
TEAL
TECHPAPER

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ABSTRACT

The use and value of data on the Internet has attained more importance than ever. Companies are being rated not only for their ideas but more and more for the way they skim and store data, especially when it is about highly detailed information which is linked to individual users.

This makes it easier to provide services that can be used freely. Frequently used services or devices grant access to all kinds of collected user data and due to this free use, users not only give permission, but also trust these companies based on their name and/or size to store their information safely and to not misuse it or sell it to someone untrustworthy. Building up user trust is essential for growth and customer loyalty. This takes a lot of time and leaves almost no room for mistakes. Losing user trust only takes a fraction of this time but can lead to immense economical damage, since these companies and their structure are designed to use growing data as fuel.

On the one hand, personal information has great value for users who seek privacy and security, on the other hand, companies rely on accessing and storing this user data. Data breaches have stopped users lightly handing out their information to companies or brands.

Blockchain technology with its use of cryptography has taken user privacy to a new level, not only by opening up the possibility to save data which the user feeds to the system through integration, but also by storing private documents encrypted on the blockchain.

Facing trust issues, companies also need a quick reliable system, that handles large amounts of data, streaming 24/7. A.I. with its learning process and its ability to improve itself and its decisions whilst handling large amounts of data from different sources is of great help.

Introducing TEAL: using the blockchain technology, TEAL is a smart blockchain ecosystem providing a solution for the high demand on security and privacy in combination with a strong A.I. creating a platform for self-organized marketplaces.

TEAL is set out to solve more than just the needs of buyers and sellers, its goal is to create a growing environment, influenced by the userbase and their demands for information and products.

Connecting a strong and secure cryptographically based blockchain technology to an A.I. that has been researched and developed for more than ten years, TEAL will define and build the platform for the future, bringing benefits to all of its actors and participants.

CONTENTS

1. INTRODUCTION

User interests are shifting, personal data is becoming more and more valuable, thus making privacy one of the biggest concerns. Sharing informative data will force companies to adapt to new technologies, that allow them to thrive economically and rebuild user trust. Users will be looking for a service to satisfy their needs that gives them more control over their own data and, at the same time has a more secure structure.

TEAL AI AG approaches this challenge, not only in preparation for future development but also to have a major impact on how the Internet is used at this level. TEAL's main goal is creating the TEAL Marketplace and TEAL Wallet.

2. A.I. AND BLOCKCHAIN

The first step is building a scalable blockchain-based platform with connections to on- and off-chain services. The increasing use of mobile devices and social media platforms, requires an architecture including future solutions for streamlined client implementation and connectors for any account that is to be connected to the network and will run as a DApp on the basis of Ethereum's proof-of-stake (PoS) approach with sharding as a scaling solution on the blockchain.

For the A.I. to operate more and more efficiently it uses constant and ongoing machine learning processes that include constant information streams building up big data that will be isolated and made available on an off-chain server with a centralized database. This will reduce the cost of data storage on the blockchain as well as the amount of on-chain transactions. [1]

Highly sensitive data will be stored on the root chain and, by using cryptography, this information will be encrypted by the individual private key of the actor.[2] With unique identifiers, set at each process in which this information is needed, combined with the communication route set by the request, this data will not leave the chain encrypted or decrypted in its original state.

The power of the A.I. is to manage and process information. Using the human body as a role model, especially the way the brain functions, accomplishes a high responsiveness even if the A.I. has to interpret decrypted values coming from the blockchain. Without sensitive data leaving the on-chain layer of the DApp, a flawless communication between the layers will be provided; this will have the advantage of interaction and creation through A.I. and/or smart contracts.

3. SMART CONTRACTS

Smart contracts are indispensable when it comes to building a DApp on the base of Ethereum's protocol. Setting conditions allows contract automation which will execute if set criteria are met. These are used to accomplish communication between services in the network itself or other network services. [3]

A smart contract can be kept simple, but its range of uses are far more than you would assume. The TEAL A.I. prediction is one of the key benefits of machine learning, which leads to the creation or update of smart contracts and through execution it will create a TEAL Template. As a result, smart contracts are flexible and can be created for applicational purpose. On the business side they make the rules for the core of the blockchain and business logic.

[1] Source: A Proof of Stake Sharding Protocol for Scalable BlockchainsY. Gao and H. Nobuhara
[2] Source: https://github.com/ethereum/wiki/wiki/Glossary
[3] Source: https://github.com/ethereum/wiki/wiki/Glossary#smart-contracts

4. TEAL DAPP

4.1 TEAL TOKEN AND TEAL COIN

The TEAL ecosystem is based on a dual token model, consisting of the TEAL Token and the TEAL Coin.

4.1.1 TEAL TOKEN

The main token is called TEAL Token and can be acquired before the launch of the TEAL Marketplace. The token amount is limited and mintable which means that the holder is able to generate a certain amount of so called “TEAL Coins”, the main currency on the TEAL Network. The number of coins generated is going to be limited by time, demand of supply and the amount of TEAL Token in existence. By creating a token and a coin, we can achieve a payment method with a native TEAL Coin occupying functionality for finalizing transactions. However, the TEAL Token can be seen as an investment which allows its owner to generate coins and therefor its value will be persistent.

The TEAL Token is based on the ERC20 token standard of the Ethereum blockchain. The TEAL Token will be sold as part of the planned Initial Exchange Offering (“IEO”) and can be used to create (mint) TEAL Coin.

The TEAL Token has the following functions:

» Minting function
» Increase in value
» Holding function

4.1.2. TEAL COIN

The TEAL Coin is based on the ERC20 token standard of the Ethereum blockchain and will be the native token of the TEAL Network. The TEAL Coin will primarily serve as a means of payment on the TEAL Marketplace. In addition to this payment function, the user will be able to stake TEAL Coins by binding a minimum amount of TEAL Coins to the system. The staking process will allow users to be selected as a validator (“Validator”) by a random method. Validators can vote for a chosen block on a shard. If they successfully validate transactions, they will be rewarded with newly minted TEAL Coins or penalized if they try to cheat the system.

The Teal Coin has two functions:

» Payment function
» Staking function

4.1.3. NATIVE TEAL COIN

TEAL Coins are seen as native coins. This is essential for the PoS consensus. For transactions to be finalized on this algorithm it is essential to have a native coin, which is used for transaction cost and for staking. By providing the TEAL Coin as payment method we can guarantee a PoS environment. A native coin/token is required for creating an independent blockchain with the functionalities of a DApp 3.0.

4.2 TEAL WALLET

The TEAL Wallet design aims towards high user experience. User-friendliness increases the interest in and interaction with the network. Every user or account created on the network will need a TEAL Wallet, this will grant a high level of security and:

- » Will make it easy for transactions between state channels,
- » Will hold TEAL Token and/or TEAL Coins,
- » Will mint,
- » the option of staking the funds/deposit held in the wallet.

Furthermore, the multisignature (multisig) TEAL Wallet allows participants of state channels to be the signer of its multisig, opening all options for the use of payment channel transactions. By using multisig wallets we provide multiple keys to authorize transactions.

4.3 MINTING

The TEAL Marketplace with its actors needs a currency for payments, fees and rewards; the TEAL Coin. Each marketplace or network where supply meets demand, defines the frequency of its use. Next to supply and demand the number of users has one of the biggest impact on the outcome of the frequency of use.

With the mintable TEAL Token it is possible to generate TEAL Coins. Having this option, the amount of TEAL Coins that can be minted will be determined by the demand for coins in the next time period, the number of TEAL Tokens in circulation, and the number of active TEAL Accounts/Wallets holding TEAL Tokens.

4.3.1 MINTING-PHASE ONE

Purchasing the TEAL Token before the TEAL Marketplace with its environment is created, minting tokens will require some sort of manual activity by the holder, in order to receive TEAL Coins. This time-period is called minting-phase one and ends with the DApp officially going live. During this period the amount of mintable coins will be determined by the number of tokens that are actively used for minting. There will be a percentage of tokens bought and passively stored by its owners. The amount that each active holder receives is determined by coin age, the number of days the coins are sitting untouched in a wallet, the number of tokens held and market research, combined with current public interest in the TEAL Marketplace, defining the demand for coins during the first time-period after the launch of the marketplace.

4.3.2. MINTING-PHASE TWO

With the launch of the marketplace the minting-phase one will be replaced by phase two. There is no more manual activity every time a minting-process is created. Keeping your TEAL Token in your TEAL Wallet and setting it to active, the minting process will automatically start after a certain time. The amount of mintable tokens is defined in phase one, but will have an additional factor for rewards. A reward is a percentage of TEAL Coins paid as a fee during a transaction and is sent to the respective right voter of the PoS consensus algorithm. Calculating the demand for TEAL Coins will dramatically reduce the risk of deflation and inflation and will enable them to react quickly in case of extreme situations and incidents.

4.4 STAKING FUNCTION

The TEAL Network is based on a PoS consensus mechanism. Accordingly, holders of TEAL Coins can qualify as validators by staking the token. A random mechanism determines which one of the qualified validators is chosen to actually validate transactions on the TEAL Network ("active validators").

Active validators are rewarded for their services related to the operation of the network. These services consist of running a client (at least a lightweight client). The reward is calculated based on the total amount of staked TEAL Coins (lower amounts leads to higher rewards to incentivize staking) and transaction amounts (expected reward is in the range of 1-8% of the staked amount) and will be covered by transaction fees (gas).

If an active validator tries to manipulate the TEAL Network, a percentage of the staked TEAL Coins will be deleted ("slashing"). Thereby, the slashing mechanism determines the number of penalties received in the past and weights this factor for calculating the percentage of the staking deposit to be slashed.[4]

5. DAPP DESIGN

5.1 OFF-CHAIN TRANSACTIONS

User experience, design and the expectations of actors from the DApp, show that the network has to follow a secure, highly responsive and scalable design, that includes fast and cheap transactions. In the past, every computing execution on the blockchain was considered a transaction. High transaction fees and unscalable blockchain solutions made DApps as good as unusable for most users. Storing data on the blockchain was far more expensive than using a distribute storage solution and made it less profitable.

Shifting from proof-of-work to proof-of-stake, implementing sharding to its protocol, and reducing the transactions and computing power on the main chain, the Ethereum blockchain has become scalable.

The way Ethereum stores data and defines its state enables us to create DApps that have on-off-chain layers with the feature of running and creating state channels outside the main chain and the option of third parties being involved in off-chain transactions.[5]

Off-chain transactions advantages:

- » Instant execution
- » Very low to zero transaction fees
- » Instant payment
- » Privacy benefits through not sharing details
- » Can be used on any use-case
- » Auditable and trustworthy transactions
- » Easy implementation
- » Good solution for injecting smart contracts

[4] Source: https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/eth-2.0-economics/
[5] Source: https://docs.ethhub.io/ethereum-roadmap/layer-2-scaling/state-channels/

5.2 STATE CHANNEL

In the past, attempts of scaling the blockchain included increasing the block size. Although this worked in the short run, constantly downloading bigger blocks when accessing the blockchain would require a lot of hard drive space in the long run, eliminating being able to have such an application on a mobile device.

The way Ethereum handles and defines the state allows the use of state channels. The global state includes mapping between accounts and account states. Using the data structure of a Merkle Patricia tree (Merkle tree) for this storage, there is no need for all clients to download all nodes for synchronization. Validation can be confirmed by merely downloading the header of nodes in one branch of the tree along with the root state.

State channels are created by two participants, who wish to interact with each other in form of a transaction. Participants can be a user-to-user communication or user-to-service communication. Both need to sign the transaction with their private key to verify their identity. State channels are only open for a period of time or can manually be closed by updating the state after the transaction.

The TEAL DApp will include the functionality of creating these state channels. To accomplish instant payments with off-chain transactions, payment channels will be generated.

5.3 PAYMENT CHANNEL

An off-chain payment channel is created and through its values the lifetime of this channel will be determined. To use it, it must be opened and closed, this is executed on-chain.[6] Using smart contracts, both participants stake TEAL Coins. The smart contract views the signed transaction for validation and accepts or rejects it. Once all parties have finished and their signed transaction have passed, the new updated balance of each account is recorded to the chain. The smart contract closes the channel on-chain as soon as the lifetime of the channel has expired or a participant commits the new state.

5.4. THE NEED FOR STATE CHANNELS

State channels can be created as payment channel or as more complex application channels, where participants codify and agree to the apps' rules that are implemented into a smart contract. A problem with state channels is the response of the participants. For example, if one party is not responding, the contract would not be fulfilled. We call this a non-cooperative state and, in the event of this state not coming true, we have to implement a certain functionality suitable for the individual state channel, that will handle such situation. This will open up the gateway to more options where microtransactions or fast communication is required.

A bigger problem is posed by upgrading state channel constructs. This would lead to deploying new sets of smart contracts, having to pay for every on-chain transaction resulting in a loss of time and money.

5.5 GENERALIZED STATE CHANNELS – COUNTERFACTUAL

Counterfactual provides a generalized framework, which will help developing state channels. By storing and locking the state, it becomes "a state deposit", that can be used for app-specific state channels, that are compatible with the framework. By using this framework, more on-chain workload and on-chain transactions are reduced, which will lead to lower costs, faster off-chain transactions and simplifies state channel development.[7]

[6] Source: https://docs.ethhub.io/ethereum-roadmap/layer-2-scaling/payment-channels/
[7] Source: https://l4.ventures/papers/statechannels.pdf

5.6 SCALABILITY IN TEAL'S DAPP

Using our own A.I. for computing large amounts of data with analytics, filtering and processing incoming data even before being processed, gives us the advantage of state channels and off-chain transactions including off-chain data storage. Off-chain scalability includes suitable methods and caching latency will be reduced.

Scaling on the on-chain side will include Ethereum's sharding. The PoS consensus algorithm uses the advantages of the blockchain state stored in a hash-tree and the ability for caching on-chain in form of receipts, that are generated with on-chain transactions.[8]

5.7 CONSENSUS ALGORITHMIC PoS

TEAL will inherit Ethereum 2.0 protocol to realize its marketplace and for running a DApp. At that point the shift from proof-of-work has changed to proof-of-stake.

5.8 INTEGRITY

The global state of the TEAL DApp is stored on the structure of a modified Merkle Patricia tree, the Root will have all data of a transaction stored inside of the block header. Using the Merkle Root is a quick way to test if transactions are correct or if something is wrong.

Integrity of data is secured by cryptography using the unique private and public key of an individual TEAL Wallet/TEAL Account.

5.9 SECURITY AND PRIVACY

The user has full control of what private info he wants to share with the network. The cryptographical algorithm of hashing information using the users' private key stores highly sensitive data on-chain in an encrypted state. Decryption can merely be processed owning the private-key, that only exists once and is held by the owner himself. This kind of information will never leave the blockchain. Information fetched from outside the chain will have a unique and temporary hash value for identification.

A high level of security comes with the PoS consensus algorithm. To participate the validator needs to stake his own deposit. For him to create a 51% attack, known from proof-of-work (PoW) on the bitcoin network, the attacker needs to own more than 50% of the assets circulating, this is very cost efficient.[9] Through the stake the attacker probably would lose the amount he bound to the network, due to a higher and stricter punishment of the algorithm. Through having and staking your own funds a lot of PoW theories and known attacks are not realistic. By adding randomness, the stacker cannot decide which block he has to take a vote for.

Privacy is set to a new level using state channels and offline transactions i.e. not sharing detailed information with the whole network, only the participating parties have insights to such details.

[8] Source: https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/eth-2.0-phases/
[9] Source: https://docs.ethhub.io/ethereum-roadmap/ethereum-2.0/proof-of-stake/

5.10 DECENTRALIZED

The degree of decentralization may seem much lower, with the A.I. having its big data and machine learning computing on a central server, but the biggest part of business logic lies on-chain. With the PoS consensus algorithm, taking part in the validation process by becoming a voter is more appealing than becoming a miner on PoW. Holding TEAL Coins on the TEAL Wallet, staking is made easy, compared to the need of expensive hardware combined with a huge electricity bill.

5.11 CONSENSUS ALGORITHM

The TEAL DApp uses the PoS consensus algorithm that is going to be actively part of Ethereum 2.0 protocol layer, ensuring uncomplicated implementation of the sharding process. Although all shards can operate independently, the rules set for the consensus algorithm will be the same!

6. DAPP ARCHITECTURE

Firstly, TEAL's business model is based on an artificial intelligence – this requires big data being tapped with every single request to ensure the best possible solution and constant deep learning. It will not only use the DApp as data source but public data as well. It is obvious that the A.I. will need to operate outside of the main chain and interact with both the user interface on the client side and the main chain via an API. This off-chain A.I. logic requires a separate database.

This leads to TEAL planning on a second-layer approach. It consists of state channels with a payment channel beneath them. The challenge lies in creating a security strategy for data exchange that still allows the DApp to be highly responsive with low latency on all calls and requests. Different to the client being accessible and compatible like with most used browsers, there should also be the possibility to access a mobile version that acts as a streamlined client. Both result in only downloading tiny data as proof instead of the whole blockchain.

Secondly, let's have a look at user data and other highly sensitive data: These are stored on the root storage and encrypted with public and private key. Nonetheless, we need to identify certain weak spots an attacker might consider to break the construct of asymmetric cryptography. We do so by thinking through the process of these data being stored, updated or called up for a request.

6.1 TEAL'S SECURITY APPROACH

At the beginning we established that breaches in centralized applications have given DApps another advantage from the users' point of view. Mostly, these breaches took place inside of apps or their databases and were found in services used by the app, like a payment system.

This leads to TEAL choosing this 4-step approach to protect data:

1. Transactions take place on- and off-chain, so wherever transactions and messaging take place there must be security measures to protect the exchange of information.
2. Hashed, highly sensitive data stored inside the root storage of the blockchain should never be decrypted and transported outside of the chain.
3. Processing data derived from user information and interactions off-chain via the API should not be vulnerable. We need to eliminate the possibility of breaking into the storage and getting all user input in some sort of clear-text.
4. Known attacks or flaws on a central or decentral network will be included in our strategy.

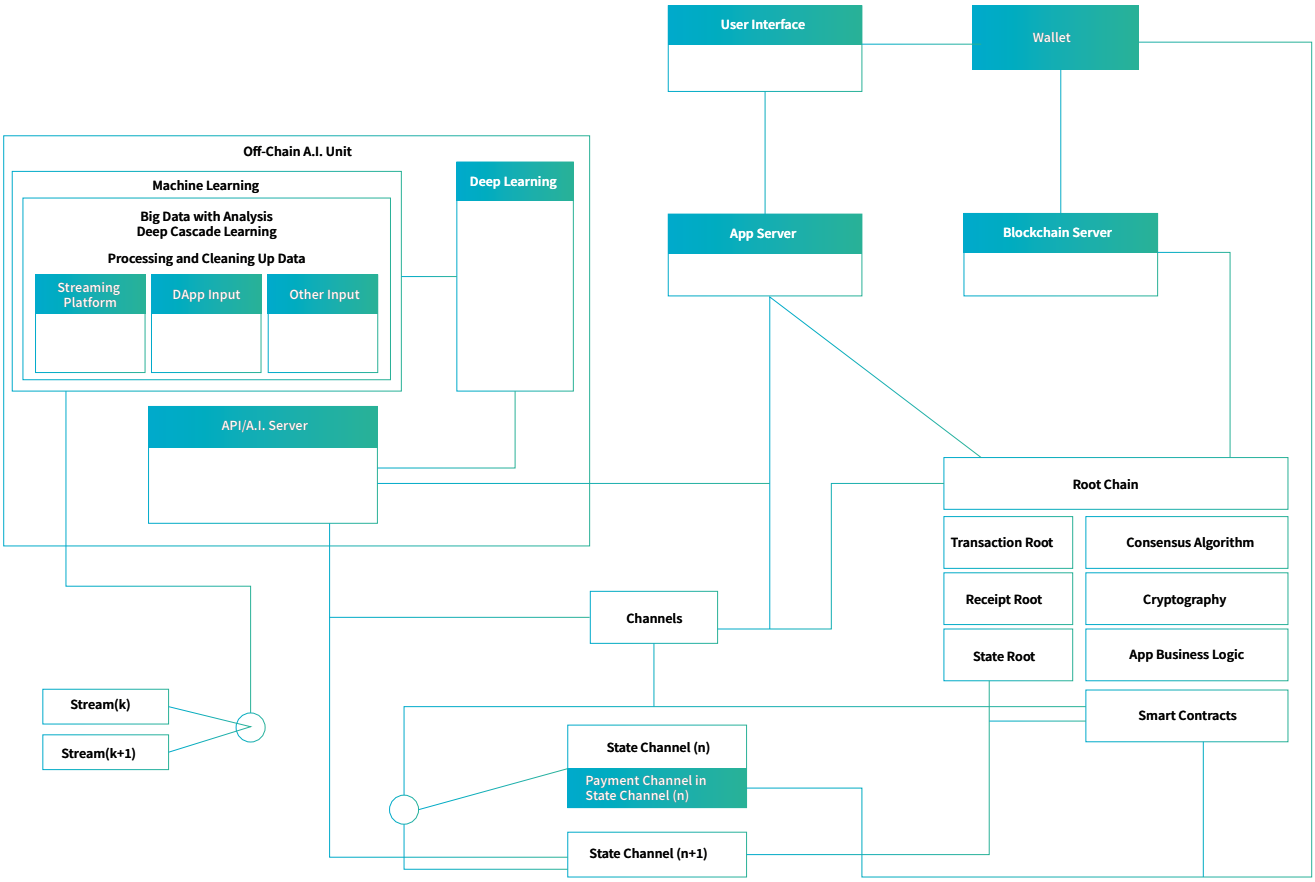

FIGURE 1: DAPP ARCHITECTURE

6.2 A.I. UNIT

The A.I. unit consist of a machine learning part, which has the purpose to evolve the A.I. using big data and feeding it with constant input/output of data.

6.2.1 BIG DATA

Inside the A.I. unit there is a section called analytics which has to filter and process data coming in from so called streams (sources inside and outside of the DApp) which has information coming into the unit. This will rapidly help the A.I. unit to evolve and build up a more efficient data base.

6.2.2 DEEP LEARNING

During the process of building a good, reliable A.I. that handles information coming in and out of the depth, an A.I. deep learning process will take place after information has processed the analytics part of its app. Deep learning does not follow strict rules, it will evolve and grow its skillset.

6.2.3 TEAL APP SERVER

The app server has a two-layer setup which stores application logic for the A.I. which is running independently off-chain, handling big data and interpreting off-chain/on-chain communication.

6.2.4 DAPP USER INTERFACE

The user interface supplied can be run as light node and allows the users to actively take part and interact with the DApp. This user interface can be run with a browser. During the process the system decides if the incoming information has to be processed on the chain or if it is possible to just run it outside.

6.3 TEAL ROOT CHAIN

The main chain or root chain will have the business logic of this application on it. This retains the ability to hold smart contracts, hashing and the sharding process. User data is stored to the chain and users will be identified to their own root by using the hashes set by their Priv/Pub-Key connected to the root chain and the user, via the TEAL Wallet.

7. TECHNOLOGICAL DESIGN

7.1 USER INTERFACE

Excellent user experience is part of the user interface. This allows users to connect to the DApp through a web browser or a mobile client. Users always need to have a TEAL Wallet in order to be a registered user.

The wallet provides the unique private- and public key, but both are needed for the blockchain to verify and identify the user when transactions from the blockchain are needed. For off-chain transactions, the user will have a unique identifier hash, that allows the application server to always identify the user.

7.2 USER INPUT

The user provides the DApp with user input. This is created by interacting with the DApp and adding or removing connectors to his profile, like social media or other accounts. With the user input the A.I. will create an interpretation of the user profile in order to try and foresee future outcomes of further interaction.

7.3 A.I./API SERVER

The use of the API server enables third-party applications to connect to the DApp, this can be for information that should be inherited from an account. It can also be used for creating a new stream, that is built up to be a consistent data input to the A.I. machine learning unit.

7.4 APPLICATION SERVER

The application server holds elements for displaying the frontend, building the user interface. When a user interacts with the user interface, the app server is the first to process, it can then determine if the response needs an additional API/A.I. call or if it can respond on its own. For example, when updating some simple user data, there is no need for calling the A.I. or having to get information from the blockchain.

Registered user connecting a third-party service to his profile-user interface:

1. After login through the client the user navigates to his profile preferences
2. Proceeds to connect with an existing third-party account
3. App server registers the request as complex
4. Uses an API call to create a response
5. On the API server the request will be identified to not call an RPC request to the blockchain server
6. It will query through the database of the A.I. unit and set this to a new stream to go through with this profile and collect data
7. The A.I. unit sends out a query to the A.I. server
8. The A.I. server » API call to the App server
9. With the information the App server creates a response
10. Response will appear on the user interface, which will encourage the user to proceed with further action, if this is what the third-party application needs for identity validation
11. User interface is updated

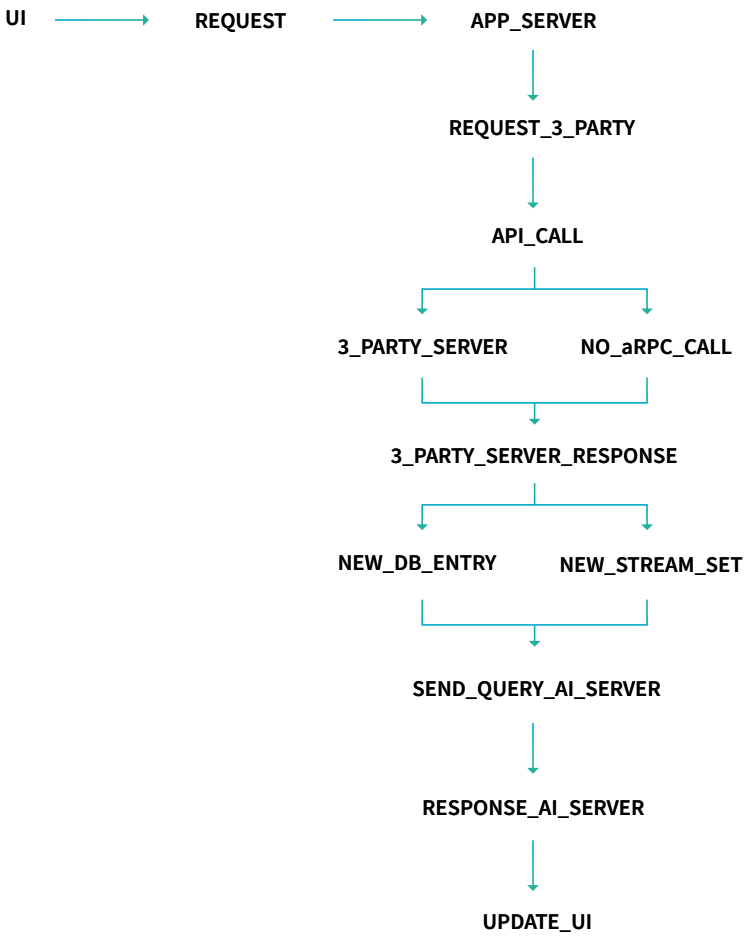

FIGURE 2: OFF-CHAIN USER REQUEST

8. TEAL A.I.

The use of neural-semantic networking to analyze text made it possible to build up a recommendation system and to have an automated relation between products and services with target group clusters (Sinus-Milieus, RCS, etc.).

8.1 TECHNOLOGICAL FRAMEWORK

Technology and implementation of the business model was invented by Dr. Klaus Holthausen, who had a breakthrough in the area of neuronal networks, by technologically emulating the human brain.

The base of this technology lies within an associated neural network, which follows rules of linking, derived from the cerebral cortex. This is the best approach to try and emulate the way the human brain associates.

The basic technological features are:

» Self-driven and dynamic algorithm
» Algorithm operates without static and updatable meta-data
» Operational closed system
» Scalability: only 20% server-load needed compared to running search engines

8.2 PATENT

Patent No.: US 8,396,9851 B2, from Mar. 12, 2013: “Scalable associative text mining network and Method” reads:

A text mining network that improves the performance of search engines by using a network of computer entities with autonomous neural networks. Each neural network provides a weighted list of associated search terms for each search query. The lists of associated search terms from two or more computer entities are merged to a unique list of associated search terms by utilization of a virtual index algorithm. Document result sets from the autonomous entities are merged to a unique result set by a weighted combination of two or more result sets.

8.3 FUNDAMENTALS

By taking the basics of probability theory or more probability calculus and starting off with a simple coin flip, there is a 50% chance of getting heads or tails, every time you flip the coin. So, the probability-distribution would look like this:

$$p(\text{headsup}) = \mathbf{0.5}$$
$$p(\text{tails}) = \mathbf{0.5}$$

The sum of possibility’s equals one, so what kind of information I do you get, by having the result:
“Head, is the outcome of the recent coin-flip”?

The information value/grade can be resolved with a logarithm, for each possibility:

$$I(p) = -\log_2 p$$

Meaning that, I equals one bit of information. The grade of information of one bit equals one question of true and false with the answers having the same possibility of accruing.

Biologically and system-theoretical this doesn't make sense and by having a neural network as an A.I. approach you usually don't have any kind of linear outcome. The constantly learning system doesn't have any access to objective possibilities. We are focusing the subjective possibilities, by letting the system generate a hypothesis of the environment and correlate it with input values. It creates an internal representation of the environment.

Taking this knowledge, we take a different example to approach the way we can resolve and grade possibilities, with a quiz about guessing a star, in which the answers can only resolve in yes or no.

One question could be, if the person you are seeking is female. By having an idea of how many stars are female and male the person asking the question would consider that there are only about 25% female stars, so the probability distribution would come out like this:

$$q(\text{female}) = \mathbf{0.25}$$

Usually the objective possibility would differ for example:

$$q(\text{female}) = \mathbf{0.19}$$

By taking the Kullback-Leibler divergence, we are able to measure the subjective information:

$$D(P \parallel Q) = \int_{-\infty}^{\infty} p(x) \times \log \frac{p(x)}{q(x)} \, dx$$

This equation allows us to derive connections (synapse) in a neuronal network. With the Max Planck Institute for Mathematics in the Sciences an own category of neuronal network emerged, having picture and medical pattern recognition as first application fields.

8.4 ARCHITECTURE OF THE RECOMMENDATION ENGINE

By transferring the previous mathematical basics into a text-processing application, with the text being a neuron and a single term as synapsis, Dr. Klaus Holshausen came up with the idea of the neuronal search engine, in 1998.

Every term has its own value, with pronouns being almost zero and special terminology grading higher and almost reach the maximum value.

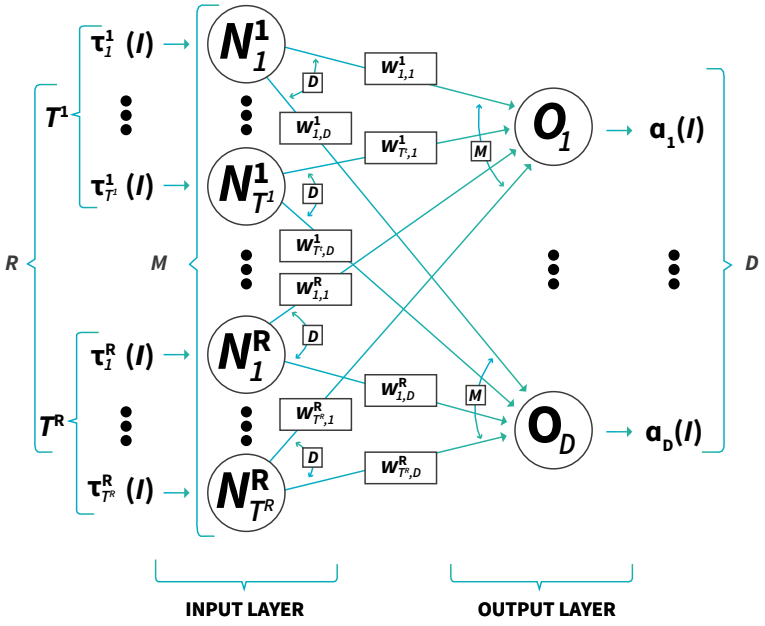

FIGURE 3: ARCHITECTURE OF THE RECOMMENDATION ENGINE

The systems learning process is created by mathematically transforming a reference amount:

$$D = \{I_d \leq d \leq D\} \quad I$$

With D being the learning set of the Universe-Template I.
With the help of function(f) we can extract characteristics of these templates:

$$^{r} = \{ \; ^{r}_{t} \; 1 \leq t \leq T^{r}\} = \quad ^{r}(I_d)$$

The output always being 0 for false and 1 for true, T as indicator for the number of characteristics that accrue. Mostly there are only two possibilities.
The next formula shows how W determines the weight of the synapsis; it represents the connection matrix:

$$W^{r} = (\hat{w}_{t,d}) \;_{1 \leq d \leq D, 1 \leq t \leq T^{r}} = (T_t^{\prime}(I_d) \times i_t^{r}) \;_{1 \leq d \leq D, 1 \leq t \leq T^{r}}$$

I = information value of its respective feature d in relation to f(r,t)
Spreading activation:

$$\_: \quad (\;_0^{+})^{D}; \quad (\;\underline{\;}\;) = (a_d(\;))^{T} \;_{1 \leq d \leq D} = \quad (\;)^{T} \times \quad \begin{pmatrix} _1(\;) \\ \vdots \\ _{T^{r}}(\;) \end{pmatrix}$$

The classes of output can be interpreted in different ways, for example affiliation for social environment.

8.5 SOCIAL GENOME

With the rise of social media users were able to interact in different ways with the environment, for example “liking”. Data collected by social media build up the fundamentals for the social genome. Every likable content (person, label, location, event, etc.) is seen as an entity. By adding informational value to an entity, this becomes compatible with the architecture shown above.

Linking data from market research, it was possible to map social profiles to social milieu, making research for special target groups fast, easy to use and accurate.

The social genome is far more than just collecting personal data, scraping the user’s social media profile as mentioned in the example above. It defines a person with all of his/her demographic variables, like ethnic group, age, environment etc.

This process is being used by management consultants around the globe.

8.6 NEURO SEMANTIC NETWORK

A neuro semantic network puts the natural way of recognition into perspective, with data like text, images, videos and sound. This type of technology relies on analyzable data sets to create semantic mapping and association.

The human brain is taken as a role model for independent and constant learning. Analyzing occurring patterns in the data set, it is language independent. If the data set changes, the known patterns will be updated and processed with the new data set. This ensures constant learning in the TEAL system.

8.7 TEAL A.I. PROOF OF CONCEPT

The neural recommendation engine, created by Dr. Klaus Holthausen, is currently implemented at one of leading the holiday homes booking platform. With putting weight (information value) on attributes (neurons), it generates highly accurate recommendations for the users.

8.8 IN DEPTH USER A.I. INTERPRETATION

Creating a user profile for the A.I., the user does not use just his own input but, depending on his profile, relies on the interaction of other users with his environment and social network.

By gathering information of users and processing it into the A.I. database a kind of social genome will be created. Now the A.I. can also interpret a user on the level of:

- Similarity: what accordance does an individual account have with the other users in the social genome.
- Tie strength: at what degree does an individual user interact with his environment, for example, how many messages has he sent or answered in combination with his reaction time.[10]

At this point we can create new groups with higher levels of similarity of its users. We believe that having a high value will create a greater bond between each other. The tie strength can determine which group has a higher priority and in depth, which other account would have the highest value of trust.

[10] Source: https://www.researchgate.net/publication/318199816_What_do_we_really_need_to_compute_the_Tie_Strength_An_empirical_study_applied_to_Social_Networks

8.9 TEAL-TEMPLATE

Searching for matching patterns and cluster with a high level similarity upon the members linked to these creates constructions, the TEAL Templates. The creation can be triggered by an upcoming or ongoing event. The A.I. bot will create a certain number of rules that will forge a notification of some sort. Potential users will see this on their interface and through interaction the user can communicate if he is interested in the offer or not. If a fee or payment is required, the A.I. bot will create a smart contract; this will trigger a payment channel for the potential user.

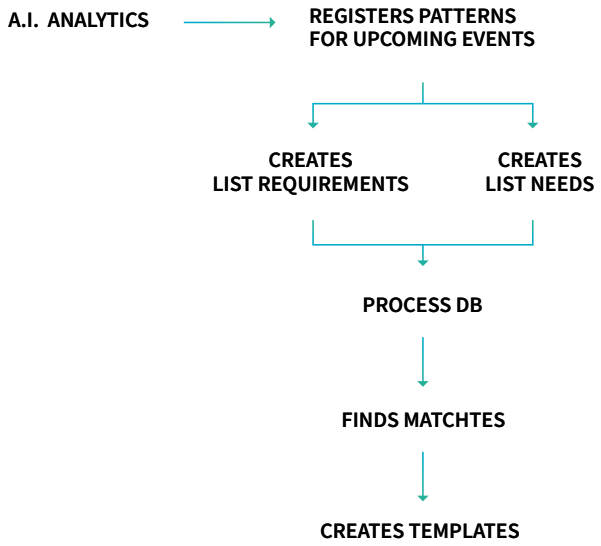

FIGURE 4: TEAL TEMPLATE CREATION

EXAMPLE

By processing data, the A.I. unit defines an upcoming event of a jazz festival that is going to take place in Berlin, linking this to an increase in hotel bookings during this time from users that have an interest in jazz music. With this information, the TEAL bot will try and find a need for a TEAL Template and finds a location near the festival that has not published an event for that time. Going through the location's requirements for having a band playing, the TEAL bot finds different matches from jazz bands, that have not published playing at the known time or festival. Then an offer will be created and sent out to the location and the bands, to verify the information fetched and to get feedback on the interest. After the feedback is returned and requirements are updated, the TEAL bot will target users, that probably want to see this band and visit the festival at the given time.

If a minimum of required visitors is interested, the TEAL bot will create a smart contract that is going to fulfill the purpose of handling the payment of the band and the takings from the location.

A second contract, that is used for the micropayment of the tickets will be created filling in the usernames and necessary information. This will create a payment channel, that only exists for the time needed to buy the ticket. Action is needed from the seller/provider and the buyer. The A.I. bot only provides information for the settlements in the smart contract.

8.10 VECTOR

Covering the basic understanding, it becomes more obvious, that information is not only provided in a one-dimensional way, meaning that there is not only one score that is good or bad for the user and not only one input value is a given factor.

Basically, we can map input to output values and keep in mind, that each input value has its own weight or information value. This means you would need two sets of vectors as input value to create one vector as output. For simplicity you can image a vector as an array. Implementing two vectors as one fit value of input would not work, so we create a matrix that holds all input values, like a two-dimensional array.

8.11 CLUSTERING

By using objects like vector and matrix for values we can use a powerful technique to help us with our machine learning and analyzation of data coming into the A.I. unit. Clustering will also help the recognition of patterns and is ideal for the data set to be divided up into cluster/subsets.

Let's take similarity as an example for creating and/or searching for new clusters with the help of the well-known K-Means algorithm. By having values inside the vectors, a number of clusters that should outcome will be set. With the vector's attributes we can set user vectors into subsets, so called K-Clusters. Afterwards we update the number of clusters and separately find a K-Reference for each vector in the K-Clusters. Now we assign vectors with most similar reference. Similarity in this context is represented in the form of distance. Meaning vectors with the nearest reference will be assigned.

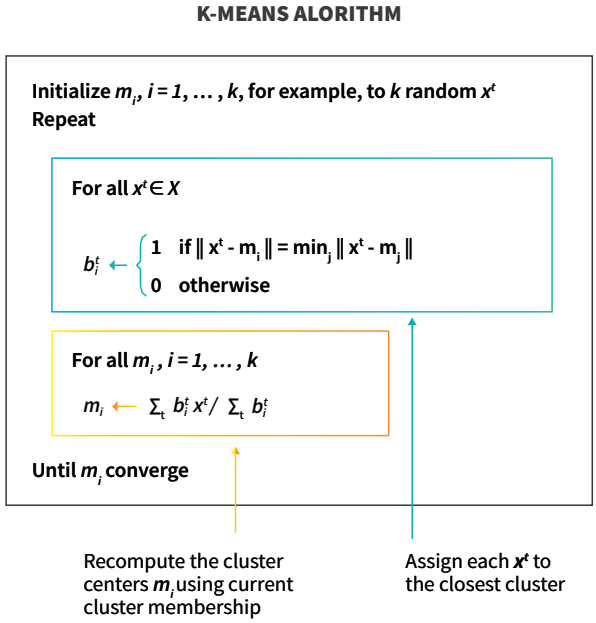

FIGURE 5: K-MEANS ALORITHM

This method is used to allow reconstructing software errors by finding reference vectors that would minimize the outcome of the error. With recomputing the cluster, the error can be reversed or even be fixed. Recomputing is essential for the A.I., to have a constant machine learning process.

8.12 MACHINE-LEARNING

If we implement this example into the machine learning process and with more data and vector being implemented, we will have to interpret the outcome of each cluster as good or bad. The quality depends on the distance function. By taking the advantages of the TEAL A.I. and the known data sets we are able to build a strong distance function and with a minimum and maximum value of distance we can have an impact on the clustering quality. The quality of a cluster always depends strongly on its algorithm, the data collected and the functionality of distance.

Clustering will make it easier to implement the process of constant learning and analyzing input data. If the A.I. has a trained set of clustering with a high quality, the prediction of future outcomes or probabilities can be reduced to clusters.

8.13 DEEP LEARNING

Deep learning uses the machine learning and the neural network of the A.I. from the TEAL Network to generate hidden layers. These hidden layers lie between output and input and build up the inner structure.

Deep learning is used primarily to emulate the way of the human brain to process data. It's a function of the A.I. which allows learning from unstructured and unlabeled data.