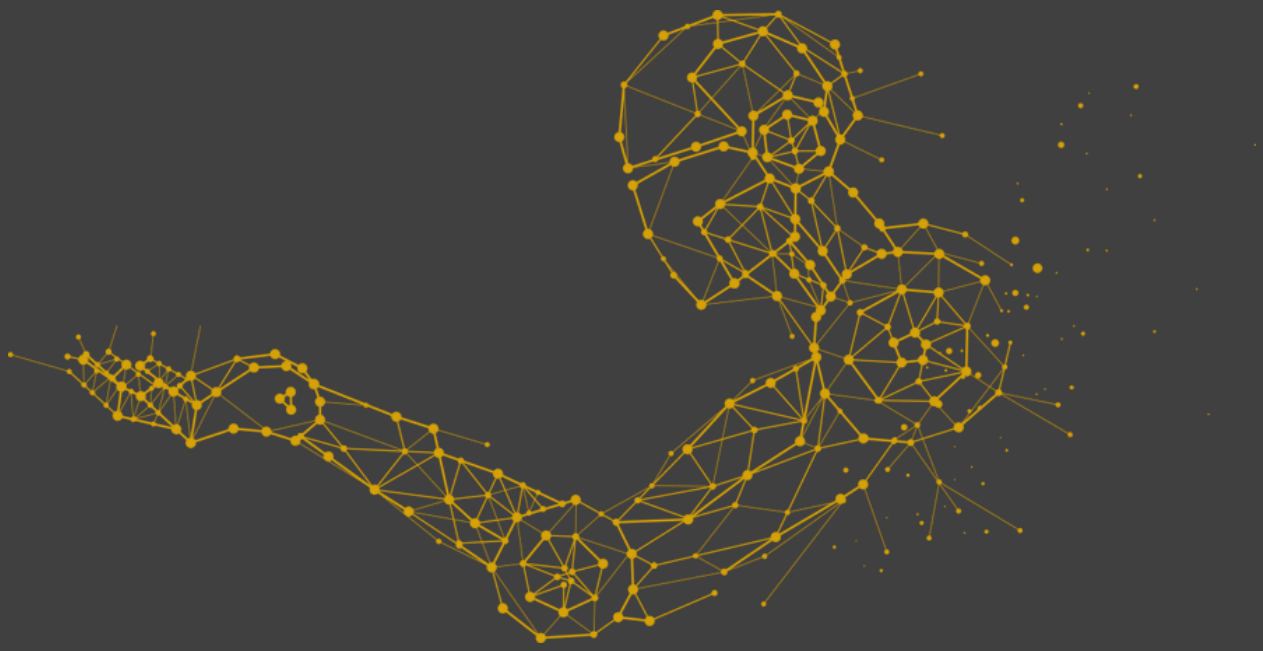
DAIN does not have its own computing resources. Instead, it makes use of free computing resources from any computer or device, from private datacenters to smartphones and IoT devices.

DAIN aims to provide easy, affordable access to AI, enabling all consumers, from small businesses to large corporations, to extract knowledge from big data, reduce time-to-market in the generation of models, and monetize data and knowledge.

DAIN enables users to rent the idle computational power of your devices and computers in order to be used by companies solving AI problems.

DAIN allows companies to generate new business models, new relationship models with their customers and new revenue streams, providing a safe space where they can sell, rent and share knowledge, solutions, data and infrastructure securely to create, consume and execute AI.

Through DAIN, a company of any size can easily and efficiently train a new model with its own data and/or data from external sources provided to DAIN. It can then refine the model with third-party data available in the data marketplace. The company can publish the model in the model marketplace and generate revenue from it while maintaining ownership, control and knowledge of the model. Or alternatively, it can monetize its data, allowing others to train their models or execute them with enriched data, all while keeping the data secure and without sharing it with any third party.



Content

1. INTRODUCTION

Artificial intelligence is positioned at the core of the next-gen software technologies in the market. Companies such as Amazon, Google, IBM and Microsoft have actively implemented AI as a crucial part of their technology. But this comes at a cost: the vast number of computer resources required to perform these tasks. The hardware must be constantly renewed and consumes huge amounts of electricity for cooling. And with the exponentially increasing amount of data to exploit, the trend is only growing.

The cloud market is valued at USD 291 billion in 2019 and is expected to reach USD 1.25 trillion by 2025, at a CAGR of 27.50% during the forecast period.

Machine learning is projected to be the segment with highest growth, reaching USD 188.4 billion by 2025, at a CAGR of 48.60%.

Leveraging a USD 188.4 billion market opportunity

We are addressing this market opportunity without making big, inefficient investments in datacenters, hardware and cooling. In the same way that AIRBNB, the largest accommodation provider, owns no real estate, UBER, the largest taxi company, owns no vehicles and NETFLIX, the fastest-growing television network, lays no cables, DAIN aims to become the largest AI as a service provider without datacenters.

DAIN can be described as a huge artificial brain composed of all kinds of computational devices located anywhere in the world. Any user can teach the brain how to perform certain tasks, and then he/she can ask for these tasks to be executed. Likewise, any user interacting with the brain can demand that the same tasks be executed, as long as the first user instructed the brain to allow others to access this knowledge.

The brain will remember every task it learns and continuously improve its performance of them. Eventually, it may execute any number of tasks simultaneously, with the sole limitation of its size.

The brain has the potential for unlimited growth through the addition of new computing devices. Like a natural brain, it requires energy to perform any task. In this case, the energy is the reward given to the device owners.

This way, users may interact with the brain to help it solve problems, or help the brain to solve these problems by enabling its growth.

2. DAIN COMPONENTS

Understanding and leveraging the possibilities of an artificial brain with unlimited scalability is a complex task. This white paper splits the explanation of DAIN's potential into three different interlinked components, examined separately and in detail:

- **DAIN Ecosystem**: DAIN is created, built, and grown by and for its users. Like the internet, DAIN users will define what DAIN will become in the future. Users can participate in this ecosystem by playing different roles.
- **DAIN Solutions**: The business toolbox designed to offer out-of-the-box value to DAIN users. It aims to streamline the democratization of AI and enable new business models.
- **DAIN Platform**: The core underlying infrastructure that enables the ecosystem and the creation of solutions. Its mission is to establish a secure marketplace for computing resources, data and AI models.

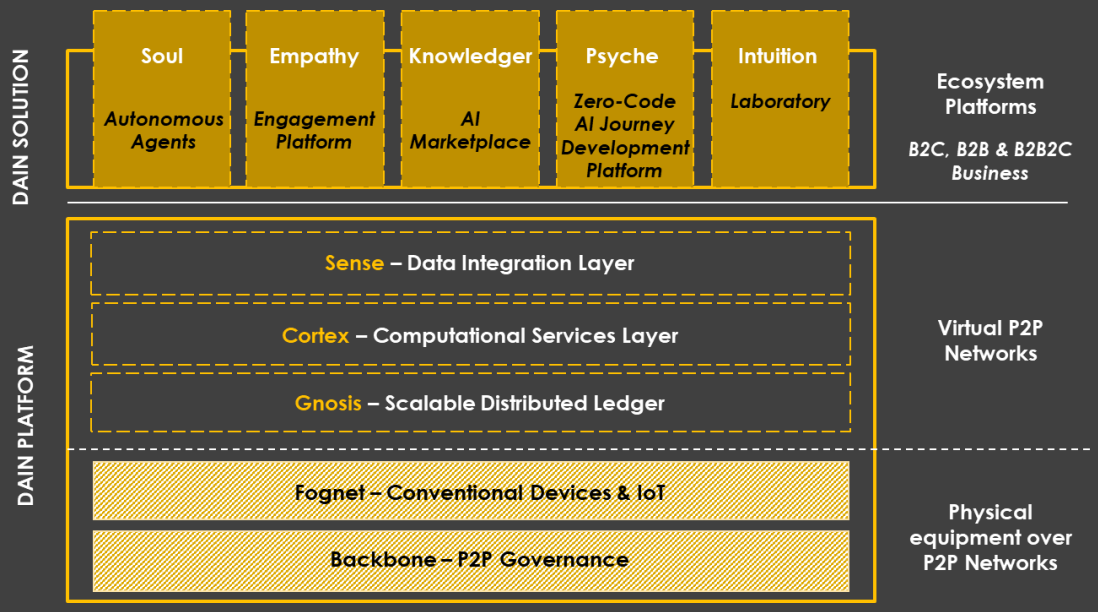


Figure 1

3. DAIN ECOSYSTEM

DAIN is conceptually designed to interact with two kind of users, end users and institutions (private companies or any other kind of institution, such as universities or research centers).

- **End Users** fuel the computational resources market, sharing the free computing capacity of their devices to cover institutions' requests for service, receiving a reward (tokens) as payment.

- **Institutions** make requests for service to the network, consuming its computational resources. Depending on the type of service request, they can be divided into:
  - **Producers**: They create new AI models trained in DAIN using their own data and/or data provided by the network members, paying tokens in exchange for the usage of the required computing resources or data. These solutions can be created only for their own consumption, or they can be exposed in the marketplace at any time to generate new revenue streams.
  - **Consumers**: They directly access the AI marketplace to reuse existing solutions created by Producers.

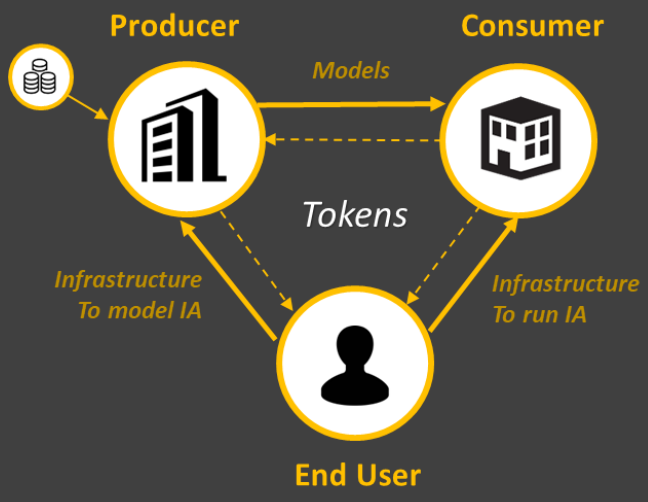


Figure 2

It is relevant to note that while initially, DAIN is expected to grow with each type of user playing the specific roles described, it is not limited to this model. For example, Institutions with their own datacenters or cryptocurrency miners could play the "End User" role and share their computing resources through DAIN, obtaining DAIN tokens in exchange.

4. DAIN SOLUTIONS

As described, DAIN Solutions provide ready-for-use business solutions. This section details the initial set of solutions that will be provided on top of the DAIN platform.

4.1 Empathy – Engagement platform

EMPATHY is a solution that enables companies to create new means of interaction and exchange with their customers or leads, allowing them to offer exclusive services and rewards.

It is especially aimed at companies that make use of DAIN's computing resources and are interested in leveraging their client base for this purpose while building customer loyalty.

With this solution, the company can create a set of services, such as special offers, subscriptions, discounts, etc., to be purchased with DAIN tokens. They are offered exclusively to users that are part of the company domain in the DAIN network.

Through Empathy, the company will be able to implement a native, internal token exchange environment with its customers, without the need for them to go to a currency exchange to obtain fiat money in return for their tokens. It also provides a full management environment to define the offered services, discounts, subscriptions, notifications, loyalty programs, etc.

AN EMPATHY EXAMPLE

A telecommunications company launches a special program through its mobile app, gaining access to the free computing capacity of mobile phones. This way, users can earn rewards in exchange for securely sharing their phones whenever they do not need them and give their permission. They can then trade these rewards for discounts, media content, data bundles, etc. The telco gets access to computing resources at a lower cost and pays its customers with its own services. And lastly, customer loyalty increases, as they are obtaining exclusive benefits and discounts in the commoditized telecommunications market.

Empathy includes the definition and management of federated domains. A federated domain allows companies to define specific policies for members' customer nodes, from access to exclusive offers to priorities in the execution of company service requests above the rest of the network. It would be even possible for a company managing a federated domain to outsource the computing resources to its own customers, offering a managed B2B service.

Empathy provides an SDK (software development kit) that any company can integrate directly into its mobile application, providing the full DAIN runtime environment and the Empathy layer.

4.2 Knowledger – AI Marketplace

Currently there are numerous platforms and marketplaces, including those based on blockchain and specialized in data, where companies can buy data to train models, enrich datasets, etc.

DAIN provides a native mechanism to allow models to be trained on the platform using data provided by other network participants. This data can be individual end-user data, data from devices participating in DAIN, for example IoT devices, sensors, etc., or full data sets provided by companies – in both cases, the data is provided in exchange for a token reward.

Through this mechanism, the requesting company does not receive shared data, but rather, directly uses it to train a model, paying specifically for this purpose and ensuring that the data's ownership remains intact.

KNOWLEDGER goes a step further, providing a way to not only build models using third-party data, but to natively expose the created models so other participants in the network can consume them. This way, the model producer can monetize its knowledge without requiring third-party integrations, proprietary software, etc., and more importantly, without losing control or ownership.

A KNOWLEDGER EXAMPLE…

A credit bureau can create a risk-scoring model using DAIN, leveraging efficient computing resources from the network and enriching its data with information provided by third parties, including end-user information from targeted companies.

The model is coded in the ledger and published on Knowledger. This way, any company can run the model directly on DAIN, without integrations, software installations, or even consuming the company's computing resources, as everything is executed natively on DAIN. And the model producer receives tokens as payment for the usage of the model.

On DAIN, all AI models and developments are stored in the distributed ledger and therefore accessible to every node in the network. But this information is encrypted using homomorphism techniques. This basically means that if anyone wants to use that model, they need to be able to apply the same homomorphism to the data source, i.e., be approved by the model owner, who may receive a reward as compensation in a pure "AI as a service" model.

Knowledger will provide a model classification mechanism, search filtering, etc., including all the information related to the model's purpose, data used for its creation, data required for execution, data types, etc. It will also implement a model "reputation" mechanism to allow users to better understand model's quality and potential.

4.3 Soul – Autonomous agents

DAIN offers the mechanisms and computing resources to natively support autonomous agents. Using the concepts already described and implemented in the network, autonomous agents can operate, exchange data, execute in existing nodes, and deliver the results of the actions they have been programmed to perform.

SOUL is DAIN's autonomous agent framework designed for the creation, configuration and monitoring of these agents within the DAIN infrastructure, allowing the designer to isolate himself/herself from the network infrastructure.

Through Soul, it will be possible to generate agents with their own business intelligence, capable of making autonomous decisions within the network and interacting with users and devices in DAIN and other agents.

Agents can perform any task imaginable as long as we provide them with the required context and data. The number of different tasks is potentially unlimited, and the only limit will be the creativity of the designers and publishers, as is the case today with, for example, mobile applications.

Agents can be instantiated by the creator, or by any other user, depending on the policies defined in Soul. The creator receives tokens when the agents' instances are instantiated. The owner of the instance needs to provide a wallet to pay, using tokens, for usage of the agent, the network usage fee, and for any other service that the agent may autonomously consume (for example, payment for data).

A SOUL EXAMPLE…

A business user wants to create a model to identify customers' propensity for buying travel packages, but he/she does not have the proper data to train the model. The user defines an agent capable of searching the internet and marketplaces for data to enrich and expand his/her own dataset, buying data in the marketplaces if required with a predefined budget, and sending the model for training once it has enough quality data to proceed.

4.4 Psyche – A Zero-Code Artificial Intelligent Journey Platform

PSYCHE is an out-of-the-box platform for the development and orchestration of AI journeys through the composition of services.

Psyche will allow any company to have its very own cognitive platform and multipurpose AI, with reduced resources and accelerated time-to-market.

Psyche makes use of the capabilities of Knowledger and Soul, so the model in the marketplace and the published agents can be integrated as part of the AI journeys.

Psyche will also allow companies to connect to cognitive services from third-party providers using proprietary solutions not based on DAIN. It will include out-of-the-box connectors to the most popular service providers.

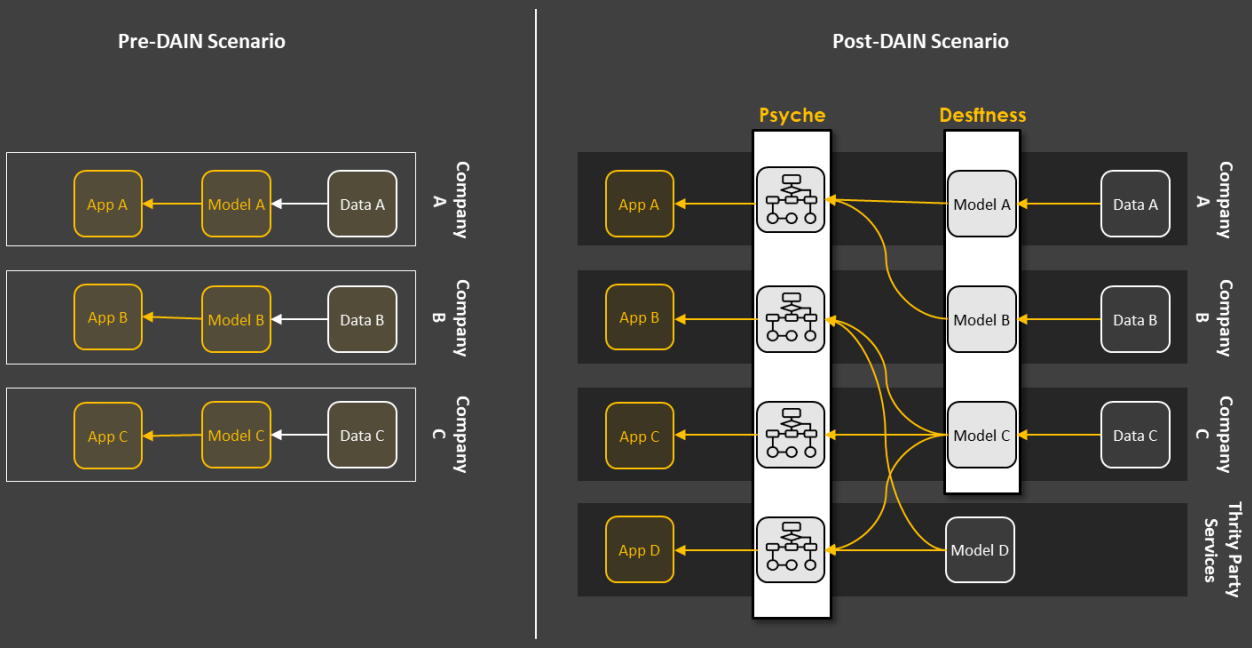


Figure 3

4.5 Intuition – Laboratory

INTUITION is a collaborative platform that supports the launch of challenges for the community for the purpose of creating new algorithms and computing models that will be subsequently included in the platform.

Intuition will help to accelerate AI technology and the growth of DAIN. Intuition will make use of DAIN's computing resources and a reward system for community members.

5. DAIN PLATFORM

Current technology implementations face many different challenges to be able to achieve behavior like the one described for DAIN. To address them, DAIN implements novel architecture based on three technology pillars:

- **Fog Computing** mechanisms over P2P networks composed of potentially any device with computing capacity (IoT, smartphones, desktops, servers, etc.), enabling the sharing of spare computing capacity.
- Permissionless scalable **Distributed Ledger Technology** (DLT) to support the tokenization and accounting of computing resources, using a new consensus approach that addresses some of the main problems of current DLT implementations.
- Useful-Proof-of-Targeted-Work protocol to provide **Artificial Intelligence** services over decentralized and non-secure open networks.

5.1 Physical Network

P2P Network Topology – Security

P2P network's flexibility can become a challenge when facing attacks from dishonest or hostile nodes.

DAIN P2P network topology, **Fognet**, implements a central **Backbone** that aims to provide a topological structure for the whole P2P network to:

- Offer security mechanisms to prevent attacks from fraudulent nodes, such as *Eclipse Attacks*.
- Ensure workload is properly balanced across the whole network.
- Enable topological location mechanisms in the nodes to optimize data propagation time.
- Certify node's connectivity and capabilities through certification probes (Proof-of-Bandwidth, Proof-of-Work, Proof-of-Capacity…).
- Allow snapshot mechanisms for the ledger, so the nodes can operate with a subset of the ledger, freeing memory and storage and letting specialized nodes (those with more memory) store the full ledger history.

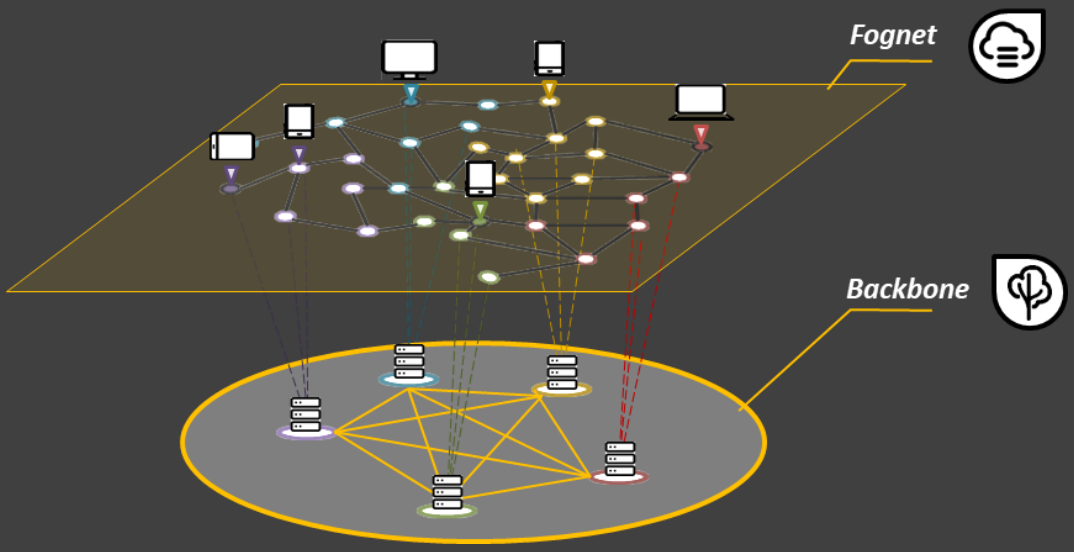


Figure 4

Zero-Cost Based Transactions – DoS Protection

The first block in the DAIN blockchain contains all the tokens that will exist in the network. In consequence, there is no mining. DAIN nodes obtain a reward by solving small parts of computational problems. There are no transaction fees.

To prevent DoS (denial of service) attacks, DAIN uses an AI algorithm that calculates a reputation score for DAIN participants through the evaluation of token flows in the wallets.

This scoring is used by a block incremental anti-spam system that can request PoW and/or impose fees on suspicious transactions before they are allowed in the system. This mechanism stops malicious activity and hinders activity from actors that may harm the ecosystem.

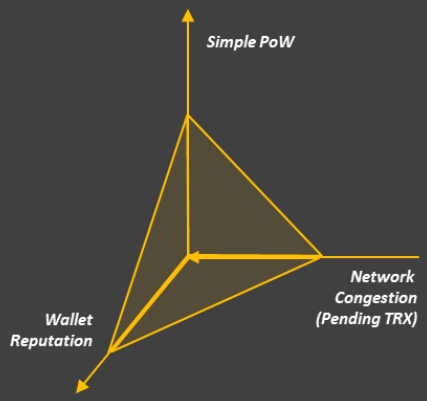


Figure 5

Next-Gen Mobile & 5G Ready

First and foremost, DAIN was designed to target smartphones, considering their specific hardware capabilities, computing resources, battery and connectivity. In particular, it envisions the future 5G-based mobile networks with lower latency and reduced battery consumption.

SOME DATA…

By 2021, there will be more people worldwide with smartphones (5.5 billion) than with bank accounts, running water or land lines. That is, more than 70% of the global population will have a smartphone.

A conservative analysis estimates that these devices will have 198,000 petaflops of accumulated computing power.

The potential to use all this computational power in a collaborative economy model is huge. And it is compatible with protecting mobile device users, i.e., giving them the freedom to always prioritize their own tasks. They have the option of allowing resource-sharing only while connected to a certain network, the battery is charging, the phone is not in use, at specific times, or a combination of all of these.

IoT Ready

DAIN was designed to consider IoT as a key potential player. It has no default capacity tests for nodes, and there are no fees for honest nodes transacting in the network. Any kind of node with any capacity can collaborate on solving a request, obtaining a fair reward based on the actual work performed.

This way, billions of IoT devices with all kinds of hardware capabilities will be enabled to participate in DAIN.

5.2 Virtual Subnetworks

DAIN defines three virtual layers on top of the physical network.

- **Cortex**: The "brain" layer responsible for learning and executing tasks, based on fog computing techniques.
- **Gnosis**: DAIN's hybrid, scalable and permissionless distributed ledger technology (DLT). Gnosis combines existing protocols and innovative solutions to address some of the issues in the existing DLT implementations.
- **Sense**: The brain's senses and short-term memory responsible for interacting with external sources and preparing data to be analysed and processed. Sense validates the quality of the requests made to DAIN, sends them to Cortex, and maintains a DHT (distributed hash tables) based filesystem where all the data to execute service requests is stored.

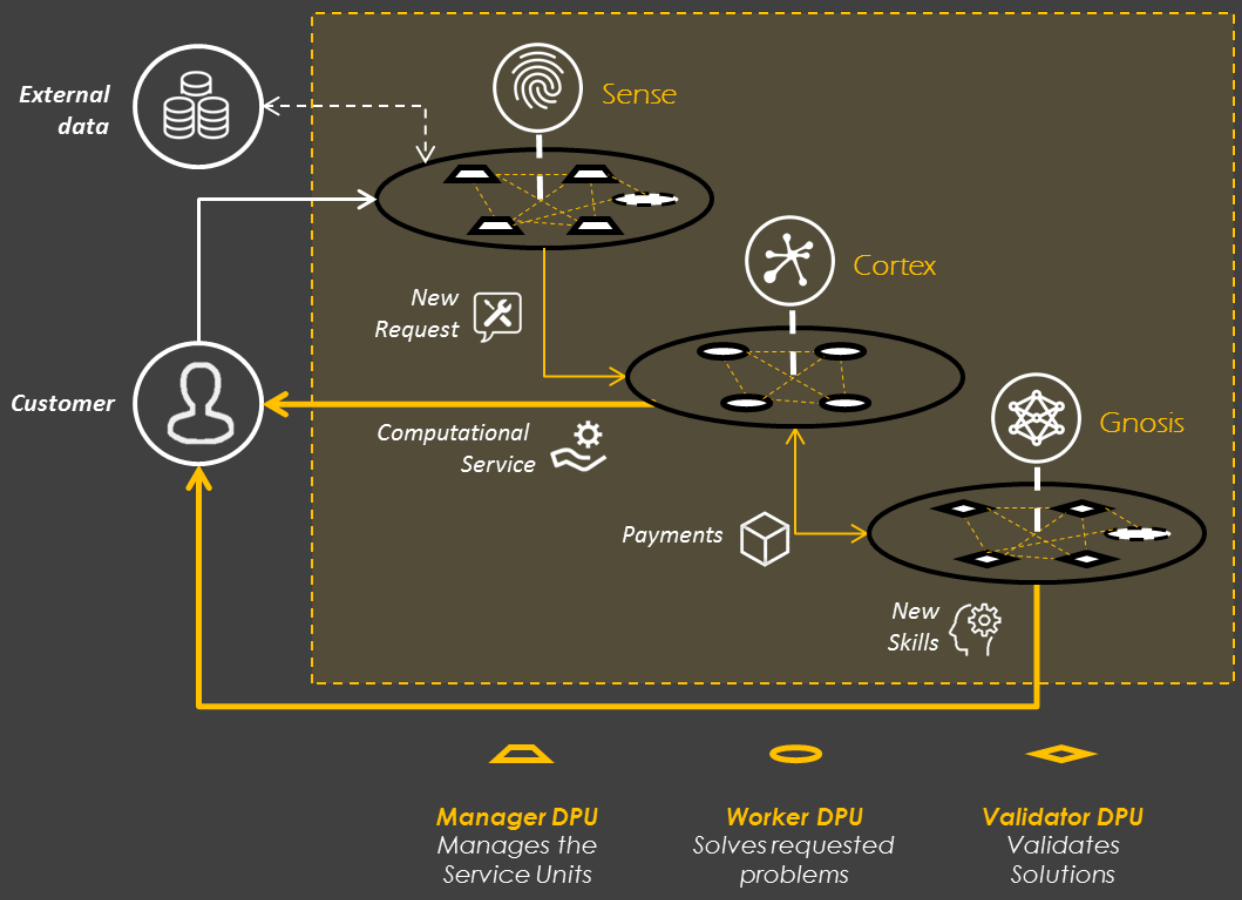


Figure 6

Hardware specialization

DAIN nodes are characterized based on their computing capacity, which is then grouped under one of several resource cells (RCs) into digital processing units (DPUs).

Based on DPU characteristics, each node can also play one or more roles in the network, depending on the different resource requirements. This way, its computing capacity can be better utilized for different purposes, and the benefits for the device owner are maximized.

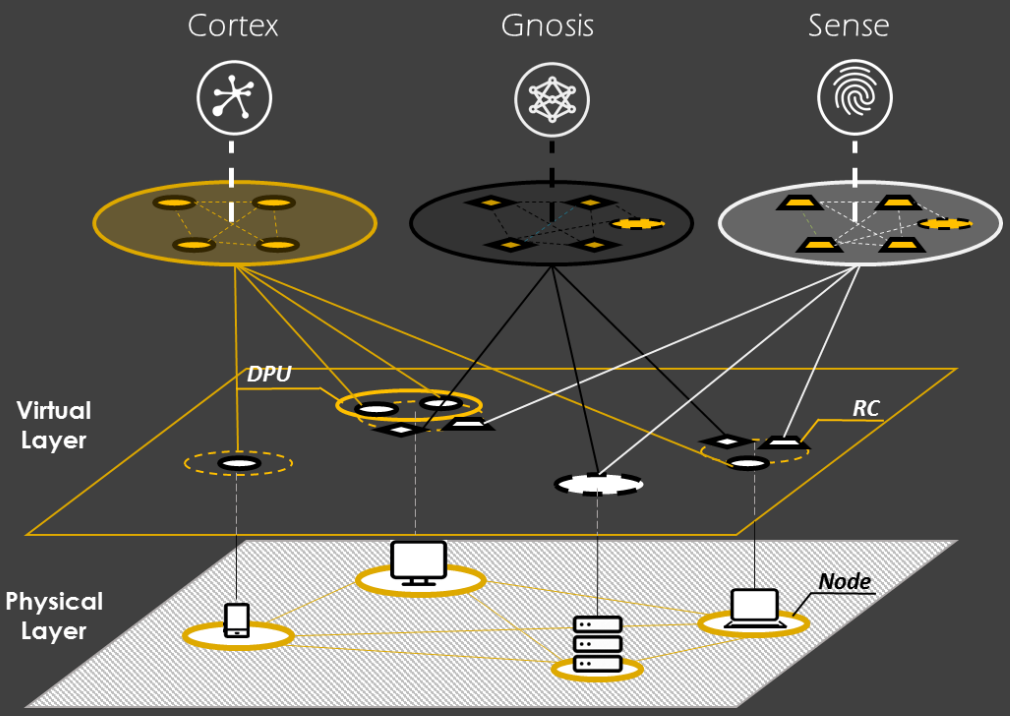


Figure 7

Sense

Data Management and Integration

Sense provides a DHT-based distributed filesystem that allows secure and persistent data storage, so it can be used in a decentralized way to process computational problems requested of the network.

Sense is also responsible for splitting the datasets so they can be distributed along the different nodes, ensuring that only those authorized can read the specific data portion for which they have permission. Data is encrypted using homomorphism techniques, so even when gaining access to it, the nodes have no insight into the data.

This filesystem can be fed with information from external data sources, from public marketplaces to corporate information systems, enabling a data marketplace within DAIN that allows models to directly consume data without this data being directly shared with the data consumer.

No Technical Knowledge for AI - AI for AI

When Sense processes a service request, it analyzes the data and is able to identify and select a pipeline of candidate models to solve the problem:

- Sense first pre-processes the data, searching for correlations that identify non-relevant data, format errors and information gaps, so the data can be cleaned and prepared ensuring data quality standards.
- Sense then analyzes the pre-processed data considering the requestor's objective. Based on those characteristics, DAIN identifies the most suitable models and generates a proposal for the user.
- Once one of these models is selected, Sense identifies optimal parameters for the algorithm, with a starting point that can be used to accelerate the modelling and optimize the search for solutions that fulfill the defined acceptance criteria.

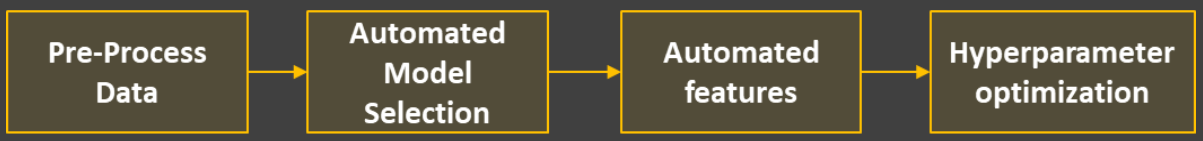


Figure 8

Cortex

Low-cost Infrastructure as a Service

All computing resources available in DAIN nodes are represented as resource cells (RCs). DAIN can manage these resources and offer them on demand, grouped into dynamic processing units (DPUs) within each node.

As RCs and DPUs can have different computing capabilities, characterized in tiers, and are geographically dispersed with different network latencies, DAIN uses a distributed algorithm to identify the optimal resources to complete each specific task, based on their suitability, availability, node historic behavior and interest (such as offered price). These resources are grouped into a cluster called a ***Service Unit*** (SU).

SUs can be created for different computational purposes:

- AI models training tasks.
- AI models execution tasks.
- Autonomous Agents instantiation and execution.
- Others

Consuming computer resources through DAIN will be more affordable than using general-purpose commercial IaaS providers.

IaaS providers must invest heavily in facilities and hardware and have high costs associated with datacenter operations, cooling, marketing and sales. None of these investments or expenses are necessary for a user providing capacity to DAIN, as their hardware will usually be conventional hardware with another primary purpose (for example, a smartphone),

THE IaaS MARKET …

- *More than 3% of the energy consumed worldwide comes from datacenters, and the absolute and relative number is growing. An important part of this energy comes from cooling needs.*
- *On average, building a fully loaded datacenter costs 1 million euros per 60 square meter*
- *Cloud market is valued at USD 291 billion in 2019 and is expected to reach USD 1.250 trillion by 2025. AI will be the fastest growing consumer, reaching USD 188.4 billion by 2025, at a CAGR of 48.60%.*

Secure Infrastructure

The DPUs forming an SU are geographically dispersed, which implies that in each SU, different nodes from different owners will be represented. This mechanism allows the creation of heterogeneous SUs, hindering the creation of dishonest SUs and allowing for maximization of opportunities and rewards distribution.

Each SU in the network is identified by a unique public key obtained through the execution of a DKG (distributed key generator) t-threshold cryptographic algorithm, following a secure multi-party computation (sMPC) schema.

This algorithm is solved by all the DPU members of the SU, allowing all the information published by the SU to be previously agreed upon by the participants (unanimous consensus pooling) using ***Multi-signature Validation***. This system forces the nodes with CPUs that are part of the SU to cooperate and cryptographically seal their agreement.

To guarantee the honesty and security of this model, DPUs within an SU play different roles, with different individual objectives and specific economic rewards. These roles are defined according to game theory dynamics, allowing the detection, penalization and expulsion of nodes with malicious behavior.

All these techniques allow the implementation of innovative approaches to managing the ledger in non-trusted open environments, lending trustworthiness to the block producers. This approach is used by DAIN, making the properly formed SUs the only authorized entities to produce blocks in the Gnosis ledger.

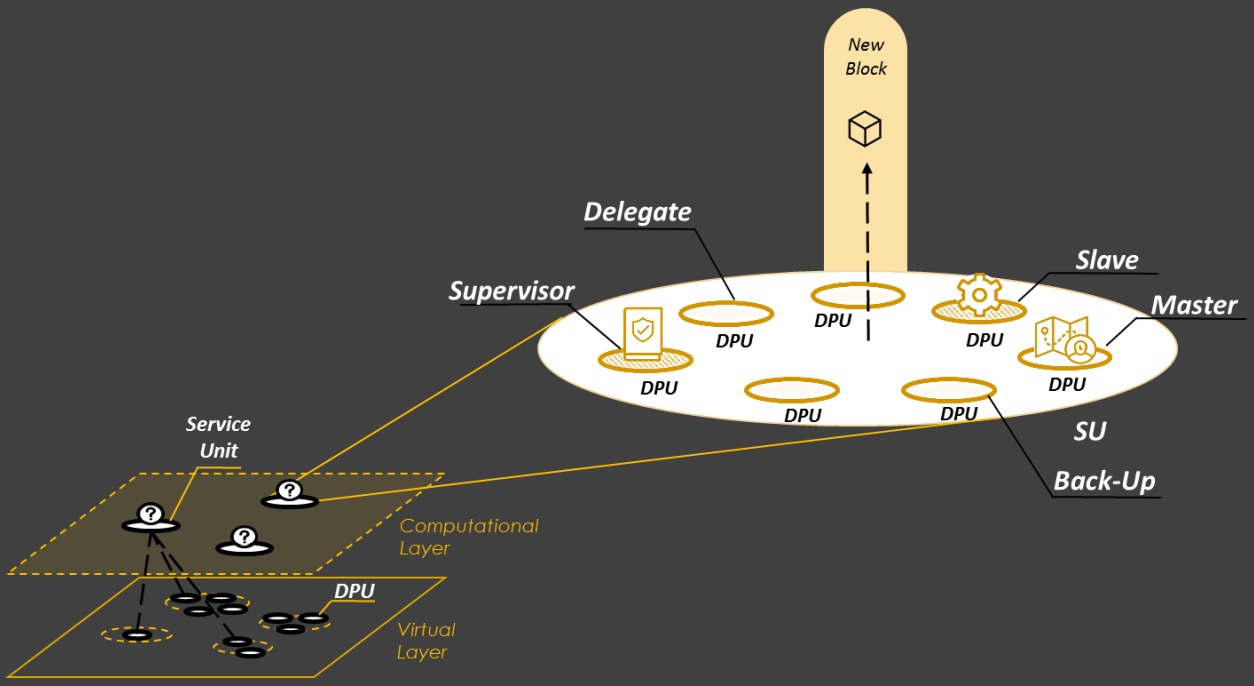


Figure 9

DAIN Lifecycle

DAIN manages the service request's full lifecycle, the service provision and the block production, making efficient use of specialized virtual networks and innovative protocols and mechanisms.

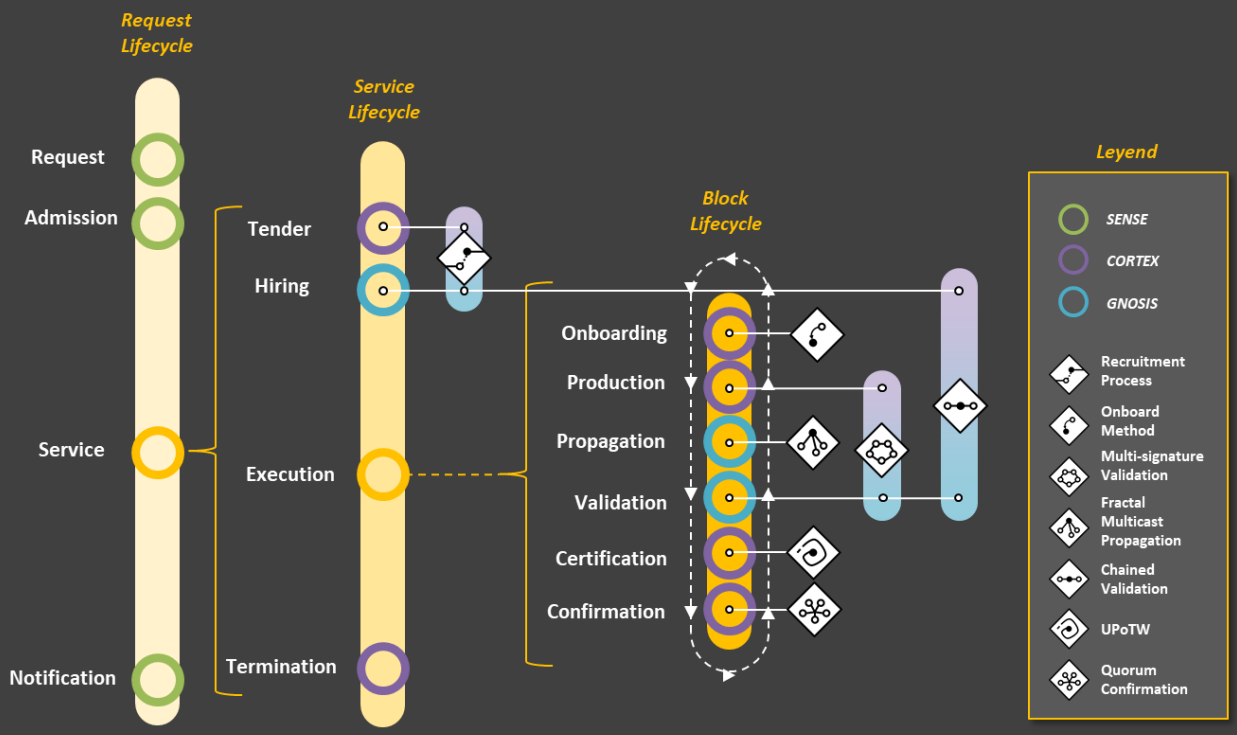


Figure 10

Recruitment Protocol – Computational Versatility

DAIN SUs are dynamically formed through the **Recruitment Protocol**, a decentralized protocol based on Proof-of-Weight and designed to identify the most suitable and efficient combination of DPUs depending on the service and network requirements.

The protocol is activated when there is a new request, whether it is an internal or external event. For example, this could be a service request to complete a task, a Gnosis internal need, or a specific need from an autonomous agent.

Under the protocol, a set of DPUs with specific hardware requirements playing masternode roles will finish creating SU proposals in a phase called Competition.

During this phase, the protocol defines certain SU target characteristics to evaluate SU suitability:

- Cost Model
- Dispersion Model: Resource's topologic location within the P2P network. This information will be relevant to ensure efficient data propagation in the network.
- Decentralization Model: SU wealth distribution.
- Reputation Model: Reputation of the accounts where the nodes send their rewards.

Each SU proposal obtains a score on each characteristic. The protocol gives a final score (suitability score) to each proposal, thus obtaining a single SU proposal with the best score.

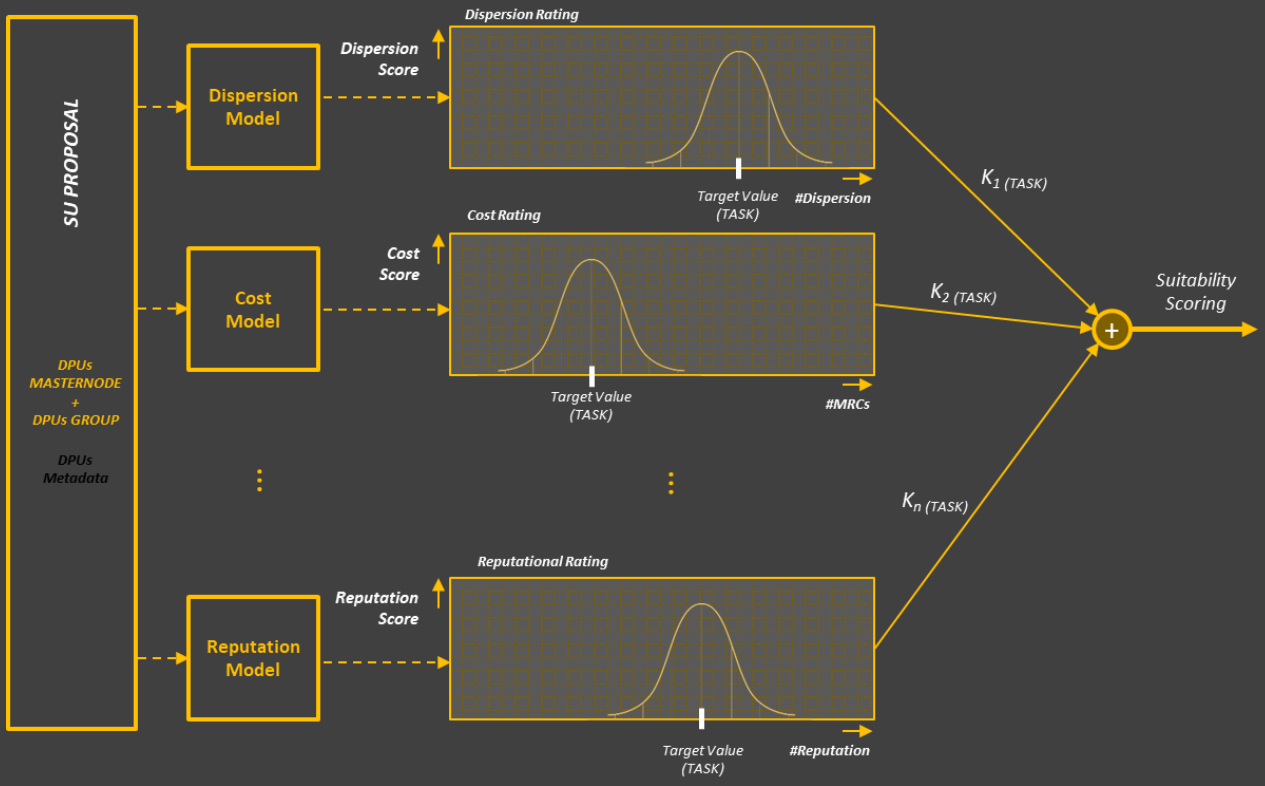


Figure 11

The SU finally selected to provide the service will go into the Hiring phase. The SU will be recorded as an active SU, allowing it to start its activity and record information in the ledger.

The masternode with the winning SU obtains a key role within the SU, receiving a bigger reward.

Cost Model - Smart occupation of the network

DAIN uses a **cost model** based on computational complexity theory to identify the optimal resources to solve a task in terms of efficiency and performance.

This mechanism not only ensures the optimal usage of computational resources, but also can guarantee that all users receive a fair reward based on how much their nodes contributed to solve the task.

Trusted decentralized AI

DAIN allows the outsourcing of computing jobs to train and execute AI models. These jobs can be described in business terms and validated under specific acceptance criteria and SLAs.

To ensure a valid service execution, DAIN implements a useful proof of work mechanism denominated **Useful-Proof-of-Targeted-Work** (uPoTW). This algorithm is implemented at the DLT layer and certifies in an open, untrusted and decentralized environment that the work performed complies with the requirements and therefore should be rewarded.

uPoTW is composed of different AI algorithm packages that can be characterized to solve specific problems where the result can be verified through a decision problem. The set of all these algorithms forms the DAIN **Suite**.

The validation is performed by impartial network members, avoiding conflicts of interest, and the submitted work results are only considered once there are enough certifications to guarantee that the result is trustworthy and compliant with the validation criteria as set by the requestor.

uPoTW also allows the ledger to make a decision about whether the result of that job should be persistently stored as a new ***skill***. Skills are the brain abilities learned by DAIN, which can be executed natively afterwards by ecosystem users.

Encrypted AI – Confidentiality

All network data and models are secured through homomorphic encryption, guaranteeing confidentiality for data and models shared with part or all of the network.

Data provided by the service requestor or by third parties is encrypted and consumed encrypted by the working nodes, ensuring that the data is not exposed at any point in the service lifecycle.

This technology also allows code confidentiality: the models resulting from training performed with encrypted data are homomorphic and be can executed afterwards using data encrypted with the same homomorphism.

Useful-Proof-of-Targeted-Work – Computational efficiency

A network is fully efficient in computational terms if there is no waste; i.e., all the computational resources are used to produce output. Inevitably, managing the network requires part of this capacity, which needs to be minimized to ensure an optimal level of efficiency. In open and untrusted networks, this objective becomes harder to meet, as mechanisms must be implemented to ensure trust and security.

A typical example of one of these mechanisms in blockchain is proof of work. Proof of work not only requires huge computational waste that generates no useful output, but also is designed for competing nodes trying to solve the same problem, while only one will meet the desired objective.

DAIN implements a cooperative and useful proof-of-work algorithm. As such, the algorithm promotes cooperation to solve a problem, which is a real problem that has been sent to the network as a task. This algorithm provides a mechanism to certify the work and output generated by the nodes cooperating to solve the problem:

- Ensuring that a single set (SU) of nodes (through DPUs) participate and cooperate to solve a problem; i.e., there is only competition in the hiring phase, not in the execution phase.
- Validating through quantitative criteria that the achieved output solves the requested need, and therefore is eligible to be rewarded based on the computational effort required.
- Hindering Sybil attacks and denial-of-service scenarios through certification of the devices performing the work.

Scalable parallel and distributed evolutionary computing

DAIN enables the search for solutions to AI problems to be parallelized through the utilization of evolutionary algorithms. These algorithms coordinate the work performed by different nodes working independently and sharing partial solutions to the problem.

This technique is especially apt for machine learning and neural networks, as:

- The search space can be wide and multimodal. Different solutions can achieve the same performance.
- As the data set grows, and the topology complexity increases, the search space becomes more complex, and the error function contains more local minimums. Genetic algorithms provide high efficiency in wide and complex search spaces, facilitating the search for solutions close to the global minimum.
- Genetic algorithms are fit for general-purpose neural network training. These algorithms require little information about the problem structure and therefore can be used to train different neural network types, such as recurrent networks, networks with discontinuous activation function, etc.
- Evolutionary processes are continuous processes.

Gnosis

Noesis – Overview of a Scalable Distributed Ledger

Noesis is a hybrid consensus algorithm, taking the more interesting capabilities from conventional blockchain implementations and the synchronous directed acyclic graph (DAG) model to implement an innovative approach to distributed ledger technology (DLT).

Noesis is designed under the following architectural principles:

- Temporal scalability
- Network scalability
- Sustainability
- Fork resistance

Temporal Scalability

Noesis is a DAG-based consensus algorithm that implements a decentralized clock system that triggers events and their conclusions.

This mechanism is based on a modified version of Proof-of-Stake (PoS) enabling multi-signature validation according to the Recruitment Protocol. This technique is referred to as **Collaborative-Proof-of-Stake (CPoS).**

The original proof-of-stake allows network nodes to make a deposit so they are eligible for publishing blocks by a decentralized algorithm. This way, PoS allows the establishment of a temporal block sequence by assigning orderly turns to the nodes. The nodes are then rewarded with the transaction fees, and the frequency with which the node is chosen depends on the amount of coins/tokens in the deposit.

Similarly to PoS, CPoS creates a list of nodes interested in publishing nodes and makes a deposit with that purpose, but the implementation differs in some aspects:

- The algorithm selects a group of nodes.
- Chosen nodes, instead of producing blocks, must work to produce SUs for proposal through the Recruitment Protocol. From all the different proposals, the algorithm will choose the most suitable two.
- These two SUs have a specific network internal purpose, and they are denominated as **Hemisphere**. Hemisphere SUs' mission is to publish a finite number of decentralized events in the network as a block. The SUs have a finite lifetime, and once the work is completed, they are replaced by two news SUs repeating the previous process.
- Published blocks from Hemisphere SUs are sequentially confirmed at a constant rate. This way, block publishing acts not only to make those events official to the network, but also as a decentralized clock.

This behavior is similar to a conventional blockchain, but in DAIN, it differs in that the mechanism is not used to process transactions, but to govern a secondary DAG-based ledger where transactions and models are stored.

The governing chain is called **Mainnet**, while the transactional DAG is called **Strandnet**. Mainet and Strandnet combine to form **Noesis**.

Blocks in Mainnet are published at a constant rate, which acts as a heartbeat in Strandnet. These blocks have accountability over authorized SUs and available jobs. Finally, Mainnet acts as the Strandnet coordinator, identifying the most trustworthy state and preventing conflicting blocks and double spend scenarios.

Strandnet allows the simultaneous publication of multiple non-conflicting blocks, allowing the dynamic scalability of the transactional capability. To ensure there are no conflicts across blocks, an **Onboarding Mechanism** based on sharding techniques is used. Through this process, pending transactions are distributed across all the active SUs in Mainnet, ensuring dependent resources are sent to the same SU and allowing parallel independent processing.

In DAIN, these resources are the source accounts for the transactions. In other words, any transaction coming from a single source account will be published only by a specific SU. This mechanism prevents double spending and allows the network to escalate dynamically and adjust to demand.

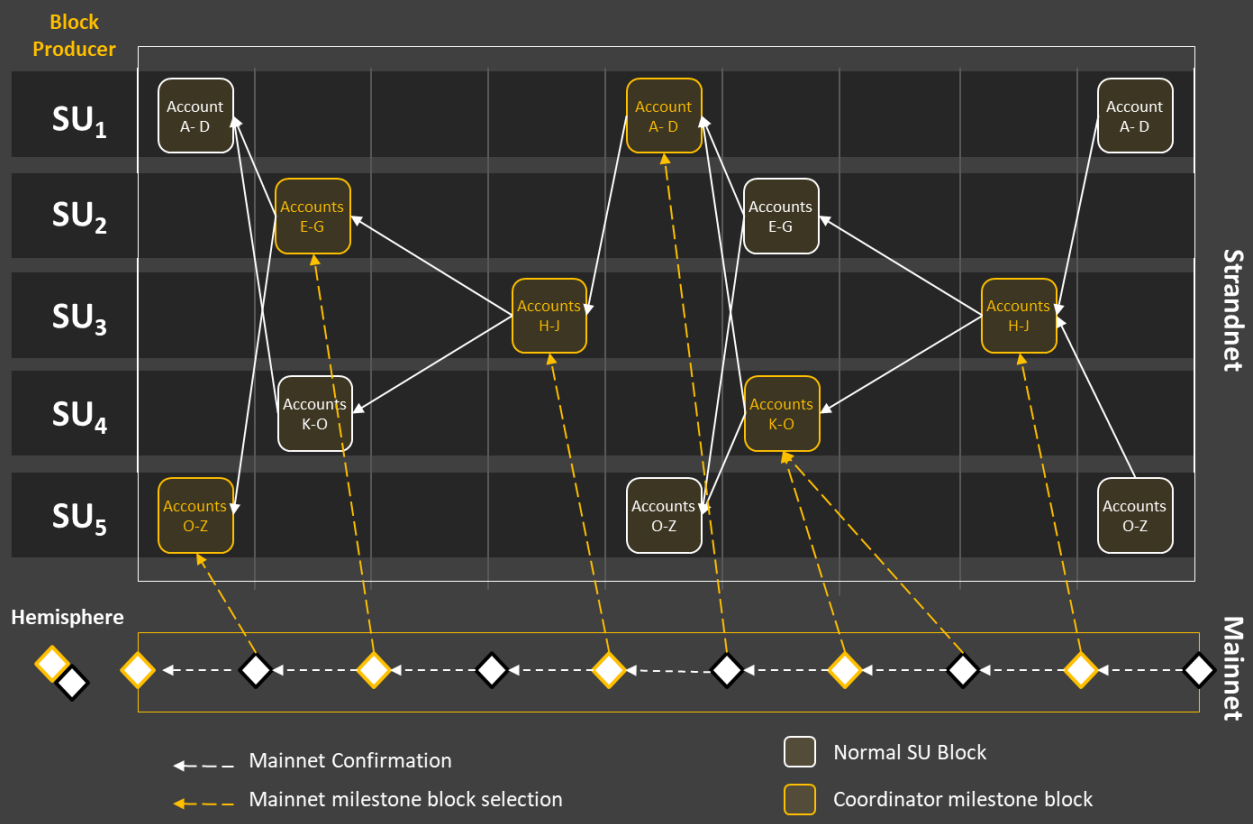


Figure 12

Network Scalability

DAIN's **Fractal Multi-cast Propagation** mechanism enables blocks to be propagated in the network following a pattern that is replicated proportionally to the network size. This mechanism is supported by the Recruitment Protocol, which ensures that the SUs created in the network have disperse topology, enabling information to be broadcast from different sources that are topologically equidistant.

This process reduces the number of hops required for a block to be fully propagated and allows the propagation time to be stable, independently of the number of devices participating in the network, as long as the pattern is maintained. The constant rate of information propagation ensures that every node in the network is synched, receiving the same information at the exact same time.

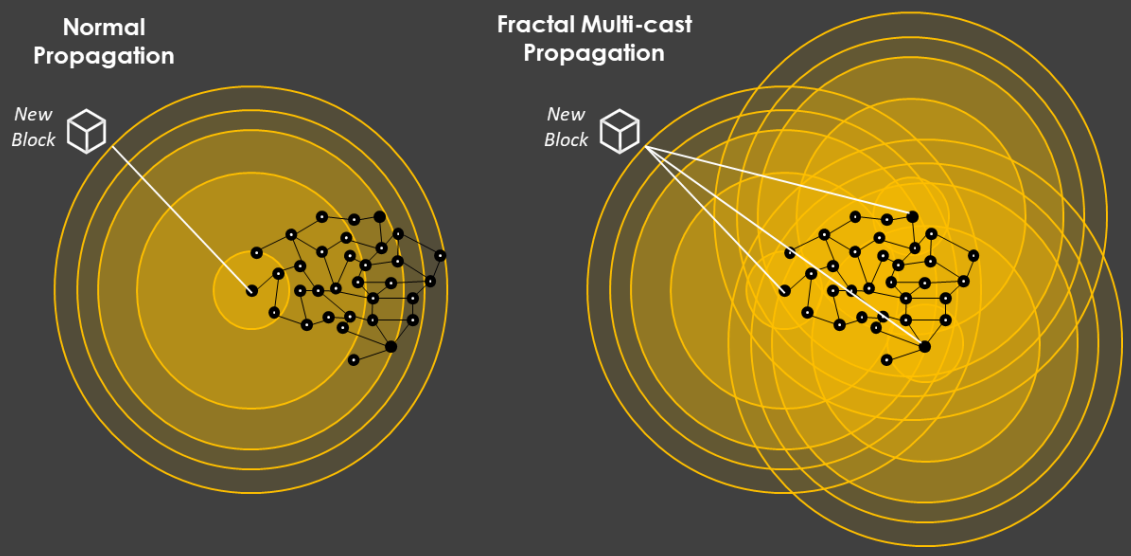


Figure 13

Sustainability

Block validation in Noesis is the confirmation of the two previously presented mechanisms:

- Guarantee timing among blocks for each SU.
- Distribution of accounts in each block as determined by the Onboarding Mechanism.

Unlike other consensus algorithms, these validations require few computational resources. Reduced computing time enables higher transactionality rates. But it also guarantees agreement among nodes prior to block validation to perform the consensus and the sustainability of the ecosystem.

Fork Resistance

DAIN's **Quorum Confirmation** is the security protocol against network forks, applying voting statistical convergence to Byzantine fault tolerance.

The nodes in an SU, which per the Recruitment Protocol are topologically dispersed, share beliefs about the last steady state of the DAG to compose a high-resolution image of the global network state. This picture is used to reach an internal consensus on which blocks on DAG can be considered reliable, discarding conflicting blocks, guaranteeing network synchronism in decision-making and adding an additional control layer to the chain evolution.

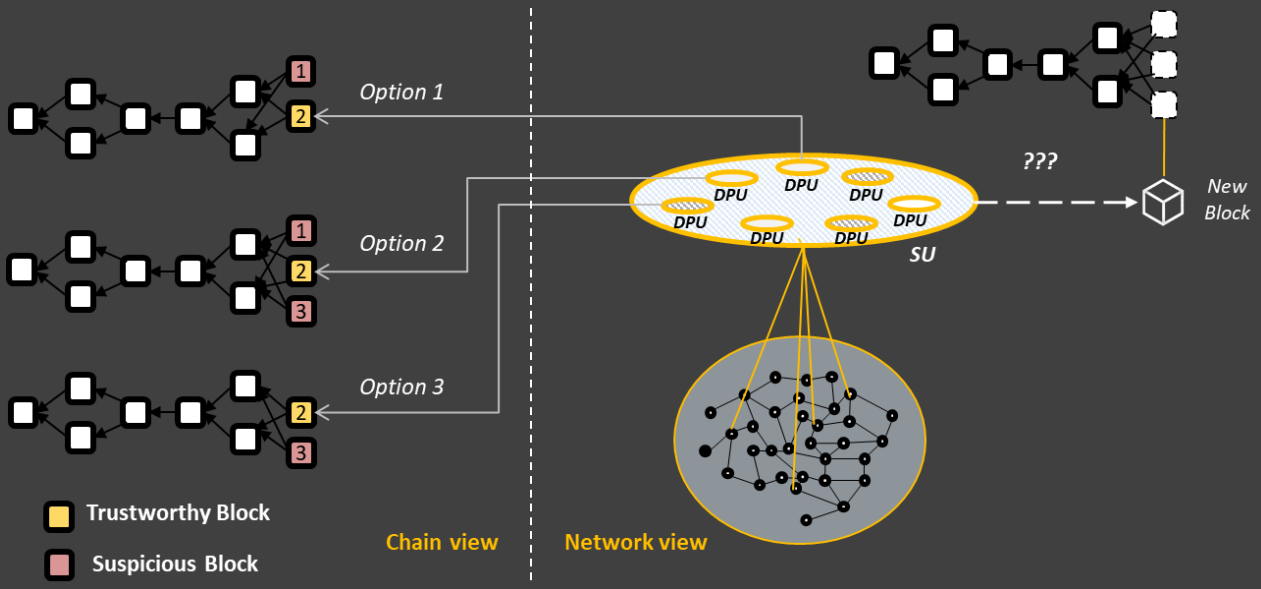


Figure 14

6. DAIN ECONOMY

DAIN implements different techniques to promote the stability of the utility token and the overall system:

- DAIN token value is referenced by the computing power constituting the network.
- The token has reduced volatility, as the value (not the price) is linked with real and measurable indicators.
- There are clear token value growth drivers.
- Wealth distribution

6.1 DAIN Token Value

A DAIN token is directly linked to the computing power of the network.

To quantify the network's computing power, a reference index is defined: DIPS (**DAIN Index Performance Standard**). Every service request handled by the network can be characterized by a DIPS number, which represents the estimated computing power required to solve it.

A DAIN token (DAINT) is defined as the computing capacity allowing the execution of a service request of 1 DIPS, in every active **Minimum Resource Cell** in the network.

1 DAINT = 1 DIPS x #MRCs

The bigger the network, the bigger the value of the token, as it would provide access to more computing power.

To prevent artificial network growth, each MRC requires a DAINT reserve to be considered active and allowed to provide services.

While the price of a specific task is driven by supply and demand, there is a pricing mechanism that links it to the token value, reducing volatility.

6.2 Service Fees

Services provided within DAIN have a fee (dsf, DAIN service fee*) paid by the requestor. The purpose of this fee is to reward DAINT holders.

The fee is determined as a % of the service price, and the corresponding DAINTs are "burned" (i.e. no longer circulating in the network). As the total number of DAINTs in the network decreases, the value of the DAINT increases, directly rewarding DAINT holders.

The bigger the usage of the network, the bigger the value of the token.

6.3 Wealth Distribution

In order to guarantee the network's survival, it is necessary to ensure that all the participating actors earn a fair reward, avoiding wealth centralization by actors with more capacity or voting power.

This mechanism incentivizes new users to share their computational resources through DAIN, regardless of how big or small the device's computing capacity is.

The DAIN protocols implement rules designed to ensure that all device types can have equal access to collaborative associations of nodes with heterogeneous characteristics, subsequently ensuring a proportional distribution of the rewards.

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Annex

Technical Overview

To learn more about the technical design of the DAIN platform, you can access the following link to the technical presentation of the product:

https://dain.ai/docs/DAIN%20-%20Technical_ENG.pdf