DAD Blockchain - Decentralized Advertising

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Abstract

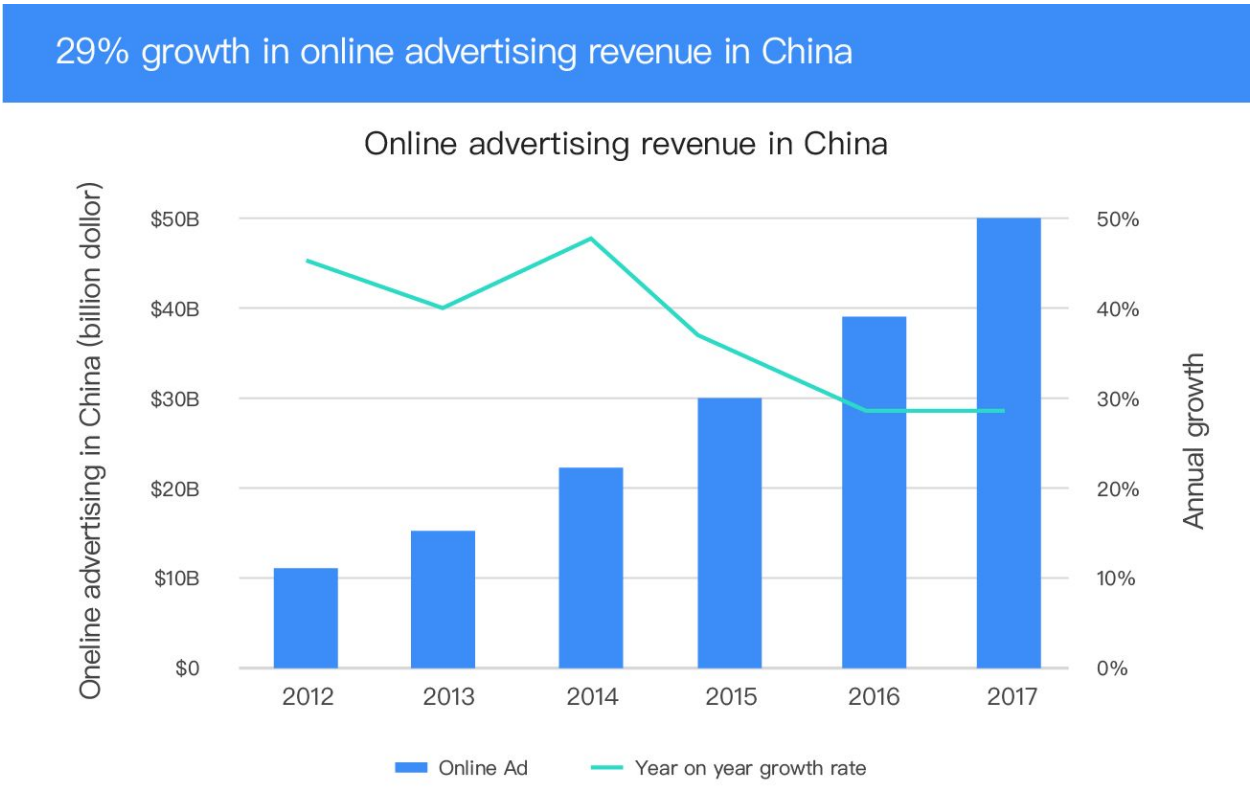
Online digital advertising has reached a huge market size after many years of rapid growth but is plagued by many fundamental problems. Advertisers spend a huge amount of budget on invalid traffic and lack trust in the ad network. Users as the ultimate value creator do not receive any reward and have no decision-making power.

DAD blockchain will be built on top of Ontology, the new generation public blockchain and distributed trust collaboration platform. Via smart contract and token economy, DAD achieves data openness, transaction transparency and user revenue sharing, to improve ad quality and delivery efficiency, building a new generation of blockchain ad system and reshaping the ad industry as we know it today.

Online digital advertising

Online ad market size and development

Global online ad revenue has reached 200 billion US dollars in 2017 - an 11% growth over 2016. The annual growth in China's online ad revenue is 29% in 2017.



The global ad market is already huge and keeps growing at a rapid rate. Facebook alone makes up almost 20% of the total revenue, as much as 29.9 billion dollars. Industry giants occupies the majority of the market share.

Fraudulent and invalid traffic

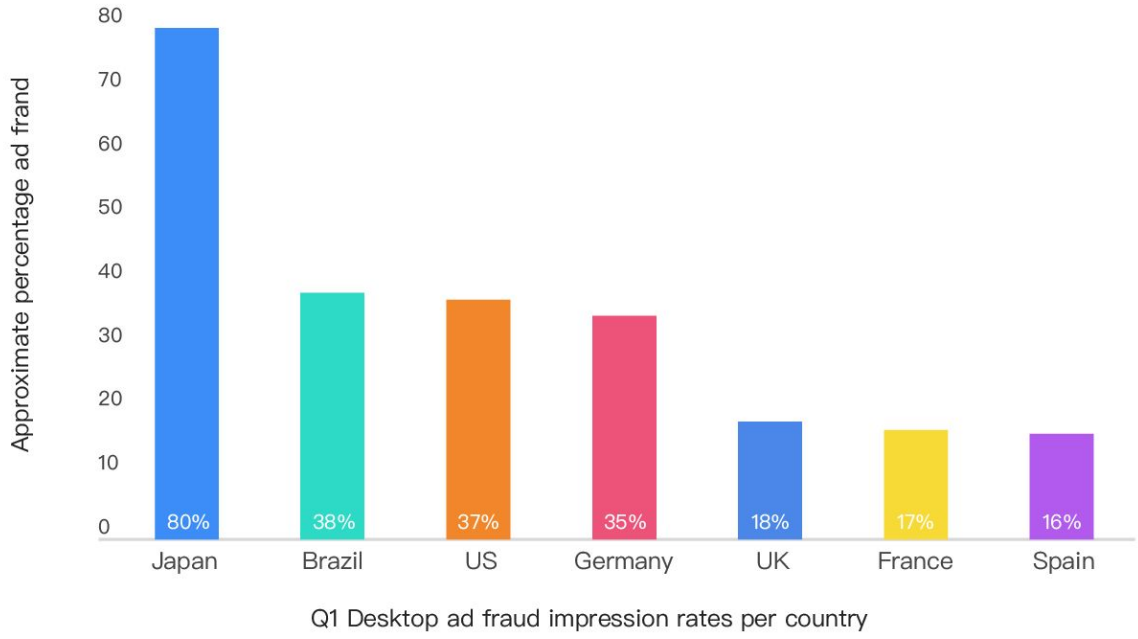
The global advertising spending wasted on fraudulent traffic and clicks automatically generated by bots was $16.4 billion in 2017, according to a recent study commissioned by WPP and cited by Business Insider. 78% of brand marketers are concerned with ad fraud and bot traffic. Over the next 10 years, the global cost of ad fraud is projected to rise to $50 billion, according to the World Federation of Advertisers.

Ad agents and publishers are accused of reporting exaggerated traffic and clicks for higher revenue. Bot networks are prevailing, producing fake traffic and ad impressions. With interests aligned, some publishers don't apply restrictions even if they know the requests are coming from

bots. Malware, zombie network and darknet manipulators have formed an organized fraud traffic system.

Ad cheating is a global problem

Not a single place in the world can escape from the swamp of ad cheating. Pixalate pointed out in the first quarterly report of 2017 that on overage 24% of the traffic is fraudulent across the globe, which is a 4% growth over the prior year. Japan is on top of the list with 80% fraud traffic while Brazil, United States and Germany are also above 35%.



Obviously, traffic cheaters go to great lengths to hide their tracks, making it almost impossible to analyse data in a thoroughly and accurately fashion. Therefore the statistical data shown above should be considered only part of the actual digital ad fraud. It nonetheless gives us a sketch of how astonishing the scale, the influence and the loss can be.

Trust issues between advertisers and the ad network

According to reports by CNN and other websites, Unilever condemned that digital advertising lacked transparency and threatened to pull its advertising from digital platforms like Google and

Facebook due to the swamp of fake news and other misinformation and might wind up using blockchain technology from IBM to deter fraud.

Due to data isolation of ad agencies, advertisers have no way to obtain the original data for verification. The ad supply chain may involve many intermediary agencies like DSP, SSP or DMP, etc. The number of participants and their beneficial connections makes traffic statistics and result attribution untraceable. Industrial data show that discrepancies between different parties in the supply chain can be as high as 20%. All these makes it hard for advertisers, platforms and publishers to trust each other.

Attribution difficulty

In advertising, a significant portion of the budget is wasted on fraud traffic, another portion is wasted because of poor placement that has no effect. When an advertiser notices low ROI, the platform can only provide aggregated statistical report and attribution analysis is difficult due to the lack of data. "Half the money I spend on advertising is wasted; the trouble is I don't know which half" -- This is the famous question by John Wanamaker.

According to AdMaster's Anti-Fraud White Paper published in 2017, more than 29.6% of the traffic was invalid in the first half of 2017. Moreover, IAB's estimated that invalid traffic caused 4.6 billion dollar loss in digital ad industry in 2015, of which 169 million were spent on invalid or fraud traffic. “Frankly, there’s, we believe, at least 20 to 30 percent of waste in the media supply chain because of lack of viewability, non-transparent contracts, non-transparent measurement of inputs, fraud and now even your ads showing up in unsafe places,” says Marc Pritchard, P&G.

Users are excluded by ad economy

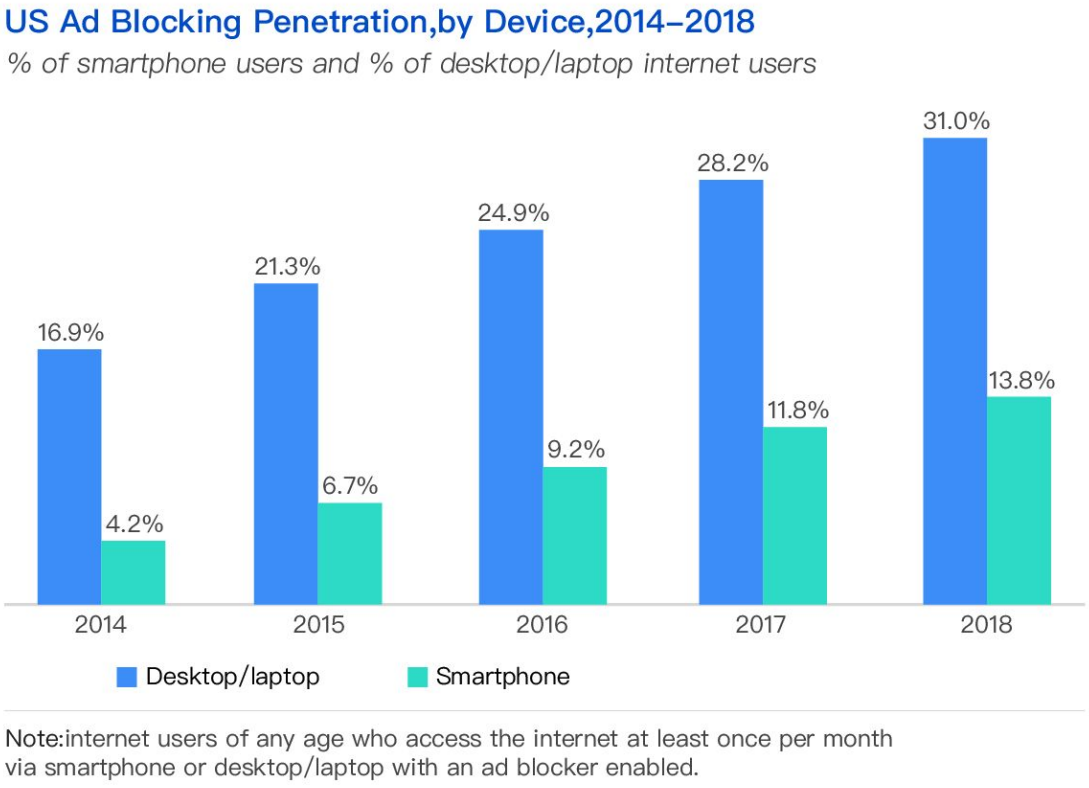
Users pay their time and attention to ads and generate conversions. They also pay for the extra network traffic and processing power consumed by ads. But they share none of the revenue. There is no place for users to express their disturbance and disgust caused by low quality ads.

Without any decision-making power, users are in a very passive position. The blatant unfairness inevitably causes user resistance and that's why ad blocking software has become so popular.

User privacy leak and poor user experience

10% of the internet traffic is used to transmit ad and ad related data. According to statistical data, mobile users spend as much as 20 dollars on ad traffic each month. Battery life of mobile phones is also greatly shortened because of extra processing of ads. Big data powered tracking renders user privacy protection useless. Millions of users have adopted ad blocking software because of frustration and anxiety.

According to a study by the research group eMarketer, 28% desktop and 11.8% mobile internet users are using ad blocking software in the United States.



Some mobile firmware systems with large user base have even integrated ad blocker into their vendored distributions to gain users' approval.

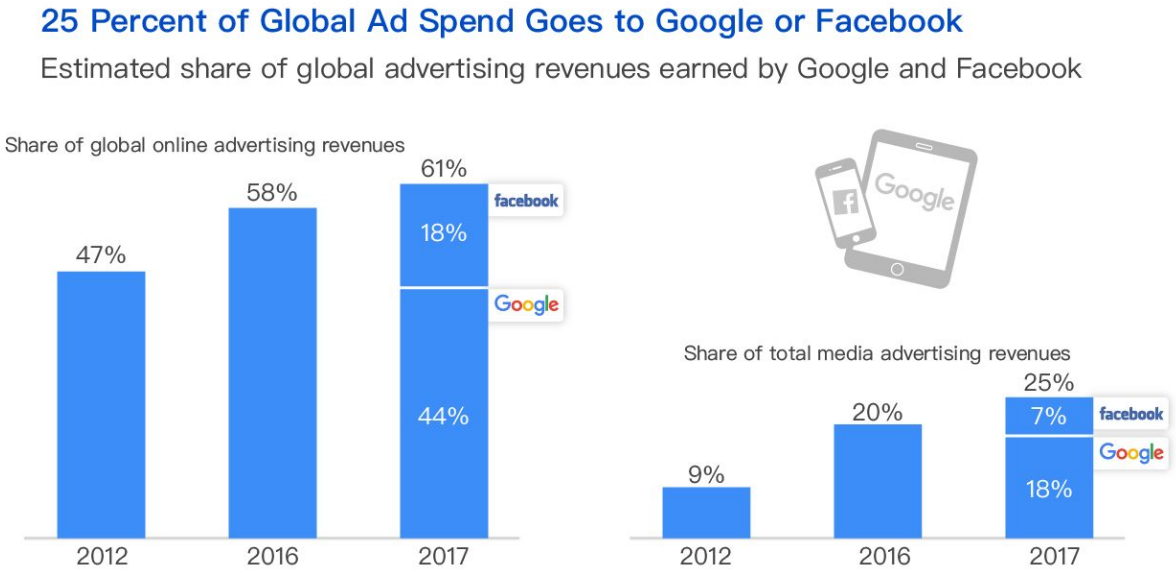
The problem is, if everybody uses ad blocker software, the ad industry will not exist. Advertisers and publishers should have a better understanding of users' worries and fundamentally solve the problems.

Ad review and censorship

If platforms or publishers don't do a good job reviewing their ads, users will be exposed to illegal or nonconforming content. For example, one leading search engine company in China is publicly denounced for displaying fraudulent medical ads. This kind of problematic ads can not only harm user experience but also cause financial or even physical damage to users. The publisher who accidentally displayed such ad will also suffer reputation damage. Advertisers, platforms and publishers all have the obligation to review and censor their ads properly.

Data and targeting accuracy

In 2017, 25% of the world's ad budget is spent on Google and Facebook. The number can reach a whopping 61% only accounting digital online media.



While the two industry giants monopolize the market, their traffic only accounts for 1/5 of the world ad traffic, meaning Facebook and Google earned 60% of the revenue with only 20% of the traffic. Compared to the rest 40% revenue earned by 80% of traffic, Facebook and Google's average eCPM is 6 times as high as the others'.

Besides the brand trust of Google and Facebook, it is primarily their unique data advantage that makes advertisers willing to pay most of their budget for such expensive traffic.
Google, being the world's largest search engine, has the most relevant search data of users present actual demands. The data value has far succeeded the value of ad slots, creativity and other peripheral factors. For example, OTA ads are displayed to users who search "flight from A to B", financial ads are delivered to users who search "stock price of ..." and law firm ads for searchers of "how to resolve dispute of ...".

Facebook, the world's largest social media, possesses the most comprehensive and largest demographics data, user social activity data and user preference data. Lipstick ads for women, shavers for young men, Pepsi for people who are following Coke. The effectiveness is undoubtedly higher than those media who blindly optimize delivery based on irregular user behavior data.

Smartinsights' report shows that

- Across all ad formats and placements Ad CTR is just 0.05%
- Rich media Ad CTR is 0.1%

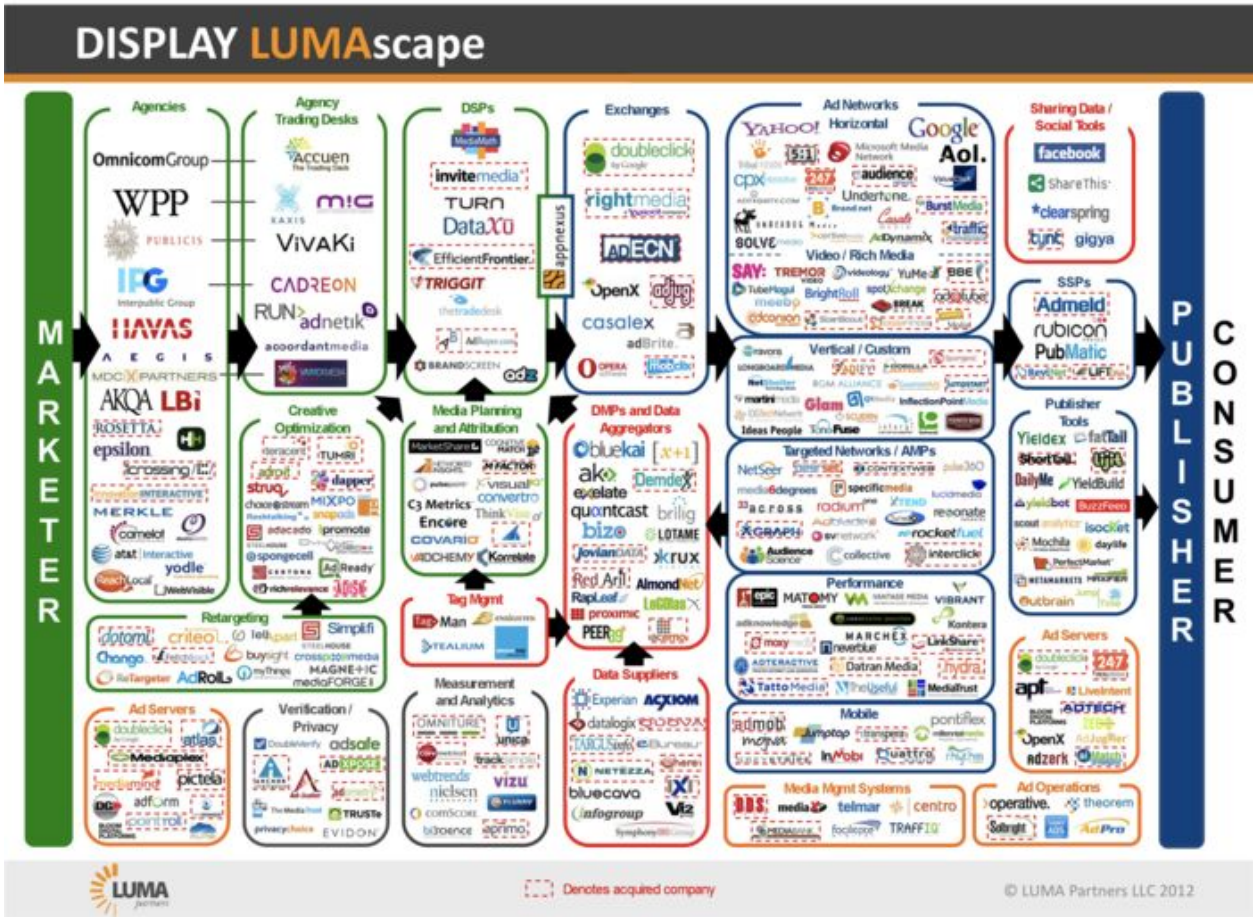
During the same period, the average CTR published by Facebook on Nasdaq is as high as 2.98%, which is 30 times as high as the global average. Thus, while Facebook and Google charge for their traffic several times more than other media, their targeting accuracy brings far higher CTR and CVR than average, effectively guaranteeing the advantage in ROI.

However, even if the data bringing such huge benefit to Google and Facebook come from users, users are never rewarded with what they deserve. In other words, if users can, under the premise of privacy protection and security, authorize other media to utilize their data and thus

greatly increase the revenue, part of the revenue increase can be allocated back to them. This will eventually lead to a better internet environment with lower cost and better user experience.

Too many intermediaries

The influence distribution graph below shows that unlike the winner-gets-all situation found in other fields of the internet, the ad industry, due to its unique supply chain upstream and downstream relationship natures, has formed a dozen industry roles with differentiation. Each role itself has at least tens of or as many as hundreds of companies participating.



Excessive intermediaries form complex relationships. Not only does it bring serious challenges to ad quality control, it also, due to rebroking, leads to layers of budget dividing and lowers the quality and effectiveness of the ads.

DAD solution

DAD blockchain proposes a solution addressing drawbacks and pain points found in today's ad industry by combining the blockchain and smart contract technology with accumulation of more than 10 years of technology and experience in the ad industry from our team and partners.

Highly efficient ad delivery algorithms

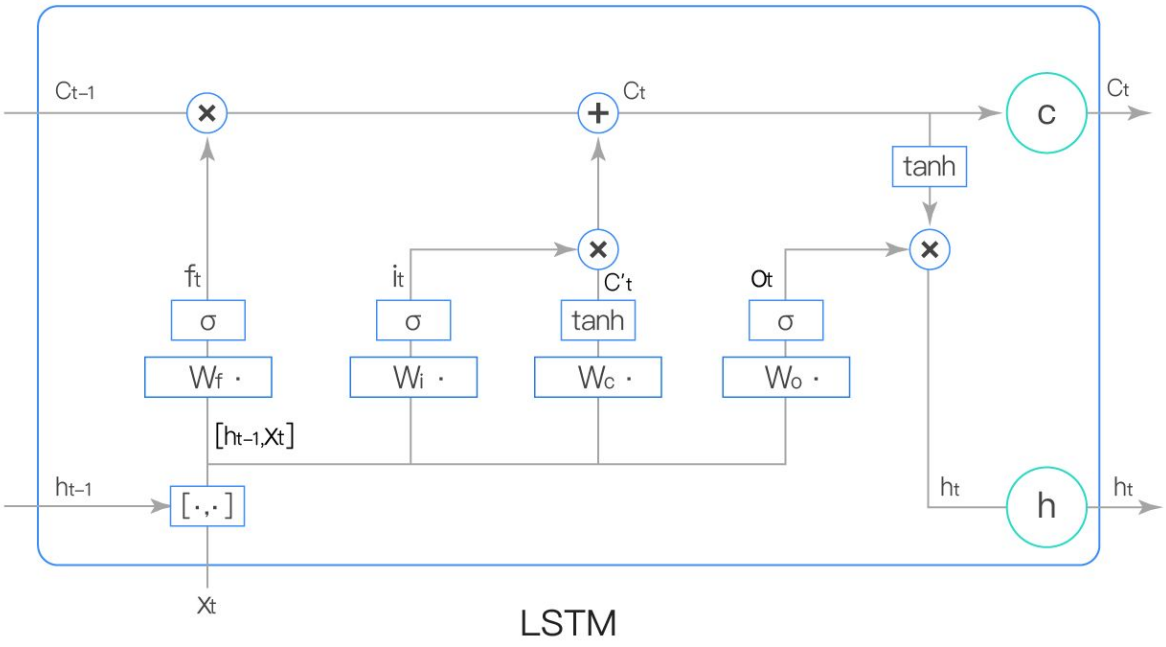
Besides big data algorithms used by traditional online advertising, blockchain technology brings new space for improvement to distribution efficiency optimization. Incentivized by token economy, users can share personal behavioural and preference data to help further improve data quality. Under the premise of privacy being protected, data sharing helps improve the accuracy of ad delivery. Big data system and AI algorithms combine data collected by SDK, data shared by users and data shared on the blockchain to compute the optimal delivery plan with highest ROI and best user experience.

Powerful anti-cheat mechanism

In addition to battle proven data cleansing and cheat detection algorithms, DAD blockchain keeps track of ad delivery and impression process on the blockchain. Data transparency ensures consistency in revenue calculation and allocation, eliminating links in the ad supply chain that are prone to cheating.

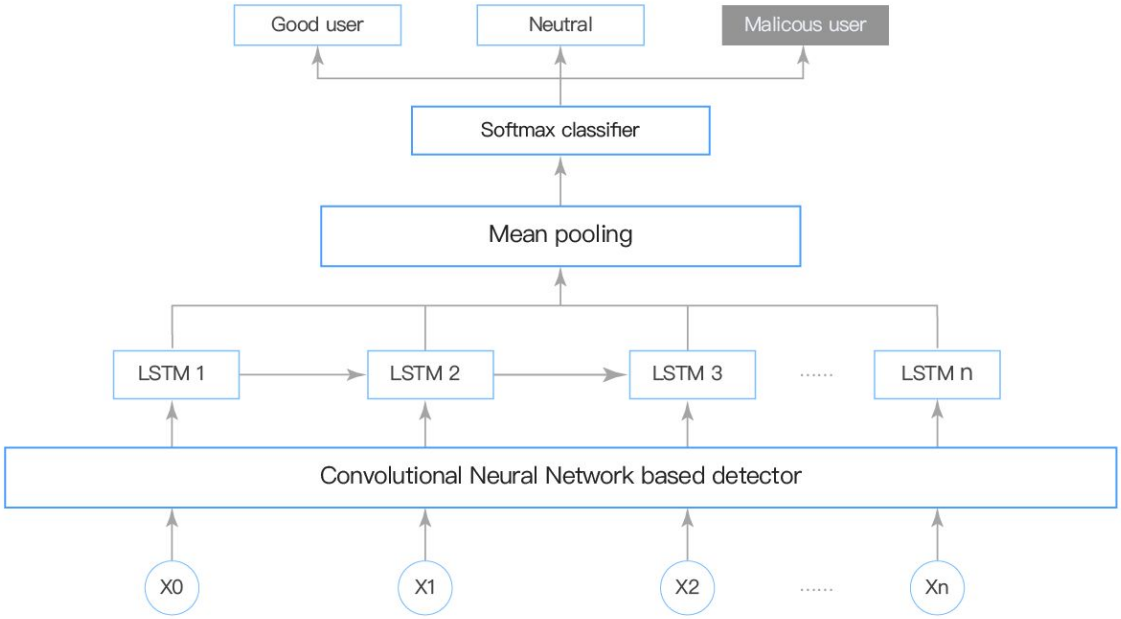
DAD ad system provides mature algorithms for data cleansing and fraud detection as well as trained models with optimized parameters. User side data (collected by wallet and browser extensions), publisher data and platform collected data are combined for cross validation.

To better identify fraudulent ad traffic and malicious nodes, we will use long short-term memory (LSTM) and train the model with history malicious behavioral data. In the first phase, we will use TensorFlow for offline model training and provide anti-cheat service via REST style API. As technology advances, real time training and services will be available.



Recurrent Neural Network (RNN) is quite sensitive to short term input. However, in ad industry, historical cheat data have equal advisory value. LSTM network adds state units on top of RNN and makes better use of longer time sequence data. LSTM adds 3 gates to the neural unit, an input gate, and output gate and a forget gate. The input has to pass the input gate in order to be recorded in the "memory". The output gate decides whether the value in "memory" can be read out. The forget gate determines whether the the remembered value will be preserved.

The diagram below demonstrates the training model of LSTM. User behavioral data are used as input for the model. It has time sequence nature. A 1-day sliding window is used to prepare the training set. All input data will first be processed by a concurrent neural network (CNN). LSTM net constitutes the hidden layers. After the softmax classifier, the final output value is a number between 0 and 1. The closer to 1, the higher the probability of being a good users it is and the lower if it's closer to 0.



Increased transparency with distributed ledger

Adopting the "walled garden" model, industrial giants like Google and Facebook all restrict data access. Agents and other intermediary parities form a complicated benefit relationship and the complexity makes advertisers lose confidence in other parties. The key to resolve the distrust is to reduce intermediary links and increase transparency.

DAD blockchain allows publishers to register their identity on the blockchain and publish their ad positions available for sale. Advertisers choose positions and a delivery plan and sign the purchase contract using smart contracts. The price bidding rules and the complete process are recorded by distributed ledger nodes. The decentralized nature of blockchain eliminates the need for trusting a single party. A transaction can never be altered once recorded. Transparency in the transaction process eliminates distrust found in traditional ad purchase and thus provides a foundation for an efficient ad economy.

Opening up closed data

Data is an key element of an efficiently running ad system. Audience analysis, targeting accuracy, result assessment and anti-cheat algorithms all require data. In an exclusive competition system, ad platforms and publisher platforms don't share data. Data advantage becomes a key competitiveness for industry giants so they never want to share anything with competitors. Some smaller publishers have united to form data alliances in order to higher their bargaining power and competitiveness. Many isolated data islands have formed and it's hard to break because of user privacy and company interest issues.

DAD blockchain enables users to authorize use of shared data while having their privacy protected. Data sharing by integrating multiple data sources leads to a win-win situation for multiple parties.

Digital identity and authorization

DAD blockchain protects user privacy and, at the same time, provides a way to verify user identity and authorize information use. In traditional internet big data industry, data consumers purchase data from various channels, unpermitted or nonconforming data usage has become a de facto industrial practice that is hard to testify or eliminate. Big data companies make a great fortune from user data but almost never share any with users.

The digital identity and data authorization mechanism brings forward a new possibility. Users can voluntarily publish their data and authorize use to trusted parties to improve ad quality. Part of the ad revenue will be allocated to data contributors to encourage further sharing and updating.

Rewarding users with tokens makes them happy to share their data. Incentives trigger motivation to share. But unless the concern about data security and privacy is actually resolved, it is hard to relive user resistance.

DAD blockchain allows transacting parties to anonymously and securely share their data without disclosing real world identity. Security mechanism backed by cryptographic algorithms makes user data leak much more unlikely than before and encourages users to share their data.

Cryptocurrency economy and incentivising

The entire economy system of DAD blockchain is centered around cryptocurrency token. Ad readers, who ultimately create value in the ad economy, have always been passively receiving ads and have never been able to share any revenue, nor do they have any decision-making power. DAD blockchain allocates part of the ad budget to end users and makes them an important role in the economy system. Users' gain is calculated according to browsing behaviours and actions such as mouse hovering and clicking. Publishers' gain will also be based on the same metrics. So users become a participant of the economy of equal importance as advertisers and publishers, not only sharing revenue of ads but also having more rights. Such mechanism encourages high quality and well targeted ads, encourages users to pay more attention to ads instead of habitually ignoring or even actively blocking them. The design of the token economy allows parties to share revenue in a fair and transparent way and improves ad quality and accuracy, greatly increasing value of the entire economy system.

Publishers and advertisers can have verified account on DAD blockchain. The credibility score of an account is maintained by and stored in the blockchain and determined by traffic quality, ad quality and content delivery speed. For example, if a publisher's server suffers from frequent malfunctions and is unable to effectively deliver ads, its credibility score will be deducted. Advertisers will lose score if the ads they publish are fraudulent, violates local laws or causes user discomfort.

DAD blockchain's distributed democratic voting system turns its wide audience into supervisors of the industry. Users can judge ad content quality, report nonconforming ads. The blockchain system contract provides a fair voting mechanism. Voters will receive tokens for their participation in administration.

The parameters of the blockchain itself and its system contracts can also be upgraded based on voting.

Methodology in DAD

DAD towards a huge number of users and advertisers and requires information retrieval, optimization, machine learning and related technologies to handle real world problems like data processing, ad retrieval and user profile, etc.

Vector space model

Vector space model is one of the most important document similarity models in information retrieval. The model uses a vector of term weights to represent a text document.

$$\vec{d} = (x_1, x_2, x_n)^T$$

x_i represents the TF-IDF of the i-th term in $\vec{d}$ where TF means term frequency, i.e. the number of occurrences of the term and IDF means inverse document frequency, i.e. the reciprocal of the term's frequency in all documents. TF and IDF can be expressed as

$$TF_{i,j} = \frac{n_{i,j}}{\sum_k n_{k,j}}$$

$$IDF_i = log\frac{|D|}{|\{j : t_i \in d_j\}|}$$

Based on description above, we define the similarity between two documents as the cosine distance between their vectors.

$$cos(\vec{d_1}, \vec{d_2}) = \frac{\vec{d_1}^T \vec{d_2}}{||\vec{d_1}|| \cdot ||\vec{d_2}||}$$

In DAD system, vector space model is used for ad similarity search and large scale data mining, etc.

Quasi-Newton method

In application scenarios of DAD, there are constrained optimization problems to be solved. A common approach to such problems is to use gradient descendent to find the (local) optimum

solution. In practice, gradient descendant is often found too slow and quasi-Newton method can work better.

The matrix of second-order partial derivatives of $f(\vec{x})$

$$\nabla^2 f(\vec{x}) = \left\{ \frac{\partial^2 f}{\partial x_i \partial x_j} \right\}_{D \times D}$$

is a $D \times D$ Hessian matrix. Using optimization of the gradient and second-order derivatives at the same time, that is to apply second-order Taylor expansion at current location and find the minimum of the quadric userface. The update method is

$$\vec{x} \leftarrow \vec{x} + \epsilon [\nabla^2 f(\vec{x}))]^{-1} \nabla f(\vec{x})$$

When $\epsilon = 1$, each iteration in the Newton method finds the minimum of a quadric surface. Apparently, the minimum only exists when the Hessian matrix is positive definite. In real optimization problems, it is hard to make sure that every point of the Hessian matrix is positive definite. The solution is to construct an approximate Hessian matrix and used to replace the actual Hessian matrix for parameter update. Different approximate Hessian matrix update formula make different quasi-Newton methods. BFGS is a widespread quasi-Newton method, of which the update formula is

$$\vec{B}_{k+1} = \vec{B}_k + \frac{\vec{s}_k \vec{s}_k^T}{\vec{y}_k^T \vec{s}_k} \left[1 + \frac{\vec{y}_k^T \vec{B}_k \vec{y}_k}{\vec{y}_k^T \vec{s}} \right] - \frac{1}{\vec{y}_k^T \vec{s}_k} [\vec{s}_k \vec{y}_k^T \vec{B}_k + \vec{B}_k \vec{y}_k \vec{s}_k^T]$$

where

$$\vec{y}_k = \nabla_{k+1} - \nabla_k$$

is the gradient difference between two iterations

$$\vec{s}_k = \vec{x}_{k+1} - \vec{x}_k$$

is the difference of the independent variable.

Trust-Region method

The way Quasi-Newton method searches is to first determine a descendant direction and perform one dimensional search following that direction. A trust region method restricts search

in a trust region during each iteration and determines the direction and step of the next iteration at the same time. The trust region is updated to be smaller if a feasible solution cannot be found with in current region. In each iteration, the independent variable difference $\vec{s_k}$ of function $f(\vec{x}_k)$ must satisfy

$$||\vec{s_k}||_2 \leqslant \delta_k$$

To make the Taylor expansion of $f(\vec{x}_k + \vec{s})$ near point $\vec{x}_k$ approximate to the original function. The subproblem in each iteration has the following form

$$\min_{\vec{s}} f(\vec{x}_k) + \nabla^T f(\vec{x}_k)\vec{s} + \frac{1}{2}\vec{s}^T\nabla^2 f(\vec{x}_k)\vec{s}_k$$

$$\text{s.t. } ||\vec{s_k}||_2 \leqslant \delta_k$$

Based on $\vec{s}$ found in previous iteration, the direction and step of the current iteration can be obtained at the same time. The method converges faster sometimes because it usually guesses the descendant direction better without approximating the first and second derivative of the objective function.

In practice, the choice between quasi-Newton method and trust region method needs to be made based on the specific optimization problem.

Exponential family distributions

Due to its mathematical convenience, exponential family distributions play an important role in machine learning. Common distributions like Gaussian distribution, γ distribution, β distribution, polynomial distribution all belong to the exponential family. The normalized form of exponential family distribution is represented as

$$p(\vec{x}|\vec{\theta}) = h(\vec{x})g(\vec{\theta})exp\{\vec{\theta}^T\vec{u}(\vec{x})\}$$

Where $\vec{u}(\vec{x})$ is the vector form of aggregated characteristics function, $\vec{\theta}$ is the exponential distribution parameter, $g(\vec{\theta})$ is the normalization term. The max likelihood of $\vec{\theta}$ can be solved by

$$-\nabla \ln g(\vec{\theta}_{ML}) = \frac{1}{N}\sum_{i=1}^{N}\vec{u}(\vec{x}_i)$$

Exponential family distributions are the foundation of mixed models and EM algorithms.

Mixed model and EM algorithm

Mixed model refers to the data modelling method using a mixture of multiple exponential family distributions in engineering to fit a complex distribution. It is used by the DAD advertising system to estimate the click through rate and conversion rate. The mixed model of exponential family distributions can be represented as

$$p(\vec{x}|\vec{\omega},\vec{\Theta}) = \sum_{k=1}^{K}\omega_k h(\vec{x})g(\vec{\theta}_k)exp\{\vec{\theta}_k^T\vec{u}(\vec{x})\}$$

In which, $\vec{\omega}$ is the prior probability of each component, $\vec{\Theta}$ is the parameters of each component. Expectation-Maximization algorithm plays a very important role in solving the max likelihood of the mixed model. Because in the mixed model shown above, we can introduce a hidden variable $\vec{z}$ to represent the probability directed graph state, changing it to

$$p(\vec{x}|\vec{\omega},\vec{\Theta}) = \sum_{\vec{z}}\prod_{k}\omega_k^{z_k}h(\vec{x})g(\vec{\theta}_k)exp\{\vec{\theta}_k^T\vec{u}(\vec{x})\}^{z_k}$$

The EM algorithm can effectively solve max likelihood problems with hidden variables iteratively. To be more specific, each iteration has an E-step and an M-step. In the E-step, we fix the parameters and observed variables and try guess the posterior distribution of the hidden variable. In the M-step, the parameters are updated based on the posterior distribution of the hidden variable and the observed variables. Each iteration in the EM algorithm can be transformed to an optimization problem solving the auxiliary function below

$$\max_{\vec{\omega},\vec{\Theta}} Q(\vec{\omega},\vec{\Theta};\vec{\omega}^{old},\vec{\Theta}^{old}) = \max_{\vec{\omega},\vec{\Theta}}\sum_{\vec{z}} p(\vec{z}|\vec{X},\vec{\omega}^{old},\vec{\Theta}^{old})\ln p(\vec{X},\vec{\omega},\vec{\Theta}|\vec{z})$$

For the problem above, it is easy to solve the E-step and M-step of the EM algorithm, which is

E-step:

$$\gamma_i(k) = p(z_k = 1|\vec{\Theta}^{old}, \vec{\omega}^{old}, \vec{x}_i) = \frac{\omega_k^{old} g(\vec{\theta}_k^{old}) exp\{\vec{u}^T(\vec{x}_i)\vec{\theta}_k^{old}\}}{\sum_l \omega_l^{old} g(\vec{\theta}_l^{old}) exp\{\vec{u}^T(\vec{x}_i)\vec{\theta}_i^{old}\}}$$

M-step:

$$-\nabla \ln g(\vec{\theta}_k^{new}) = \frac{1}{N}\sum_{i=1}^{N}\gamma_i(k)\vec{u}(\vec{x}_i)$$

$$\omega_k^{new} = \frac{1}{N}\sum_{i=1}^{N}\gamma_i(k)$$

Mixed models of exponential family distributions are widely used in DAD advertising. For data distributions that are difficult to describe with a single model, we can model with some form of exponential family distribution superposition to get a more precise prediction.

Bayes Model

DAD may encounter sample insufficiency in real world data modelling. And methods described above may generate significant estimation bias. Therefore we need to introduce Bayesian learning, of which the basic equation is as below

$$p(\theta|X) = \frac{p(X|\theta)p(\theta)}{p(X)}$$

In which $p(\theta)$ is the prior probability and $p(X|\theta)$ the posterior probability. One of the key problems in Bayesian learning is how to choose the prior distribution so that the posterior distribution have the same form. We call a prior distribution satisfying the criterion conjugate prior:

$$p(\theta|\eta) = exp\{X^T\theta - vg(\theta) - b(X, v)\}$$

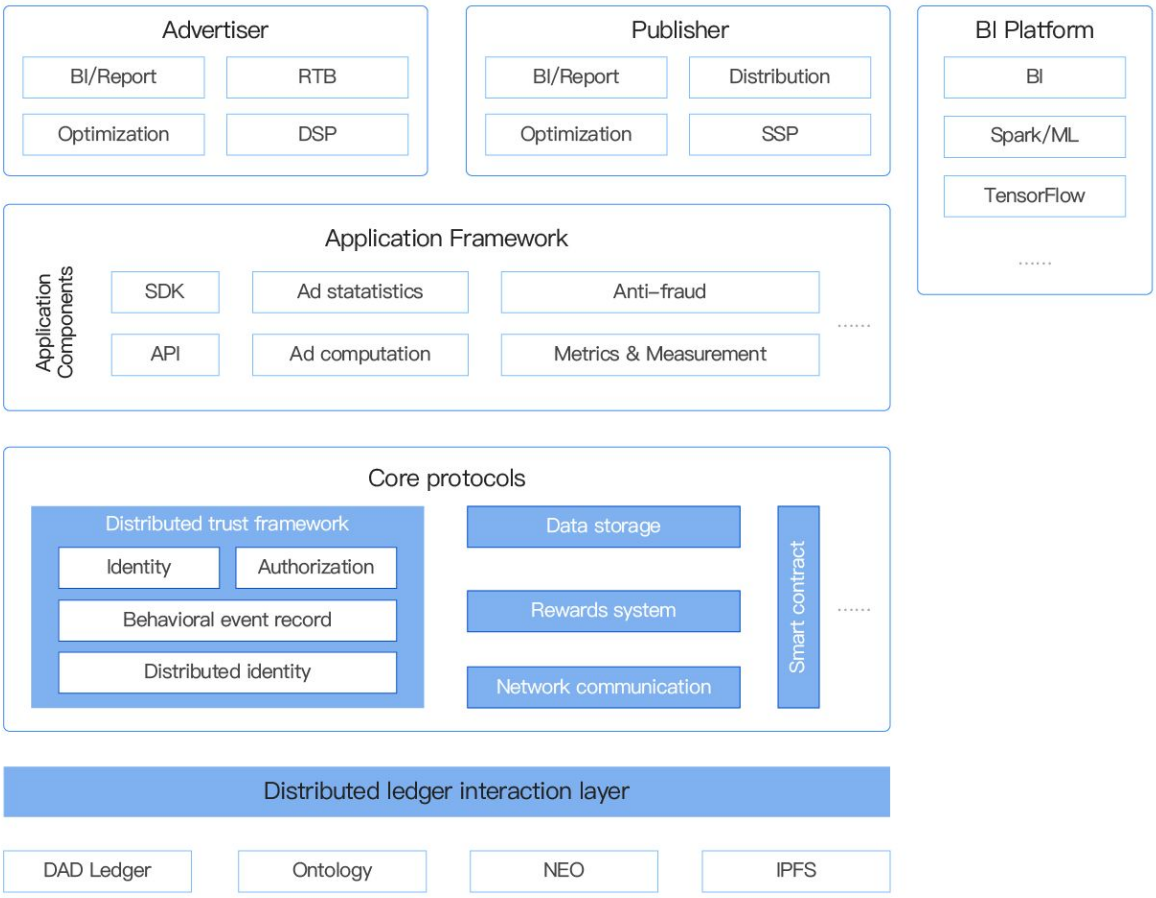
The prior parameter $\eta = \{X, v\}$, called hyper-parameter, determines the shape of the prior distribution. Its posterior distribution can be expressed by

$$\tilde{X} = X + \sum_{i=1}^{N} u(x_i)$$

$$\tilde{v} = v + N$$

From the equation above we can see that the purpose of using Bayesian learning is to constrain model parameters and thus improve the estimation robustness.

DAD ad system architecture



The DAD system consists of 4 layers, the distributed ledger layer, the core protocol layer, the framework layer and the application layer.

The distributed ledger layer adopts a decoupled design. Besides DAD's own ledger, it is also compatible with Ontology and NEO. As DAD blockchain technology matures, the system will eventually be migrated to the DAD public blockchain. Moreover, IPFS distributed file storage system is used to store video and image files used by ads, the main blockchain only needs to store the mapping hash thus greatly saving on chain storage requirement.

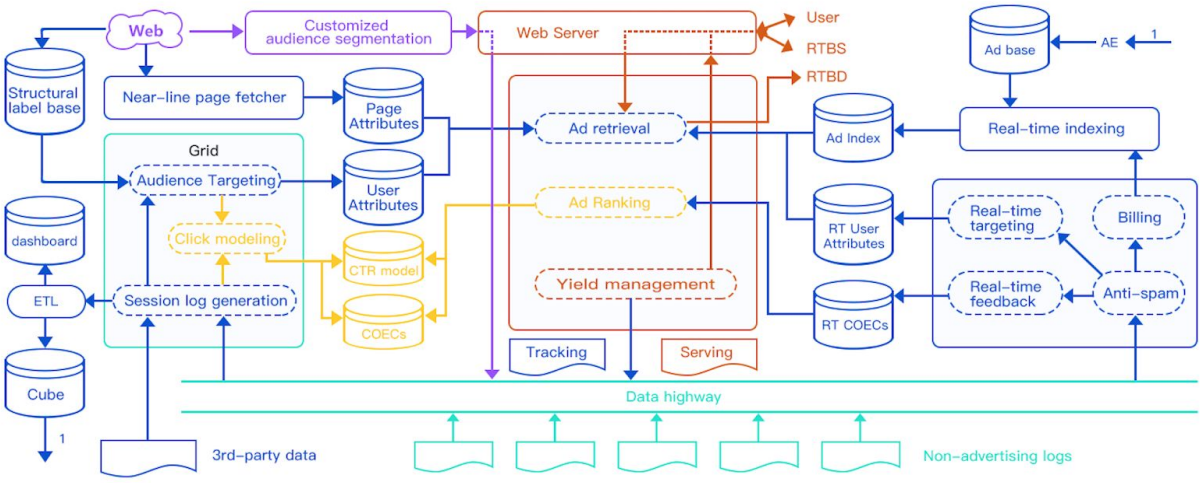
The core protocol layers builds a complete distributed trust framework on top of traditional public blockchain, ensures that ads are authentic and traceable to their source. The framework employs ONT ID to perform trusted identity verification. Users' ad related behaviours will be anonymously recorded on the blockchain. When a data consumer business wants to analyse the user profiles behind behaviours of their interests, it will have to acquire users' authorization first.

The application framework layer allows interaction between DAPPs and the underlying blockchain modules. It provides a rich set of application components satisfying needs for ad delivery, statistics, anti-cheating, big data analysis and so on. Developers can start developing DAPPs using the DAD SDK and high level APIs without worrying about the underlying blockchain implementation.

The DAD application layer supports a rich set DAPPs including but not limited to ad purchase system for advertisers, system for publishers and BI systems derived from business big data. BI systems continuously analyze big data and optimize machine learning models to create more value for advertisers, publishers and users.

Key technologies of DAD

DAD System Framework



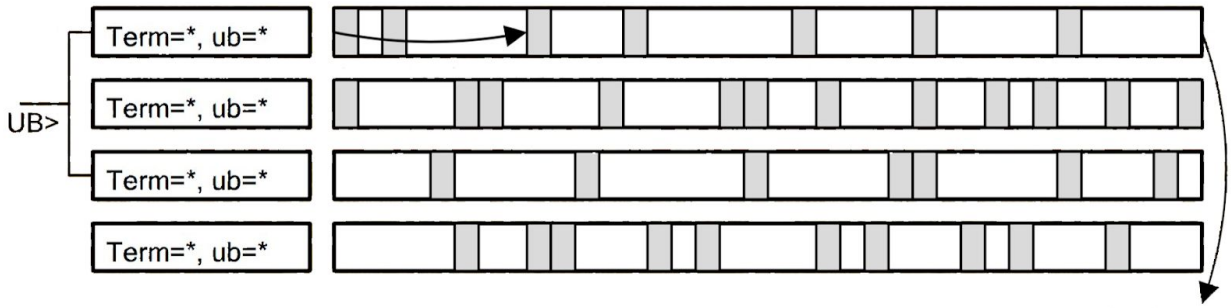
The DAD system primarily consists of the DAD advertising engine, the DAD streaming computation platform, the DAD offline computation platform and peripheral assistant software facilities. The DAD advertising engine is a high concurrency, low latency service directly oriented towards mobile and PC traffic providers which combines advertising requirements and user interest labels on the fly and performs ad delivery in real time. The DAD streaming computation platform performs near real time task control, including fraud traffic detection, advertiser budget deduction, user label update. The DAD offline computation platform performs full scale click model training and offline feature update to guarantee advertising effectiveness. The peripheral assistant software facilities, including but not limited to structured and unstructured storage middleware, visualization tools, ETL components and messaging middleware, ensures that the entire delivery system running smoothly and efficiently.

Advertisement retrieval technology

When online ad delivery exceeds a magnitude of 100 thousand every second, high performance ad criteria filtering and traffic context based relevance retrieval technology becomes a challenge. The basic idea to solve such problems is to introduce some kind of score function in the retrieval phase and accelerate the retrieval with suitable data structure and algorithms. When a linear score function is chosen with all its weights being positive, the WAND algorithm can be used for retrieval speed up in order to meet the requirement of high concurrency and low latency online real time advertising.

$$score(a, c) = \sum_{t \in F(a) \cap F(c)} \alpha_t v_t(a)$$

Not considering the normalization denominator in the cosine distance, we can use the linear score function for approximation. F(a) and F(c) represents set of non-zero features of advertisement a and context c respectively. For example with a query term t, $v_t(a)$ represents the contribution of t in advertisement a which is the TF-IDF of t in advertisement a. And α_t represents the TF-IDF of feature t within the context c. With the linear function, WAND can be used to create a very useful fast search algorithm.



The image above is based on the search procedure of the WAND algorithm. An inverted-index linked list is created for the term. Each element in the linked list contains the ID of an advertisement containing the term, shown in shade. The algorithm maintains a top-K min-heap. The search procedure iteratively executes the following two steps.

(1) Sort the inverted-index linked lists of each term in ascending order by its minimal document ID

(2) Access each term t in the ascending order given by (1), accumulate its corresponding v_t to U until U is greater than the top of the heap. Let the term being accessed at this moment be the n-1th, if the inverted-index linked list of the 0th term has the same minimal document ID as the n-1th, then calculate the precise relevance of the document and push the document onto the heap if it's still greater than the top; If the minimal document ID doesn't match, which means the candidate has no chance to win, then we pick one reverse-index linked list from the previous n terms, set the head of it to the n-1th term's minimal document ID of its inverted-index linked list and jump to step (1).

Audience targeting technology

Audience targeting is one of the key technology for improving advertising results. Audience targeting technology involves the process of extracting meaningful labels from 3 dimensions - ad, user and context. The processed labels can help establish the traffic sales system for advertisers and provide algorithm models (e.g. CTR estimation, retarget) with raw features.

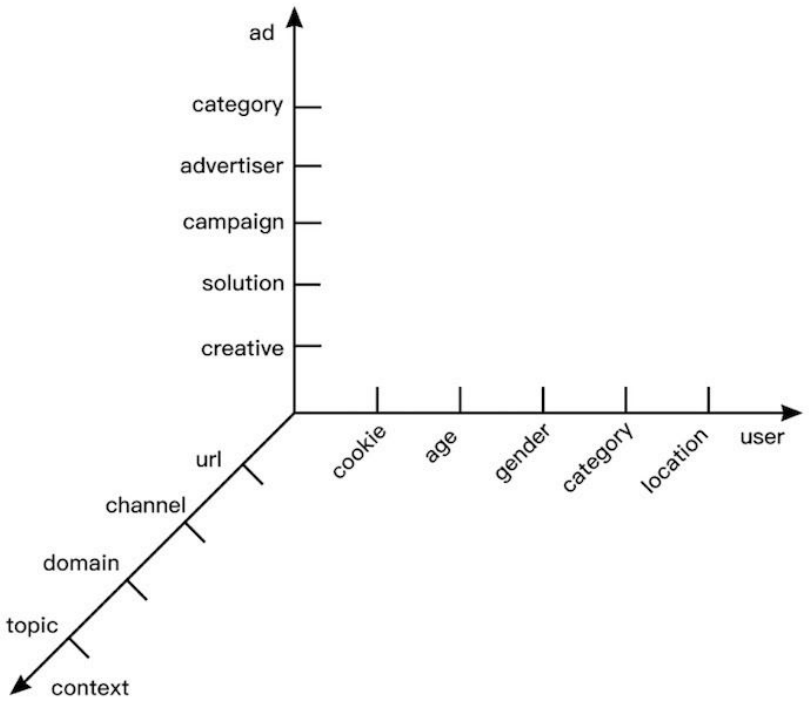


Image of ad, user and context label space

By analysing user's browsing history of different types of web pages and geolocation information, we can get user's interest labels and location labels. These require data mining technology which is based on user's history behavioral data. The data volume involved grows linearly with time and requires specific data models for processing. Here we introduce the sliding window method and the time decaying method for use in different scenarios.

In the sliding window method, let the time window length of user behaviors be D, the cumulative feature value x' can be represented with the following formula (where x means a single feature within a specific period of time).

$$x'(d) = \sum_{\alpha=0}^{D} x(d-\alpha)$$

In time decaying method there won't be a time window, a decay factor β is used instead. Current feature value x' is obtained by summing the value of the current time window with the prior accumulated value.

$$x'(d) = \beta x'(d-1) + x(d)$$

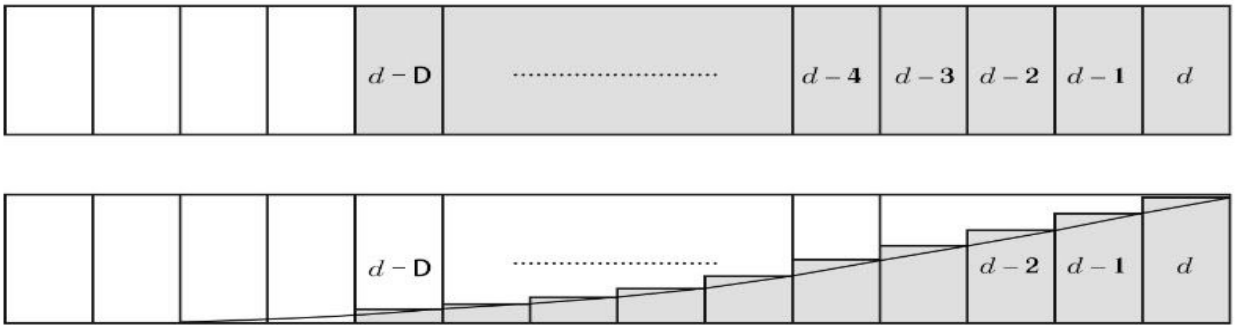


Image of sliding window and time decaying method

During online advertising, in order to achieve better accuracy and conversion, time window D is inclined to take as maximum value as possible. The data volume with hundred million real users is not what regular computers can handle and requires distributed computation framework such as hadoop. To minimize computational and storage resource consumption, the time decaying method is the first choice of the industry.

Labels obtained from methods above perform differently in different advertising scenarios. The accuracy (usually measured by click through rate, CTR) declines as the impression magnitude increases. And the reach / CTR curve can be used to estimate advertising results and to help adjust model parameters to achieve the best performance.

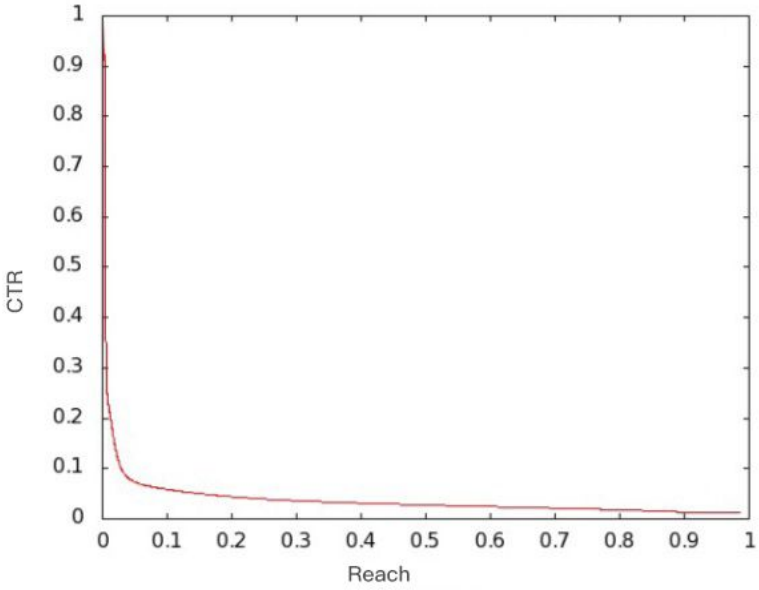


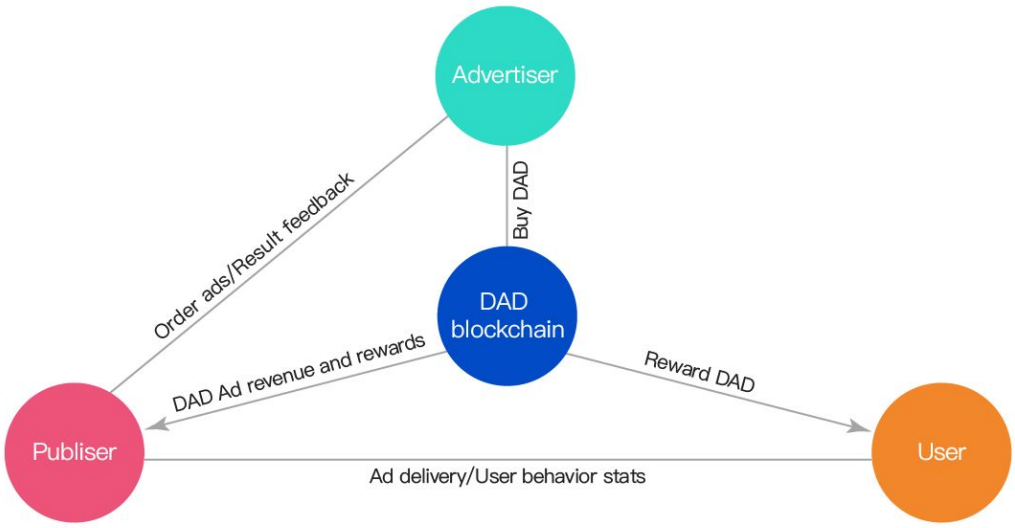
Image of reach / CTR curve

DAD ad economy

The ad industry is closely related to economic benefits. Economic rules determine how the participating roles are motivated to contribute or do harm. A good economic system should incentivize network users who actively contribute and punish perpetrators and therefore increasing the overall value of the network.

Economy model overview

The three important roles in the DAD ad economy are users, publishers and advertisers. These three roles are key participants in the ad ecosystem, sharing revenue and supervising each other. Through economic incentives and constraints, the system improves ad quality, optimizes ad delivery efficiency and matches users' need to maximize the overall effectiveness as well as each party's gain.



role relationship

Advertisers utilize tokens to place ads. Ad budget is allocated to publishers and users according to the metrics measurement model. A certain portion of the budget is taken by the DAD blockchain for destruction, block producer compensation or community rewards.

Block producers maintain the network integrity, provide computational power required to run ad transactions and the ad system. Block producers receive part of the ad budget as an incentive and compensation to cover their operation cost.

Below we explain the token flow and ad flow in each role's perspective of view.

Advertiser's view

- Purchase DAD Token for ad placement
- Spend DAD Tokens and transform them to ad budget
- Choose inventories and delivery plans. Submit ad content. Sign contract and start placement
- Ads are delivered to users. The system records impression and action events.
- The spent budget is allocated to users and publishers according to the metrics measurement model and algorithms.
- User also receives an additional bonus allocated by DAD blockchain

Publisher's view

- Publish ads positions and pricing plan
- Accept placement order and sign contract. Start delivery.
- Display ads using the SDK. The system records impression and action events.
- Receive a share of the budget spent according to the measurement model and algorithms
- Also receive an additional bonus allocated by DAD blockchain

User's view

Users will share revenue allocation by browsing and interacting with ads

- Download DAD wallet. Register account and bind account in browser.
- Browse ads, click, etc.

- Receive profit according to ads interaction
- Also receive an additional bonus allocated by the DAD blockchain

Block producers

Block producers are the consensus maintainers of the DAD blockchain. They keep track of the ad transactions and provide medium storage and network transmission. Block producers are elected. Due to the the high performance standard of ad delivery and recording, block producers are required to possess qualifying computation power.

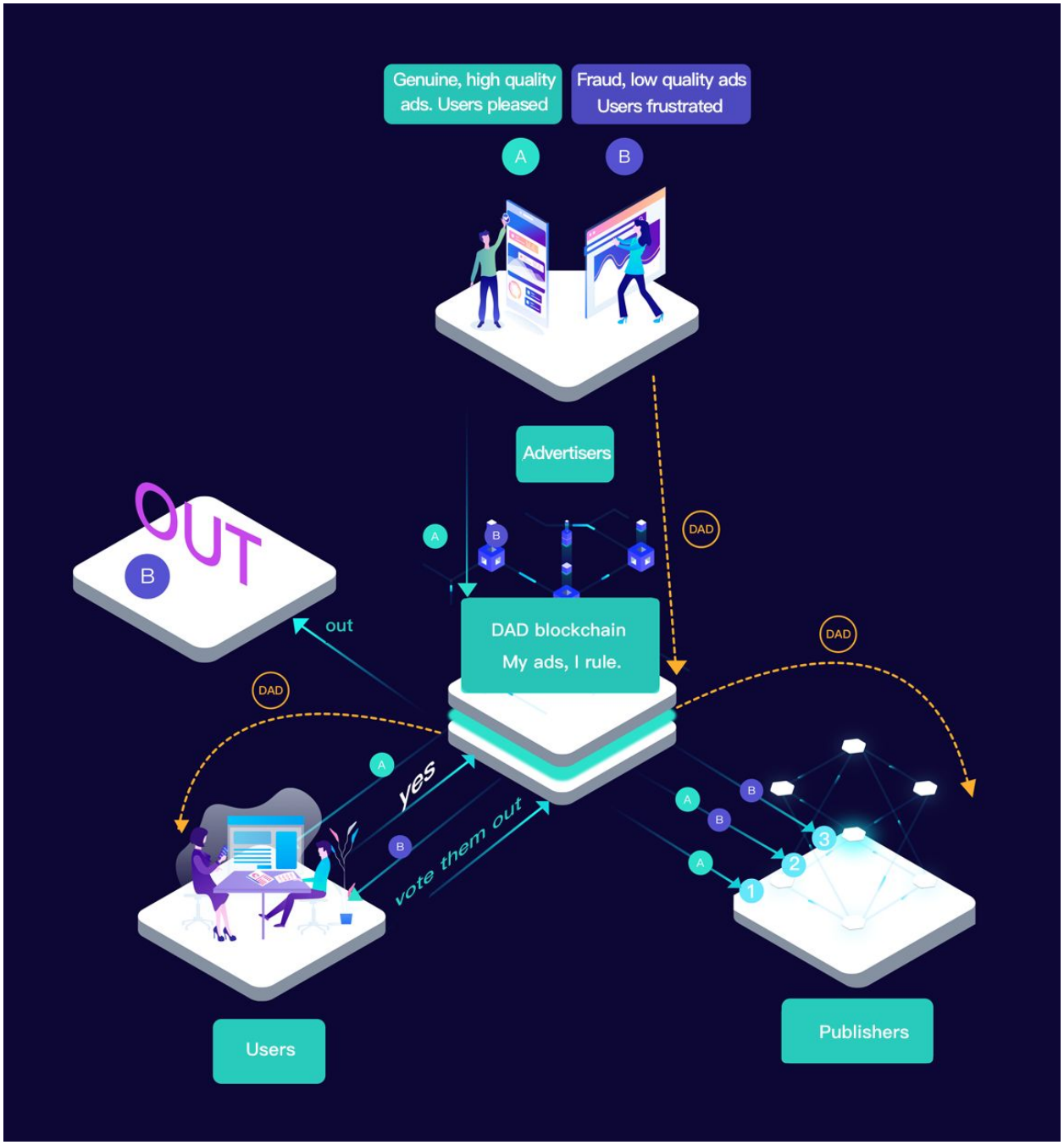
Block producers are of vital importance for maintaining consensus and ad transacting. The running cost is rather high. DAD blockchain will allocate part of the ad budget to compensate blocker producers.

DAD ad network growth program

To encourage active participation of each role and help grow the network, the DAD ad network growth program allocates additional tokens to transaction parties. With each ad settlement, DAD blockchain will allocate tokens proportional to the spent budget to users, publishers and block producers.

User rights

DAD blockchain empowers users with rights. Users are no longer passive audience without any influence. They are enabled to specify ad content that they do not wish to see or mark ads that are useful to them or content they would like to see.



Report inappropriate content

Inappropriate content may include

1. Ad content violating local laws or regulations
2. Ad content conflicting with local customs or ethical code, causing audience resentment
3. Ill-intentioned, involving personal attacks, discriminative against certains groups
4. Causing discomfort or strong repulsion
5. Advertisement of fraud organization or products of inferior quality

Users can report inappropriate content. If certain ad has been reported as illegal or nonconforming by a certain number of users, its impression will stop and the advertiser will lose credibility score accordingly.

Personal preference settings

DAD blockchain allows users to tell their preferences. For example, a user would not like to see a particular ad, ads for a particular brand or ads belong to certain category or subject. Preference settings gives users more control over the ad content they receive and enables better user experience.

Content quality rating

Users can rate the quality of the content they see. Content quality affects user satisfaction, and thus ad conversion rate. In today's ad industry, the data used for personalized content recommendation is derived from user engagement data as well as user feature data collected from various channels. DAD blockchain allows users to voluntarily feedback satisfaction with ad content directly to the ad system.

Content quality rating by users is not limited to reporting inferior content. Users can vote up high quality ads on the blockchain too, for example ads with outstanding creativity, aesthetics, or information value.

Content rating will affect ad impression and recommendation as well as the revenue of the advertisers and publishers. Low quality ads will have lower impression allocation or even be pulled from the system. Low quality ads can also affect the credit of the advertiser. An advertiser who keep publishing inferior ads will be punished by DAD blockchain and will have to pay a higher price when purchasing budget.

Data labelling

Data labelling enables users to label ad content with more specific and professional methods. The labelled data provide more useful training data to the deep learning module of the ad system.

Google, Facebook and other big ad companies are hiring dedicated team for content rating and data labelling. Manual rating and labelling can not only help filter inappropriate content but also feed the recommendation system more information and thus increase targeting accuracy and improve user experience. DAD blockchain assigns the job of content rating and data labelling to users, any user can participate if he or she wishes to.

Token economy helps improve content quality

Users who take part in content review, quality rating and data labelling will receive token as reward from the blockchain for their contribution to content quality. Advertisers publishing content of poor quality will be punished, for example, to pay a higher price for ad traffic. The extra payment will be used to reward users.

Content rating and data labelling mechanism empowers users, allowing them to have more control over what kind of ads they see. Users take part in quality control and data building on their own initiative and receive rewards in tokens.

DAD Token

DAD Token is a cryptocurrency running on the DAD blockchain. It is the core of the DAD ad economy. All kinds of transactions in the economic system are performed with DAD tokens.

DAD Token usage scenarios include

- Advertiser budget investment
- Publishers' profit allocation
- Users' profit allocation
- Block producers' profit allocation
- Block producer staking
- Voting content quality
- Administrative voting
- Content payment
- Pay to opt-out
- Other added-value services

DAD Tokens are published based on the ERC20 token standard.

The circulating supply of DAD tokens will be released in batches. The initial 1/2 will be released to launch the economy system with the following years each releasing 1/2 of the remaining supply. All remaining amount will be released in the fifth year.

DAD blockchain

Ontology customized public chain

DAD blockchain will be developed on top of the customized public blockchain provided by our partner Ontology.

Ontology is a new high-performance public blockchain project & a distributed trust collaboration platform.
Ontology provides new high-performance public blockchains that include a series of complete distributed ledgers and smart contract systems.
Ontology blockchain framework supports public blockchain systems and is able to customize different public blockchains for different applications. Ontology supports collaboration amongst chain networks with its various protocol groups.
Ontology will constantly provide common modules on the underlying infrastructure for different kinds of distributed scenarios, such as those for the distributed digital identity framework, distributed data exchange protocol, and so on. Based on specific scenario requirements, Ontology will continue to develop new common modules.

DAD blockchain is first ad blockchain using Ontology public chain technology.

Identity verification via ONT ID
DAD blockchain uses the ONT ID framework to verify identity of organizations or persons registered on the network. For example, a company may want to use an account as their official account. The verified account is legitimate for verification and confirmation of associated people, assets, objects, and affairs. On one hand, frauds and impersonation can be prevented. On the other hand, smart contracts signed on the ad blockchain have equivalent legal forces as real world contracts signed by the business entity. In some countries and areas, identity is a basic requirement by regulation, an organization lacking identity verification is not permitted to run its business.

Data management and transaction via ONT DATA and DDXF

ONT DATA framework supports data cooperation and exchange of different things, data resource management, smart contract transactions, etc. DDXF Distributed data exchange framework allows to customize data trading marketplaces with ensured data and financial security.

Statistics and behavioural data need to be shared with authorized parties and privacy must be protected at the same time. Due to the sheer amount of data, actual storage is off the blockchain, the DAD blockchain is able to manage, verify and authorize data usage in the distributed network.

Consensus algorithm

DAD blockchain will use the brand new consensus algorithm VBFT which is based on VRF (Verifiable Random Function). It supports large scale network operations and achieves high performance with eventual consistency.

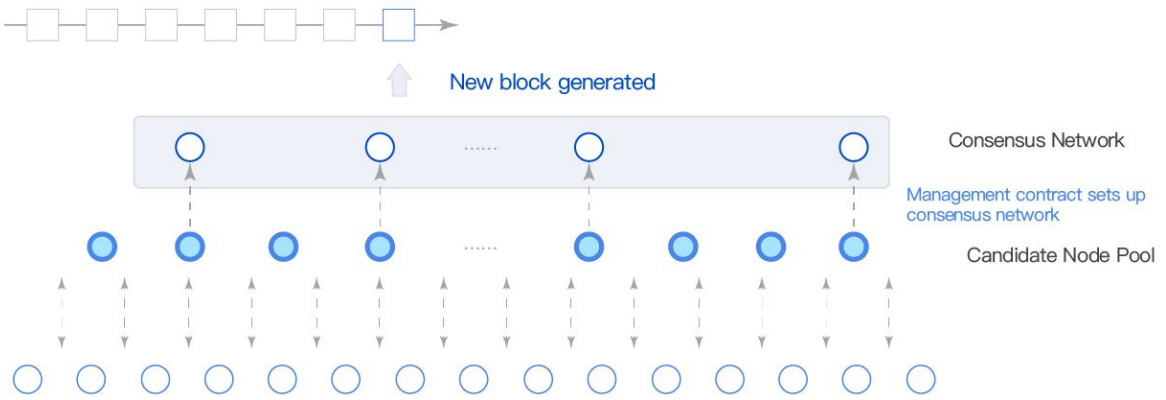
VBFT is a new consensus algorithm that combines PoS, VRF (Verifiable Random Function), and BFT. It is the core consensus algorithm of OCE (Ontology Consensus Engine). VBFT can support scalability of consensus groups, through VRF guarantee the randomness and fairness of the consensus population generation, and ensure that state finality can be reached quickly. Ontology's core network is composed of two parts:

- Consensus network

  The consensus network consists of all consensus nodes responsible for consensus on transaction requests within Ontology, block generation, maintaining the blockchain, and distributing consensus blocks to synchronous node networks.

- Consensus candidate network

  The nodes in the candidate network do not participate in consensus but remain synchronized with the consensus network and update to the latest consensus block on the blockchain maintained by them in real time. Candidate networks will also monitor consensus network status, validate consensus blocks, and assist in managing the Ontology network.



The size of the consensus network is managed through a consensus management smart contract. The stake must be locked for the node in the consensus network (the stake is from the owner of the node).

VBFT can reach a TPS over 5000 in production. Consensus confirmation only takes 5-10 seconds. It's low resource consumption and high malicious nodes tolerance provides a solid technical foundation for the high performance ledger of the DAD blockchain.

Ad event tracking and verification

Ad event tracking and recording is a very important function of a decentralized ad system. The blockchain records important events and authorizes related roles to access with transparency, eliminating trust dependency on centralized organizations. Event records provide a basis for budget spending and revenue allocation, resolving data discrepancy in the ad supply chain.

Ad events include impressions, user attention interactions (e.g. mouse hover, page scroll, tab switch) and actions (e.g. click, registration, download). DAD uses blockchain technology to track, verify and store ad events.

Events in the ad network come in huge volume and very high frequency, demanding high capacity in the blockchain and related processing modules. Ontology has made great performance improvement with optimization in the framework, algorithms and other aspects. The consensus algorithm used by Ontology VBFT can achieve a TPS of several thousands

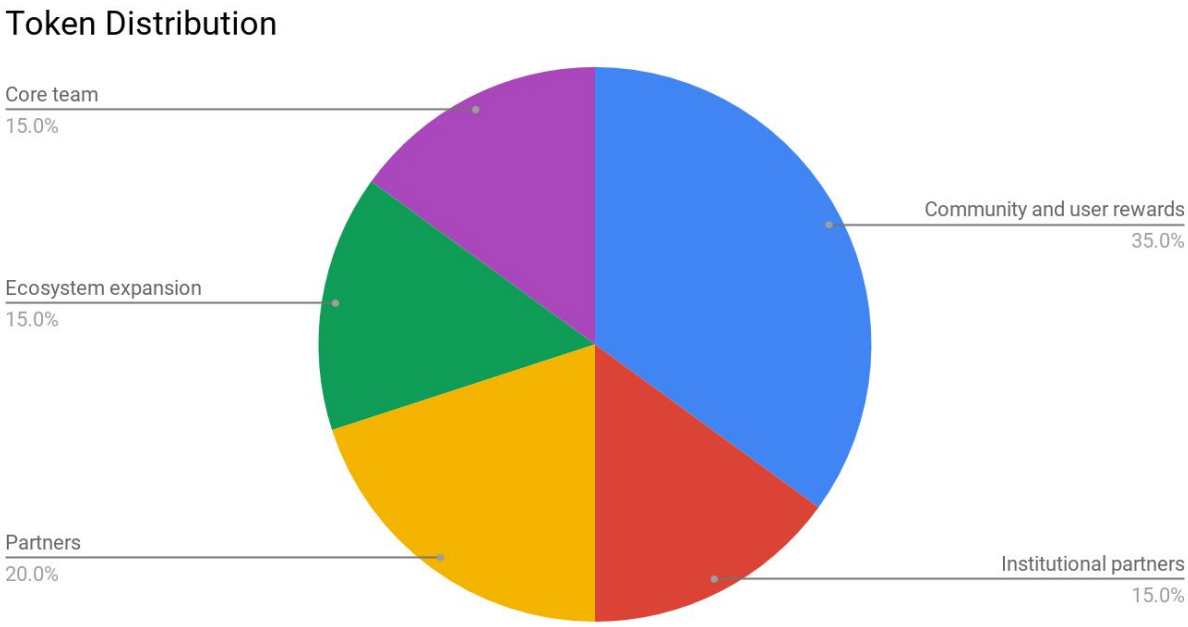
without parallelization and sharding. Raw events are stored in the trusted storage of the DAD blockchain block producer nodes. Only meta information and hash of event stream in a session is stored in the main blockchain.

M of N event confirmation

Presentation side SDK sends impression and action events to N block producers. Events mutually confirmed by M block producers will be recorded. Each event includes the hash of the previous event, forming an event chain. The event chain cannot be altered once recorded. The full event chain is stored in the block producers' trusted event storage and regularly checkpointed into the main blockchain.

Token distribution

DAD Tokens are published using the ERC20 standard with a total supply of 1 billion.
The circulating supply will be released in batches. 1/2 of the total supply will be initially released to launch the economy system. Thereafter, 1/2 of the remaining will be released each year. All remaining amount will be released in the fifth year.
DAD Token is divisible to the 9th decimal place to satisfy circulation needs after its price goes up.



Community and user rewards 35%

The community, including users and developers, are of vital importance for the DAD blockchain. This portion will be distributed to communities in various events to reward volunteers and developers who contribute code or suggestions for DAD open source projects.

Institutional partners 15%

Institutions can provide resources to support early development and operations of the DAD blockchain. They are also of great significance for long term growth and development.

Partners 20%

The DAD blockchain will have business functions in the real world economy. Partners can provide all kinds of resources required by the launch and growth of the DAD blockchain. Their help on ecological distribution and business development is indispensable.

Ecosystem expansion 15%

This part of tokens will be used for activities to enrich the DAD blockchain ecosystem, including building applications, promotions, forming strategic partnerships in order to grow the coverage and usage of the DAD blockchain.

Core team 15%

To provide long term support and incentives for the core team to complete product and technology development of the DAD blockchain and to provide continuous future enhancements and maintenance.

Budget allocation

Product and technology development 60%

The core team consists of product and technical members of the DAD blockchain, the ad system, the wallet and other core products. The core team is responsible for deciding product direction, technical roadmap and the development and testing of most of the code.

Administration 10%

Including legal, financial, organization management expenses.

Business development and marketing 10%

For seeking partnership, expanding market influence, branding and product promotion. Development of long term partnership with advertisers, publishers and users.

Partners 15%

Third parties providing services such as design, promotion, PR and development

Contingency 5%

Reserved funds for unexpected events or unforeseen expenses

Roadmap

2013.05 Global ad system launch

Global ad promotion

Developer traffic monetization

2015.04 Over 12321 advertisers across the globe

2016.12 Among the top 10 global ad platforms

Global ads over 110,000

150 million monthly active users

1.5 billion daily impressions, covering over 200 countries and regions, 99% utilization

2017.03 DAD blockchain global ad delivery system official launch

2017.04 Blockchain ad wechat bot, Coin market, went online and covered 7328716 users.

gift.one total registered users reached 5328230 with daily new users of 12931 and daily active users of 1392813

Telegram community system full coverage

2018.1 Bifanr deep ad service covered 52 countries. 1730 global ambassadors participating local promotion events

2018.5 coinadv global business launched

321 global client partners. Daily audience of 68072163, 372124 daily clicks and 4032 media partners.

Global distribution for projects including huobi.pro, FNK and Medishares. Covered 4032 media and brought 312082 daily new user registrations

2018.6 Established local communities in 7 countries, including China (Beijing, Shanghai, Shenzhen), United States, Germany, Japan, India, Indonesia and Korea

2019 Q1 Browser enhancement, DAD wallet

2019 Q2 User identity and data sharing

2019 Q3 Technical prototype test based on Ontology testnet

Upgrade SDK and ad system for simultaneous blockchain test

2019 Q4 Ad economic smart contract, system and protocol contract

2020 Q4 Launch of DAD blockchain core features on the mainnet.

2021 Q1 DAD blockchain core functionality upgrade and optimization. Client side coverage in all channels.

2021 Q3 Metrics and measurement protocol 2.0

2021 Q4 Data open up and data exchange market

2022 Q2 Next generation distributed ad network

Core team

Herman Pang

Master of institute of computer science, Chinese academy of sciences, has worked at Microsoft Research Asia, head of Yoai big data platform, initiator of 10 million DAD spark plan. He has conducted deep research on blockchain technology and complex networks, and has unique insights in digital media content analysis.

Steven Wang

In charge of CoinAdv

Northwestern Polytechnical University, Physics

Experienced in ad industry, YeahMobi oversea marketing VP, Mundomedia APAC General Manager

EffectMobi co-founder

Blockchain industry expert. Deep understanding of both blockchain and ad industry.

Yogeshwar Khadilkar

Pune Institute of Computer Technology, Computer Engineering

Data Analytics Architect @ Stericycle , Web Development Lead @ Stericycle

Yogeshwar (Yogesh) Khadilkar has 8+ years of product / services development experience. He has hands-on experience on technologies as varied as core C,C++ development to Web 2.0 Web Application development, J2EE, .NET.

Michal Raczka

Application Developer

University of Waterloo, Bachelor of Mathematics, Honours Computer Science - Co-operative Program

Worked at RIM、Symcor as senior software engineer

Elon Xu

Bachelor of Computer Science, Peking University. He used to be the head of Huawei's terminal cloud storage, Sohu R&D Center (Sogou Technology) as well as the head of Sogou Music

Product Quality Department. He has been working on the distributed systems for nearly ten years.

Jay Ding

He graduated from University of Waterloo, majoring in Actuarial Science. He is a partner of New Margin Capital Shanghai. He has 8 years of experience in investment, project incubation and product management. He focuses on DAD ecosystem construction and business development.

Youchuan Huang

One of the early blockchain technology research scholars, having in-depth research in large distributed systems, high performance areas as well as blockchain privacy protection. He is also one of the core developers of the blockchain open source project-swiftchain.

Philip Zhang

Master of Science in Big Data Mining and Visualization, University of Liverpool. He has in-depth research on Internet big data mining, machine learning and complex network analysis.

Nicholas Jeneski

Senior Creative Designer, specializing in web/app design&visual effects.

Wen Luo

The former core engineer of SingTel. He is also a network security expert, engaged in encryption algorithms and information security for many years and has in-depth research in the development of distributed systems and blockchain technology, consensus mechanisms.

Bin Chen

He once served as a software engineer in Tencent and has extensive experience in software development. He also has extensive experience in computer engineering, software system architecture and project management.

Hao Lan

He once served as the core algorithm engineer of the Financial Business Department of the G7 R&D Center. He has extensive development experience in complex system modeling, blockchain finance, and pattern recognition.

Xiaoyan Shen

She has an extensive background of finance, consultation and technology. She used to work on Wall Street for 5 years. After returning to China, she worked for some well-known companies, including KPMG and Bank of China.

Investors and advisors

Tao Feng

PhD in Mathematics.

CEO and co-founder of New Margin Capital Shanghai. Industry leader in China's VC and PE. Manages foreign funds worth of over $30 billion. Invested in more than 200 companies.

Bo Feng

Founder & Managing Partner of Ceyuan Ventures.

He has experience with fast-growing companies in China in various industries and his knowledge of Chinese regulation. He is the Co-Founder of T2CN Holding Limited. He was the founder and partner of Chengwei Ventures since October 1999. Previously, Mr. Feng served as the Chief Executive Officer and Partner at Ceyuan. He was the Co-Founder and Special Partner at Chengwei Capital (Alternative name is Chengwei Ventures). He also Co-founded Robertson, Feng Technology Associates. He served as the Chief Representative at ChinaVest since 1997 and a Vice President at Robertson, Stephens & Company since March 1994.

Eres Gross

CEO & Founder of VIIXO

B.A Economics & Management, The Academic College of Tel-Aviv, Yaffo

MBA, Bar-Ilan University

Yeahmobi M & A, Corporate Dev Advisor

SVP of Matomy Media Group

VP of Media at XTEND

Li Dong

In charge of oversea business of Department of Internationalization, Baidu
CMO of oversea content platform Baca
VP of Investment of Huying Capital
Member of North America Blockchain Association

Felix Lee
COO of Appcoach.Head of BD & Operation, Head of User acquisition and Head of ES file manager product line at Baidu int'l

Di Hu
Partner of 8 Decimal Capital
Organizer of the world's largest global decentralized geek organization and hackathon DoraHacks Global Partner
M & A analysis of investment banks China International Capital Corporation Limited
Founder of Novaone, an international investment institution

ONTOLOGY
Ontology is a diverse, integrated, distributed trust network and the infrastructure for building a trust ecosystem. Ontology encourages trust cooperation and allows projects of all shapes, sizes, and technologies with different business scenarios and compliance requirements to pass through Ontology’s chain networks and take advantage of the distributed trust network how they see fit.

Ontology has become the first blockchain project from China to join the Decentralized Identity Foundation, which aims to build a standardized decentralized ecosystem for online identities. Also, Ontology has been involved in ISO/IEC TC307 and CBD Forum’s blockchain open source project.

NEO
NEO is a non-profit community-based blockchain project that utilizes blockchain technology and digital identity to digitize assets, to automate the management of digital assets using smart contracts, and to realize a "smart economy" with a distributed network.

DHVC

DHVC is a VC fund that invests primarily in early stage and growth stage company with disruptive technology/business model, big market and excellent team. The fund's areas of focus include Artificial Intelligence, AR/VR, Big Data, Blockchain, Enterprise Software and other disruptive technologies.

Partners

Yeahmobi

Yeahmobi is an intelligent mobile advertising platform designed to help mobile technology companies reach global growth, acquire active users and monetize inventory. Headquartered in China, it has offices in Japan, US and Germany.

Our vision is to “Flatten the World with Technology”, aiming to make a more easily accessible and connected world using the power of mobile internet. Driven by technology, data and innovation, Yeahmobi has led the internationalization of Chinese enterprises through marketing, technological solutions and financial services, directed towards building a global business ecosystem with our international partners.

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Gift.ONE

Gift.ONE is the global biggest airdrop organization of cryptocurrency. Currently Gift box has locked various token projects, such as BTC, ETH, EOS. Much more tokens are being locked by Gift.ONE in successive.

50% of those tokens will be locked in long-term, equal to the value of GIFT, the official token of Gift.ONE. The left 50% amount will be distributed continuously to the support users of Gift.ONE, by various events, including airdrop, red packet,seckill,etc.

COINADV

Coinadv is a leading data-driven platform for blockchain and crypto sectors. With an experienced team of Digital Marketing, PR, Community Management and Consultants set in arguably the fastest growing tech capital of the world our mission statement is simple – to provide you with a premium service and suite of tools to make your project a glowing success in the most cost-effective way possible.

LUCKYBOX

Cryptocurrency airdrop hub. Users can get information about ongoing cryptocurrency airdrop events as soon as they are available. LuckyBox has released projects airdropping EOS, BTC, TRX and more currencies. Users can participate in a variety of forms including airdrops, check-ins, invitations, red packets and seckills.

Bifanr

Bifanr.com focuses on providing community building and management services for blockchain projects. It provides customized social media operation and management services for blockchain companies, including but not limited to Telegram, Twitter, Facebook, Medium and LinkedIn.

Media partners

Summary

DAD blockchain is built on top of the new generation public blockchain technology Ontology. It has the capability of high TPS ad transaction processing, user identification & verification and data management & exchange. Smart contract is used throughout the ad supply chain to resolve traffic fraud and trust issues. DAD token economy incentivizes advertisers, publishers and end users to actively participate in ad transactions and to improve ad quality and user experience in order to achieve mutual benefits and win-win for all parties. DAD blockchain empowers users with rights and benefits. With privacy protection, volunteers are allowed to provide personal behavioural and feature data and receive rewards accordingly. Users can participate ad review and quality assessment, filter ads and report nonconforming ads so that they can be addressed in a timely fashion.