XCAD Network Tokenomics

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This paper is intended for research and education purposes only, and the actual implementation of the XCAD network may differ from the framework presented below. This framework is version 1.0 of the creator tokenomics and ecosystem design and will evolve as the platform develops.

Abstract

The XCAD Network is a platform for content creators built by content creators: The network's goal is to allow creators and fans to create a direct relationship through value sharing, where fans and creators work together to build a shared ecosystem of community and content. The synergy of content creators, fans, and platform drives engagement and value exchange. As with all marketplace value exchange systems, the core value driver is the underlying network of users. The network comprises several components: Users interact with content via the XCAD plugin and receive rewards for engagement in creator tokens. In turn, this triggers rewards for creators. Marketplaces, particularly NFT marketplaces, allow the creator economy to gather secondary value as fans look to deepen their content relationship. We call this token earning paradigm Watch-to-Earn. The key idea is that each participant in the network receives rewards. Tokens are released in a controlled fashion, intending to bootstrap the fanbase and stabilize the economy and rewards mechanisms. Overall, the token design is such that it scales across multiple creator ecosystems, each with its respective fanbase. The present report covers the modeling used to develop the components of the XCAD network. The report is not comprehensive but gives an overview of how the platform functions, the various considerations in design, and our understanding and development of version 1.0 of the network.

1 Introduction

Since the inception of Web 2.0, content creation has been a primary driver of value on the internet: Many centralized platforms, for instance, YouTube and Instagram, have benefited from the value created by individual content creators. Unfortunately, the majority of the monetary value stream ends up going to the platform, and while some amount of it may flow to the content creator, none of this goes to reward fans; particularly the early adopters that help build up the community and following as proof of value signallers and marketers. However, where Web 2.0 is dominated by centralized platforms, the value hierarchy in Web 3.0 is aimed at community inclusion, and in order to facilitate community inclusion, tokenized systems and ledgers which facilitate networks and marketplaces are key. This is evident right from the origins of Web 3.0 in the Bitcoin whitepaper [3] and the Ethereum whitepaper [4].

The XCAD network [5] is a platform for content creators built by content creators with the goal of democratizing the value that exists between independent content creators and the fans who create a community around them. This recognizes that fans help drive adoption in a given content creator's microeconomic ecosystem and that ultimately creators and fans co-create content in unison and through feedback and exploration.

This report describes the formal modeling for the XCAD network, which took place in conjunction with the development of creator tokenomics and the algorithms that run the XCAD plugin. The report is structured as follows: In Section 2., we describe the structure of the ecosystem, including the various actors. In Section 3., we focus on the content creator. In Section 4., we develop the network aspects of the model, which takes the form of a multi-creator, multi-network system. Sections §5. and §6. consider some of the dynamics of Watch-to-Earn, and Sections §7. through §11. consider the behavior of the payments to content creators over time. For more technical details on the modeling framework used, see [2].

2 Ecosystem Model

2.1 Ecosystem Overview

This section considers the different parts of the XCAD Network ecosystem: (1) Creators play a central role as content producers, while (2) fans play the role of content consumers, and, to an extent, content champions (3) the platform plays the role of infrastructure support, and this is done through (4) the browser plugin;

which facilitates data exchange and token rewards. Each component plays a slightly different role in the system, and our goal here is to describe in a formal language a system for multiple creators, fans, and the platform and plugin to interact.

2.2 Creators

Content creators add value to the network by publishing content into a list space. Let $\mathcal{C}_i$ be the set of content creators at the end of the interval i and suppose that each creator has a unique identifier in this set. Let $|\mathcal{C}_i| = m_i$, so during interval i, there are m_i creators in the set, and suppose that $\mathcal{C}_i = \{C_1, C_2, \ldots C_{m_i}\}$. An individual creator is identified as $C_{ij} \in \mathcal{C}_i$, where i is the current interval and j is the creator identifier in the interval, $1 \leq j \leq m_i$. For creators that span multiple intervals, use the convention that $C_{i_1 j}$ and $C_{i_2 j}$, references the same creator for $i_1 \neq i_2$. In this way, the namespace created by the second index uniquely enumerates and identifies creators.

Given a creator identifier $C_{ij} \in \mathcal{C}_i$, the identifier has an associated public content list a and a private content list b. The public content list is a countable set of items $C_{ij}^a = \{1, 2, \ldots\}$, and the private content list is a set of items $C_{ij}^b = \{1, 2, \ldots\}$. Suppose that during interval i, content item k was published to the private list C^b: We write C_{ijk}^b in reference to the creator, the list type, the time interval, and the item. In this way, we can easily aggregate creators, lists, intervals, and items by summing over indices.

2.3 Fans

Fans interact with creators primarily by viewing published content from either the private or public list spaces which belong to a particular creator. Suppose that there are n_i fans in total at the end of the interval i, and any fan can 'belong' to any creator $C_{ij} \in \mathcal{C}_i$. Let $\mathcal{D}_i = \{d_1, d_2, \ldots, d_{n_i}\}$ be the set of unique fans (measured, for example, by the number of active plugin wallets on unique devices during interval i). The fan-creator-content interaction can be modeled, using this notation, as a network where the various agents are nodes, and edges between nodes represent interactions between the agents. Further, if there are metrics for each of the interactions, then these can be added as edge weights. Agent-specific metrics (for example, token holdings) can be added as vertex weights.

For each creator $C_{ij} \in C_i$, there is an associated fan club made up from elements of $\mathcal{D}_i$. (Notice that the fan club and the creators need to exist during the same time interval.) The global set $\mathcal{D}_i$ is the XCAD fanbase which is an agglomeration of the fan clubs of individual creators. Let D_{ij} be the set of fans associated with the creator C_{ij}. Thus, $D_{ij} = \{d_{ij\ell_1}, d_{ij\ell_2}, \ldots, d_{ij\ell_\alpha}\}$ is the fan-club of creator C_{ij} during interval i. The index ℓ_θ where $1 \leq \theta \leq \alpha$ is set according to the fan's unique identifier in the set $\mathcal{D}_i$. This index is not necessarily incremental over the range and cannot be used to count the elements over the set. For this reason, the number of members in the creator $|C_{ij}|$'s fan-club is written $|D_{ij}|$. We can also use an indicator vector $\vec{\ell}_{ij}$ of length $|\mathcal{D}_i|$ to isolate those fans that are interacting with creator j during interval i. The components of $\vec{\ell}_{ij}$ are in $\{0, 1\}$ with $\{1\}$ indicating an interaction and $\{0\}$ the absence of an interaction.

2.4 Platform

The XCAD platform is the backdrop of interactions between creators, content, and fans. Each creator on the platform has a unique token, and the distribution of tokens across the network is part of the value exchange and storage mechanism. The XCAD base token acts as a fungible intermediary between all the different creator tokens. Fans earn tokens by engaging with creator content off the public list space, thus increasing the reputation, reach, and credibility of the individual creator and the network as a whole. Fans spend tokens in order to get access to the private list space, thus creating secondary demand for the creators token and the XCAD token as a medium of interchange. As the secondary demand for access to the private list space (e.g., exclusive content, merchandise, and NFTs) of a given creator increases and the creator becomes more popular, the expectation is that this access will drive demand and tokenized value.

The role of the platform is to manage value in a controlled way. Let $\mathcal{T}_i = \{T_1, T_2, \ldots, T_{r_i}\}$ be the list of tokens managed by the platform at the end of interval i. An individual token is referenced as T_{ij} where the first index refers to the current interval and the second the token's position in the list. So, T_{ij} is the j-th token in the list $\mathcal{T}_i$. By convention, T_{ij} is the token for creator C_{ij}, so $r_i = n_i$. For each token T_{ij}, there is a standard set of functions that can be returned. We are interested in the following.

- $\Omega_{ij} = \Omega(T_{ij})$ - total tokens created.
- $\Phi_{ij} = \Phi(T_{ij})$ - circulating token supply.
- $\Psi_{ij} = \Psi(T_{ij})$ - trading volume during the interval i.
- $P_{ij} = P(T_{ij})$ - time-weighted average price with respect to the XCAD token during interval i.

- $P_j(t) = P(t, T_{ij})$ - spot price with respect to the XCAD token at time t.
- $R_{ij} = R(T_{ij})$ - estimated per interval rewards rate for token T_{ij} via the browser plugin.

For each creator, these are key indicators of the 'creator token economy'. Token inflation rates, and the like can be calculated from the above.

2.5 Browser Plugin

The exchange of information is a large part of the setup, and it is necessary for the platform to understand the videos and content being viewed by the collective fan base: the collection of fan clubs of individual creators. The browser plugin sends this data securely to the XCAD servers and calculates the reward values that are due to fans. The plugin allows fans to claim and manage their creator tokens, as well as interact with the XCAD decentralized exchange (DEX). In Figure 1, the plugin facilitates the links and enables the interactions between fans and creators.

Various data points modulate the rewards mechanism via the plugin. These include engagement-specific metrics as well as the age of video, date from release, and then other creator-specific details, including special bonuses and Easter eggs.

The public has the option of buying XCAD from various exchanges or using a fiat gateway. XCAD can then be sent to the XCAD Decentralised Exchange (DEX) in order to purchase creator tokens. In turn, these can be transferred into the internal plugin-based wallet. They also have the option of importing an existing wallet into the plugin or sending XCAD from an existing wallet to the XCAD-plugin wallet.

2.6 Notes on Time Parameters

In modeling the underlying behavior of the network, a formal notion of time is required; this subsection is a more technical note on how we considered and indexed time between various events in the ecosystem.

Let t be a continuous time parameter, and suppose that we measure time from $t = 0$, calibrated to a system initialization event. In order to discretize the time parameter, let $i \in \mathbf{N} \cup \{0\}$, where $i = 0$ corresponds to $t = 0$, and suppose each value of the index $i \geq 1$ references the continuous interval $(t_{i-1}, t_i]$. For example, if $t_0 = 0$, and $t_1 = 60$ and time is measured in seconds, then we are using one-minute discrete intervals for aggregation purposes. Note that intervals do not need to be periodic here. They simply have a start time and a stop time.

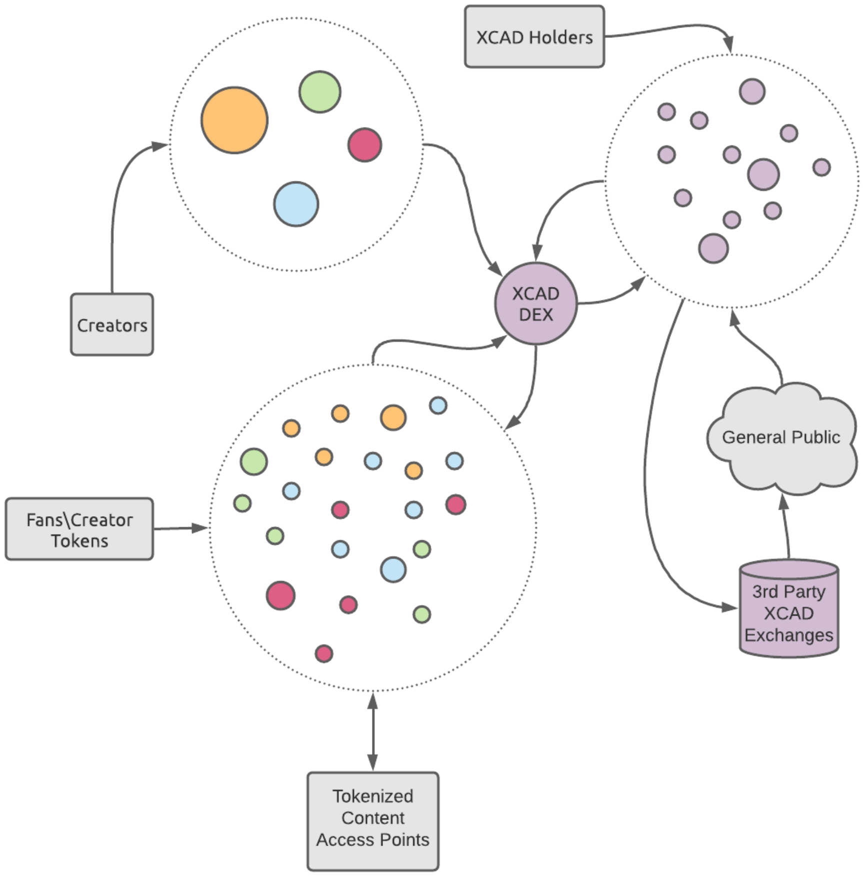

Figure 1: Global Network: The purple bubbles represent XCAD holdings, while the others represent individualised creator tokens. The figure shows the flow of tokens through the DEX and the various ecosystem participants.

In terms of notation for functions that contain time as an argument, let f be a function of time and any other arguments. For the continuous time case, write $f = f(t, \cdots)$ and for the discrete-time case, write $f_i(\cdots)$. For converting continuous functions to discrete ones over an interval, the method is to take the time-weighted average values of the interval. So, for example, if $P(t)$ is the spot price of an asset and $t \in (t_{i-1}, t_i]$, then P_i is the time-weighted average price of the asset over the interval. We suppose that our functions are suitably well defined and that this averaging is possible.

3 Content Creator Module

3.1 Formal Structure

Content creators are the primary value drivers in the XCAD network. In order to manage the content creator and the corresponding fan club, we use the module set up in Figure 5. During interval i, given a creator C_{ij}, the creator's fan club is the set D_{ij}, and token is labelled T_{ij}. Individual content creators have 'fan clubs', but the collection of creators in the system $\mathcal{C}_i$ has a fan base. These terms have different meanings in the remainder of the paper: The fan base is the set $\mathcal{D}_i$ and creator C_{ij} has the fan club D_{ij}.

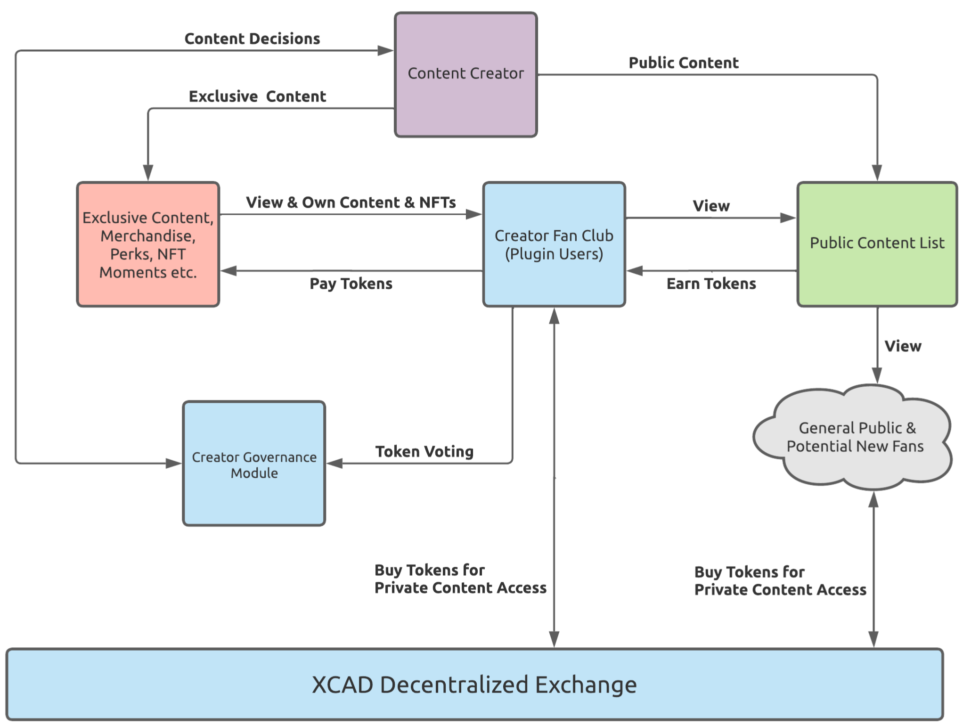

Figure 2: XCAD Single Creator Module: Describes the interactions between different aspects of a single Creator's ecosystem. Private Content Access refers, for instance, to Exclusive Content, Merchandise, Perks, and NFT Moments.

3.2 Fan Engagement

Fans view content off the public list C^a_{ij} and earn the creator tokens T_{ij} at a rate R_{ij} over the interval. Fans in the 'fan club' are those who have downloaded the XCAD browser plugin in order to engage with the watch-to-earn model.

Each fan $d \in D_{ij}$ has an associated dataset in the system, which records the creator's video content enjoyed by the fan off the public list C^a_{ij}. The data $\Delta_{ij}(d)$ determines the reward sent to the individual fan. This is some fraction $0 \leq \alpha_d(T_{ij}) \leq 1$ of the total reward for the period R_{ij}, and based on dataset $\Delta_{ij}(d)$, fan $d \in D_{ij}$ is rewarded the amount of T_{ij} tokens $\alpha_d(T_{ij}) \cdot R_{ij}$ during interval i. Individual fans accumulate tokens over time, and may accumulate an amount,

$$a_d(T_{ij}) = \alpha_d(T_{ij}) \times R_{ij},$$

during interval i. Fans may also buy and spend tokens during each interval, and so have a token spend $s_d(T_{ij})$ and purchase $p_d(T_{ij})$ variables. Tokens may also be staked or locked up, for example, in voting decisions and then returned. So, suppose that $q_d(T_{ij})$ is the staked token amount and $r_d(T_{ij})$ is the returned amount, during the interval i. The balance of an individual fan for token T_{ij} is given as:

$$B_d(T_{ij}) = \sum_i \left[a_d(T_{ij}) + p_d(T_{ij}) - q_d(T_{ij}) + r_d(T_{ij}) - s_d(T_{ij})\right],$$

where i is summed over the set relevant active intervals. If the token is clear from the context, we write a_d, p_d, q_d, r_d and s_d respectively.

3.3 Dynamics

The design is set out such that as new fans enter the ecosystem, rewards are diminished as they are shared over a larger group, but the demand for private content in the list C^b_{ij} will increase, and so the average value spent or staked per fan per interval will increase too. Creators can support this process by adding valuable content to the list space, and fans can support the development of the ecosystem by sharing what they find valuable and encouraging the general public to join an inside community of token holders. Further, there is value in engagement through governance, and fans and creators can co-create experiences/content and module ecosystem. These are the organic network effects (related to Metcalfe's law [6]) that create value in the token and community when measured against external base currency or through various content metrics - views, likes, subscribers, and click-through rates.

4 Network Effects

4.1 Multiple Networks

The structure of the XCAD platform is designed to support multiple creators with multiple fan clubs. Each of these is a type of hub and spoke network structure in which a community is organized around a particular creator and, at a finer scale, the creator's content publications. By supporting multiple creators and their fans, XCAD is able to scale up as a network of networks. The idea can be captured formally, using the notation above and setting up the underlying networks: The norm in graph theory [7] is to call V the set of nodes in the network and E the set of edges. An arbitrary node is written as $v \in V$, and an edge for $u, v \in V$ joins the nodes u and v together, so $e \in E$ where $e = uv$.

4.2 Fan-Content Networks

The first type of network underlying XCAD is a bipartite fan-content network for a single creator and fan club. Content cannot watch other content, and fans cannot watch other fans (unless one allows the duality of a fan as creator, creator as the fan in our model; which we are excluding since, on principle, creators will not be rewarded for watching their own content).

Let C_{ij} be the creator in this scenario, and suppose that the creator C_{ij} has the public and private content lists C_{ij}^x and C_{ij}^y, as above. Let D_{ij} be the creator's fan club. Let $V = \{C_{ij}^x \cup C_{ij}^y\} \cup D_{ij}$. This gives the vertex set. An edge $e = uv \in E$ is a valid edge if $u \in C_{ij}^x \cup C_{ij}^y$ represents content and $v \in D_{ij}$ represents a fan that has viewed content and has had a positive token balance for creator C_{ij}'s tokens, T_{ij}, over some period, possibly since the system was initialized.

Figure 2. illustrates the network structure: In order to enumerate the size (and value) of a single creator's network, suppose that p_{ij} is the probability that a fan $u \in D_{ij}$ interacts with the content $v \in C_{ij}^x$ from the public content list, and that q_{ij} is the probability that a fan u interacts with content from the private content list w. For simplicity, this probability is the same across fans and videos, but the model can be fine-tuned too. The expected number of edges for publicly viewable content in the fan-club is:

$$E_{ij}(p) = p_{ij} \times |C_{ij}^a| \times |D_{ij}|.$$

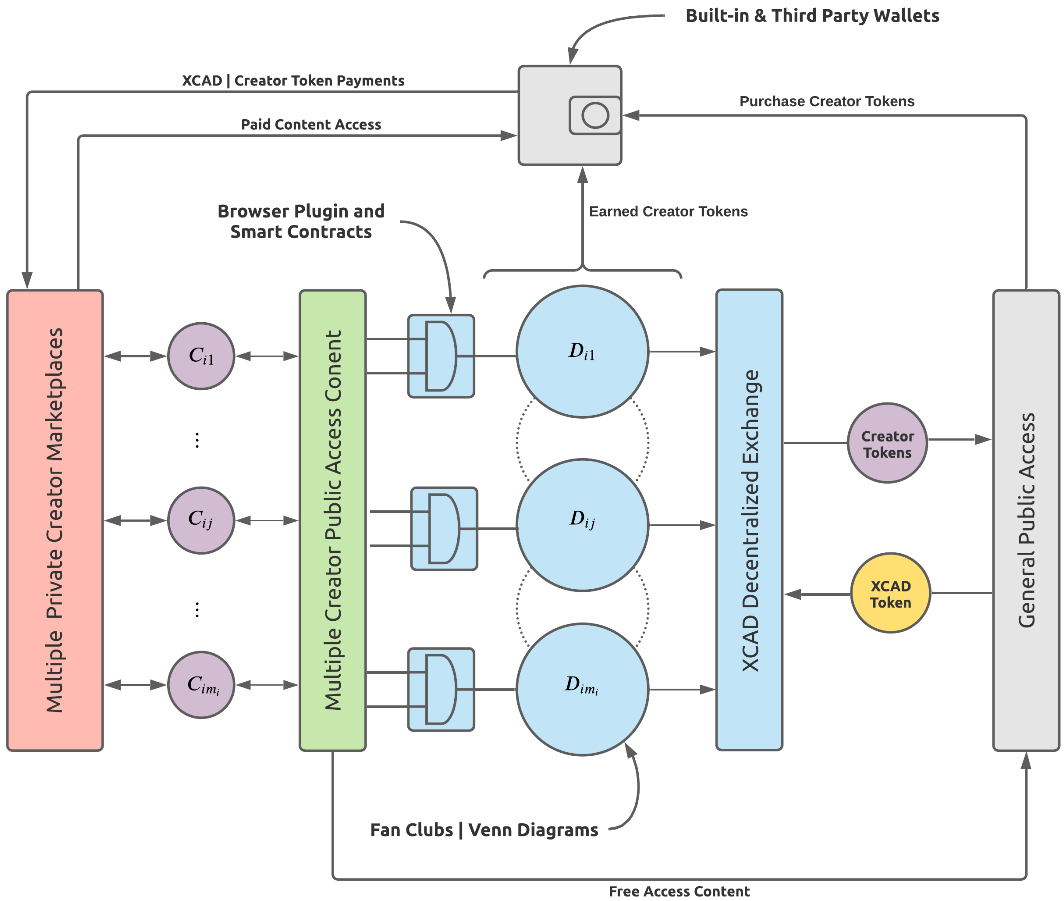

Figure 3: XCAD Multi-Creator Network of Networks

The expected number of edges for 'paid' content is:

$$E_{ij}(q) = q_{ij} \times |C_{ij}^b| \times |D_{ij}|.$$

Fans earn tokens in proportion to E_p and spend tokens in proportion to E_q. This is a formal way of saying that engagement between fans and content drives the supply and demand of the underlying token. The details of the economics are slightly more nuanced since there is a set of vesting mechanisms to help stabilize the token price. Notwithstanding this point, the network-based model gives us useful insights. Let $w_i^1(e)$ be the average weight of an edge $e \in E$ that connects D_{ij} to C_{ij}^a, and let $w_i^2(e)$

be the average weight of an edge $e \in E$ that connects D_{ij} to C_{ij}^a. Suppose that 'weight' represents token flows for viewed content measured in some base currency. In this case, the value of tokens earned by fans is:

$$\Omega_{ij}^1 = w^1(e) \times E_{ij}(p),$$

and the value of paid content in the network, during period i, is:

$$\Omega_{ij}^2 = w^2(e) \times E_{ij}(q).$$

As long as $\Omega_{ij}^1 \leq \Omega_{ij}^2$, value is accumulating in the creator token since the demand for access to the private content list outstrips the supply of tokens as rewards for engagement with the public content list. This looks only at the tokens allocated to fans, creator allocated, and platform allocated tokens are held under strict vesting conditions, which we will discuss in the next parts of the report.

4.3 Multiple Networks

The structure of XCAD is such that multiple creators create their own networks, and there is sharing of fans and creators, as well as infrastructure. As any single network scales, so too does all the others. The value allocation mechanisms for the network are shown in Figure (4): Value metrics and behavior trigger rewards mechanisms, which allocate incentives to fan creators and the network. This creation of value through content then leads to value in the private creator marketplaces, which in turn drives value in the creator's individual token and the XCAD network.

As each individual creator network scales, this builds the global network of networks and, in turn, helps create stability in the individual creator tokens, as well as the XCAD token itself. Quantitatively, there are a total of $C_i = \sum_j C_{ij}$ creators during interval i, and a total of $|\mathcal{D}_i|$ fans. Each creator and fan club creates a network economy that has an appetite for free content given by $\xi_{ij} E_{ij}(p)$ and an appetite for paid content given by $\eta_{ij}(q)$. This aggregates over individual networks to and we have $E_i(p) = \sum_j \xi_{ij} E_{ij}(p)$ and $E_i(q) = \sum_j \xi_{ij} E_{ij}(q)$ which gives the sum over the demand for paid content. All of this aggregates into demand for the network as a network of networks and the XCAD token via the DEX.

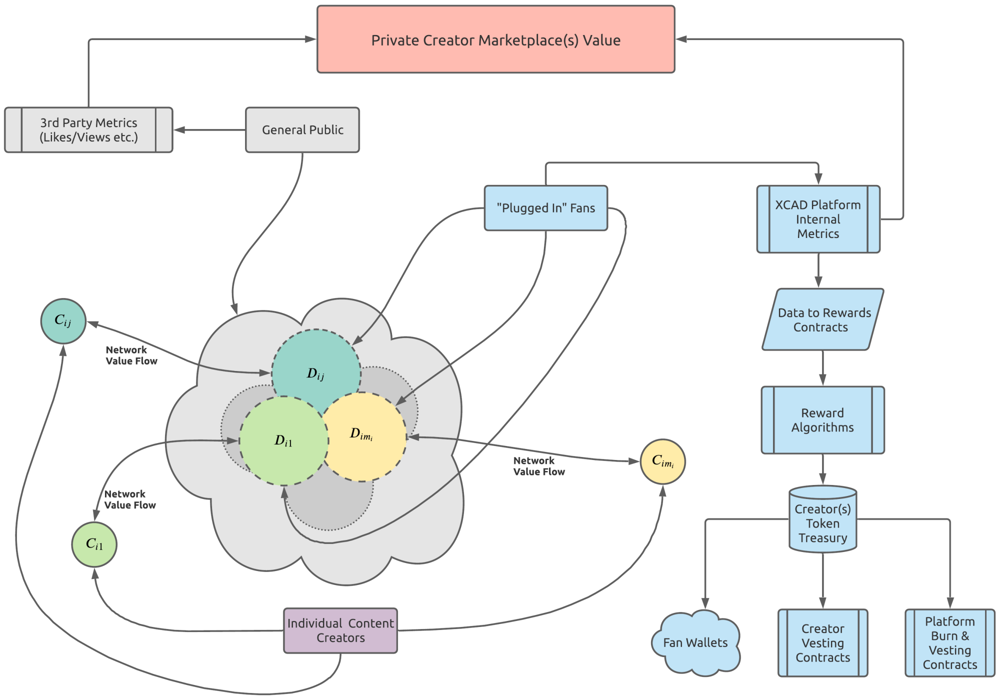

Figure 4: XCAD Network Value Allocation Mechanisms

5 Token Allocation

5.1 Creator Liquidity Offering

The initializing event for a creator economy on the platform is the Creator Liquidity Offering or CLO. The economics of creator liquidity offerings are detailed in the next part of this series of papers, but for now, we introduce them briefly. An introductory medium article by XCAD is given here [5], along with other pieces that detail the network. The step-by-step process is indicated in the box below.

Creator Liquidity Offering

1. A new creator C_{ij} wants to launch on the XCAD platform during the interval i.
2. The platform indicates an XCAD amount to be locked up in the pool, for example, 50,000 XCAD, into the creator's liquidity pool on a permanent basis.
3. The pool fills up with liquidity, and the creator's personalized token T_{ij} is allocated to contributors in proportion to their contribution. Alice contributes 5,000 XCAD, and Bob contributes 2,000 XCAD to the CLO. Alice receives 10% of the creator's initial tokens T_{ij} allocated to the pool, and Bob receives 4% of the creator's token that is allocated to the pool.
4. Any further tokens in the ecosystem are to be generated by the watch-to-earn mechanics.

For modeling purposes, let L_{ij} be the total tokens released in the CLO for creator C_{ij}, and let Ω be the total creator tokens in existence. For now, the value of Ω is left unspecified: Initially, the idea was 1 Billion creator tokens, but this is subject to change.

6 Watch-to-Earn

6.1 Token Allocation

The platform browser plugin is used to generate a set of viewing metrics for an individual fan $d \in D_{ij}$ who forms part of the creator's fan club. With watch-to-earn, as the fan views, creator content from the public list C_{ij}^{a} the fan is rewarded in creator tokens T_{ij}. For each token allocated to the fans in D_{ij}, a token is sent to the creator's vesting contract system on the platform, and a further token is sent to the platform's token vault: These tokens are vested and allocated very slowly in a way that defends the ecosystem as a whole, but we do not go into detail on this topic here. The next key variable is the rewards rate per interval: For each creator token, let $R_{ij}(T_{ij})$ denote the rewards rate per interval i of token T_{ij}. During a given interval, at most, R_{ij}, tokens are introduced into the economy as rewards, and these rewards accumulate until they are claimed by fans in D_{ij}.

Formally, the rewards rate is a random variable R_{ij} that is bounded above by some daily/monthly/quarterly and annual limits. We suppose that $\sum_i R_{ij} \leq R$ where R_α is the annual limit of tokens that can be issued as a reward, and α is the current year. Suppose that tokens are issued over an N year period and that $0 \leq \alpha \leq N$. The total tokens that can be issued to fans are capped at $\Omega/3$ including the CLO L_{ij}, and we write

$$(\Omega - L_{ij})/3 = \sum_\alpha R_\alpha$$

since tokens are issued in equal amounts to fans, creators and the platform.

For example, consider the setup where rewards tokens are issued annually according to a predefined schedule. If initially, $L = 10^8$ or 100 million tokens. The figure below shows an annualized schedule that peaks around the third or fourth year. This may be good for a creator that is looking to scale up an existing fan club and content creator economy as opposed to one that has an established presence that they want to build into a token economic community. A daily reward limit can be set by just

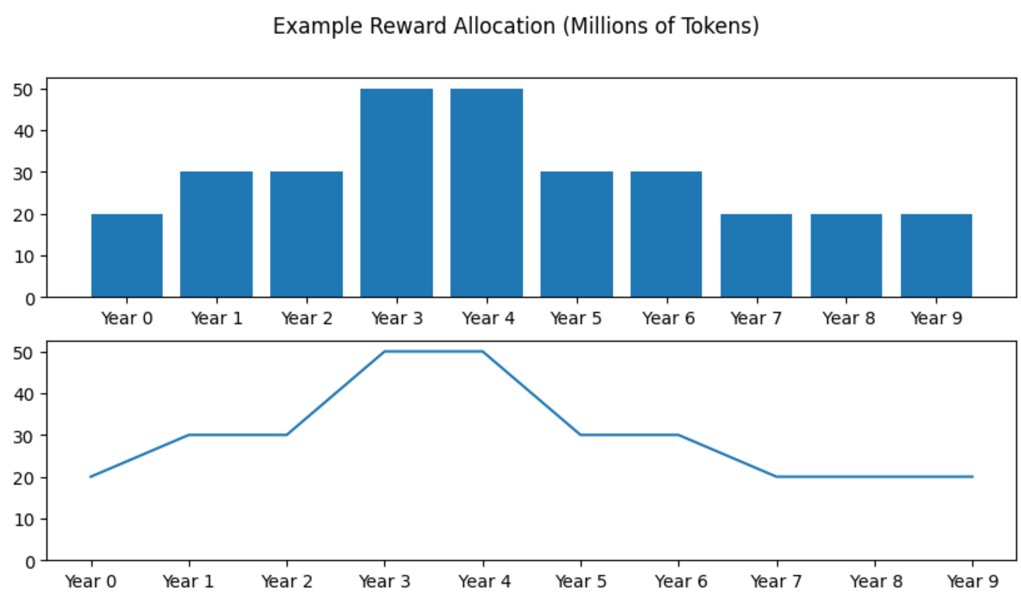

Figure 5: Example Token Allocation

taking the annual limit and dividing this by 365. It distributes the rewards evenly on an annual basis and helps keep inflation levels consistent. In order for the flow of rewards to be maximized, new content and new fans need to be introduced into the ecosystem. In order to eliminate inflation, this initial mechanism was extended to consider various stabilization criteria. These are discussed in detail in the next subsection.

6.2 Ecosystem Stabilization

After the initial bootstrap phase of the creator ecosystem, in which daily rewards are issued against user behavior, creator tokens will enter into circulation, but at a much slower rate, with that rate determined by the economic value that is being generated in the creator token. As transactions take place in the ecosystem with fans buying, for example, NFT moments, trying to optimize their token yield via staking, or participating in voting (voting micro-burns), creator tokens will consistently be burned from the ecosystem. The rewards that are released via the plugin will be correlated to the number of tokens burned. Along with Creator token staking - for additional earnings multipliers, these mechanisms help ensure that the dynamics are not purely inflationary. Our goal is to build a stable ecosystem that scales in market-cap as the creator improves their offering and reaches a larger audience: This is where the real economic value and utility of the ecosystem lies.

6.3 Claiming Rewards

Reward scores accumulate in the plugin and need to be claimed by users in order to convert 'views' into tokens. There is an aggregation across participating members of the fan club D_{ij} in order to allocate tokens for engagement. The goal of the aggregation is to ensure fairness amongst engaged fans, so the token rewards may differ from day to day since the number of fans making simultaneous claims is a factor. The question is, how are the rewards values calculated?

To understand the rewards mechanism, we need to look at individual items in the creator library. Let $v \in C_{ij}^a$ be an item in the creator's public list. Given a fan $d \in D_{ij}$, define the status of the item v as $\psi(d, v)$: If the user has already been rewarded for the item v, then $\psi = 1$, and otherwise $\psi = 0$. A second factor has to do with a complete engagement. If the user completes the engagement, for example, watching more than 80% of a video, then let $\phi = 1$, otherwise $\phi = 0$. The item in the library is rated with a current value of $K_i(v)$, which accounts for various factors such as video length, age, and popularity. This value is set solely at the discretion of the platform.

A fan d that engages with the content item v receives a utility rating $\psi\phi K_i(v)$. This represents the utility generated for the network when the fan engages with the video. After the video is watched, this utility is given a token weight $w_i(v, d)$ which represents the number of tokens per unit of utility generated that the network is willing to award fan d for engaging with item v. The fan is then assigned a token rating for the content item. This is found by multiplying the utility value by the weight. Set $Q_i(v, d) = \psi\phi K_i(v) \times w_i(v, d)$. If the fan has not engaged with the item at all or has not completed the engagement, then this value is zero. A fan accumulates the value of $Q_i(v, d)$ over some set of items in C^a_{ij}. Let

$$Q_i(d) = \sum_{v \in C^a_{ij}} Q_i(d, v)$$

be the value for a single fan for these accumulated 'token points'. Now, if this accumulation is run over all fans, this gives $Q_i = \sum_{d \in D_{ij}} Q_i(d)$.

The value of Q_i represents outstanding claims across fans and content. This is a token-utility metric that a fan can convert into tokens via a claims contract. The conversion is expected to be some fraction of this total, and the value of Q_i is the maximum number of tokens that can be converted via the contract. Let ϵ_i be a residue factor that represents unclaimed tokens from previous rounds. The total 'token points' that can be submitted by fans is given as $Q_i + \epsilon_i$. We expect that only some fraction of this will be submitted and set $0 \leq \lambda_i \leq 1$.

This gives us an expected claim of:

$$E_i = \lambda_i(Q_i + \epsilon_i)$$

Note that this value does not represent tokens as yet - it's just a rating system that aggregates a metric. Once this claim is submitted, the token allocation in the claims contract is then disbursed amongst fans. There are two possible scenarios: Let A_i be the number of creator tokens scheduled to be transferred into the claims contract, and let B_i be the current balance of tokens that are in the claims contract (from previous rounds or initially zero). If the claim $E_i \leq A_i + B_{i-1}$, then the contract pays out an amount E_i and this amount is allocated to users on the basis of their individual claims, say $E_i(d)$ where $d \in D_{ij}$. In this way, 'token points' are mapped one-for-one into tokens. On the other hand, if $E_i \geq A_i + B_{i-1}$, then the rewards mechanism is oversubscribed, and the rewards are essentially re-based. An individual fan is responsible for a submission $E_i(d)$; and will receive a percentage of the claimable tokens:

$$P_i(d) = 100 \times E_i(d)/E_i.$$

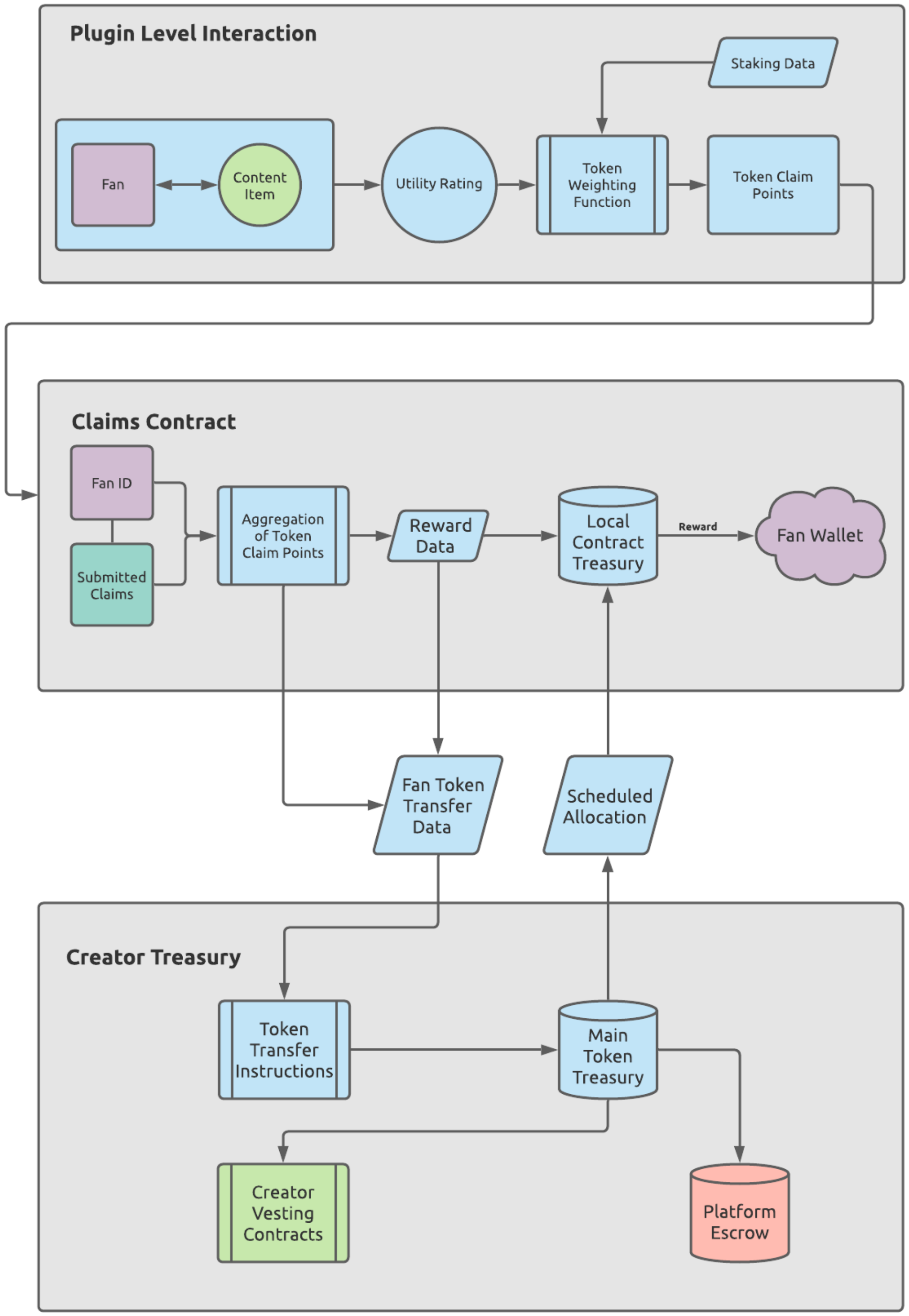

Figure 6: Watch-to-Earn Setup

So if there are 10,000 creator tokens allocated for rewards on a given day and $P_i(d) = 5\%$, then fan d receives 500 tokens on that day.

Additional factors that affect rewards are related to the age of the video, the amount of XCAD being staked, and multipliers that take into consideration NFT moments and ecosystem participation by the individual fan.

7 System Overview

Figure 6. gives an overview of the entire system. At the plugin level, individual token claim points are generated based on fan and content engagement. This information is passed into the claims contract, and individual fans submit claims, which are then aggregated. Payment data is fed to the contract treasury, which then sends the reward to the fan wallet as required. A secondary data feed that goes to the creator treasury contract is then created. This feed triggers payments to the creator vesting contracts, as well as the platform escrow contract. A further aspect is that the treasury makes a scheduled allocation to the claims contract for the next set of claims. This process repeats for each claim interval, and on schedule, tokens are transferred, and these are translated into rewards for users.

The XCAD platform is designed to launch many creators and allow them to build and scale their own economic communities. The Watch-to-Earn mechanism ensures that fans are engaged in the process and that the token is fully decentralized upon release. The safety mechanisms: scheduling and reward re-basing help to ensure price stability, along with more token burns and a correlation between tokens rewarded and tokens burnt, as well as various staking incentives.

Each creator C_{ij} has their own setup, as is detailed in Figure 6, and there are various policies in place to govern the creator treasury and economy. Our goal in this paper was to detail the watch-to-earn mechanism. In the next section, we consider the behavior of the creator treasury and vesting contracts which govern the flow of tokens to creators over time.

8 Content Creation in Web3

Content creator economies are a central part of Web 2.0 across a multitude of arenas: the evolution of the internet that led to tech-service giants such as Amazon, Google, Youtube, and Facebook was all about user-generated content that could be accessed through a central platform. By extension, it is not a far stretch to see that content creation will play a key role in Web 3.0. The difference in moving from a Web 2.0

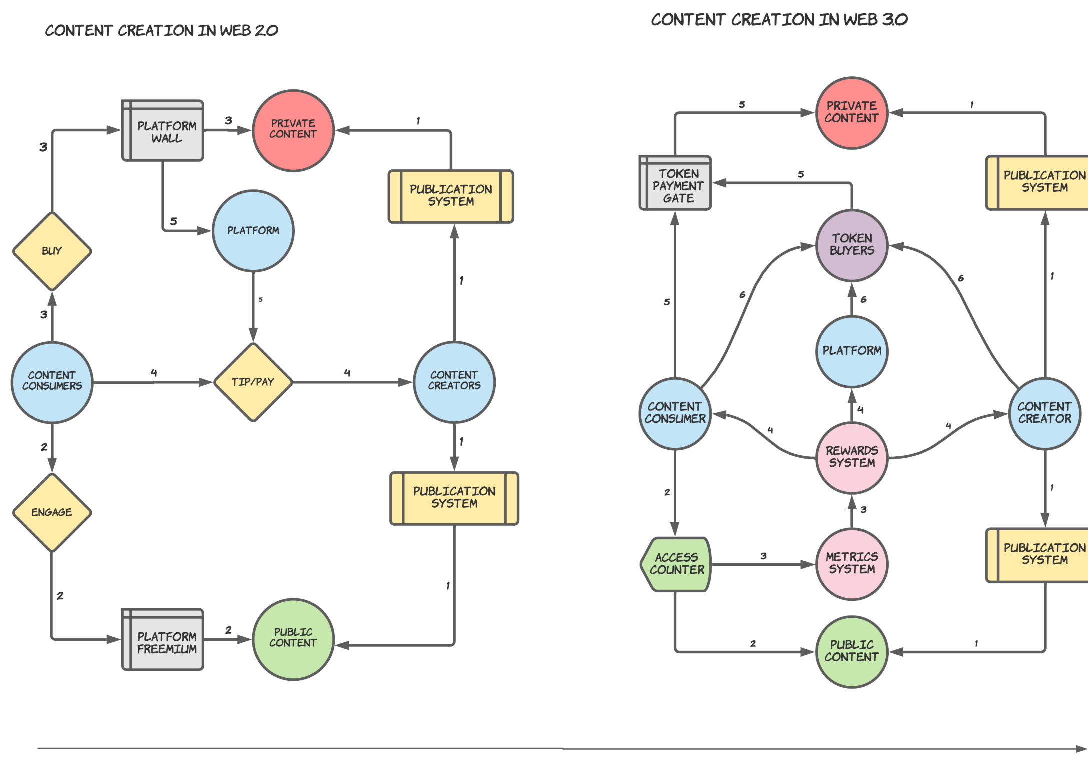

Figure 7: Web 2.0 vs Web 3.0

environment is the nature of rewards and incentives for creators and for their corresponding audience. An underestimated factor is that audiences, particularly earlier ones, help to grow the community and develop value in the content. Word of mouth and content sharing are a big factor in the success or failure of a given creative endeavor.

Figure 7 shows the difference between content creation in Web 2.0 and Web 3.0. The numbers indicate the order of events. The box entitled Web 2.0 Creator dynamics explains the ordering for Content creation in Web 3.0, while the box entitled Web 3.0 Creator dynamics explains the XCAD model and how we see content creation in Web 3.0.

Web 2.0 Creator Dynamics

1. Creators publish content to platforms that have both public-facing and paywalled access points.
2. Users engage with the underlying platform on a freemium basis in order to access the content. Usually, the platform benefits from the exchange between users and creators.
3. If the users wish to access paywalled content, then the user has to go through the paywall before getting access to private, exclusive content.
4. The user may (possibly) tip or pay the creator directly if the platform is designed for this or through third-party means.
5. Finally, the platform may pay the creator for content that is successful by some metric.

The Web 3.0 model is different in the sense that users and creators can have a direct relationship with rewards that are tokenized and flow directly to all parties via smart contracts.

Web 3.0 Creator Dynamics

1. Creators publish content to platforms that have multiple access points for engagement and value exchange public (Watch-to-Earn) and tokenized, including NFTs, merchandise, and other content.
2. The public access content is measured for engagement by the user base. These metrics are passed to a rewards system that considers all the agents involved: consumer, creator, and platform.
3. Rewards are sent to the various parties in some ratio.
4. As the content gets popularized, more agents enter the space, and there is an early adopter versus later adopter premium.
5. Token holders use a token payment gate to access more desirable private content, and the value of the token is connected to this demand for access.
6. The current pool of token holders - early consumers, platform, and creator may sell off their token rewards in order to realize a fiat benefit or continue to hold them and create more value in terms of content.

The driver of value is engagement in the network by agents with different narratives: Fans have the narrative of Watch-to-Earn, while creators benefit from direct economic engagement through the token; the platform supports and defends the underlying infrastructure. This joint engagement drives the underlying network effects that are synonymous with Web 3.0; and inherently different from centralized platform-mediated economics that is the hallmark of Web 2.0.

9 Creator Payments Model

The basic primitive in the XCAD system is a viewing event where fans engage with the video content of a particular creator. Viewing events earn tokens for fans, and these tokens move via the plugin from a treasury-type contract into fans' personal wallets. As these tokens are released from the claims contract to the fan's personal wallets, an identical amount of tokens moves from the master treasury to the creator vesting contract system. For each content creator, there is a totally separate vesting contract system, and each creator's vesting contract system can only hold the tokens for that particular creator. With this in mind, we consider the design for a single content creator's setup only.

To begin with, we start with a treasury contract that contains an amount of $\Omega(t)$ tokens. The treasury contract is initialized with an amount $\Omega_0 = \Omega(0)$ tokens, and over time these tokens move from the treasury contract into circulation.

During a given interval, fans engage with content at some rate, and the creator's engaged viewership has a particular size. Let $N(t)$ be the size of the overall fan club for a particular creator, and suppose that this follows a logistic growth model. The fan club here is measured by the number of fans that have downloaded the XCAD plugin and are able to earn rewards. At any given point in time, fans earn tokens at an average rate of $\lambda(\cdot)$, and this average rate may vary based on different parameters, including the number of videos that they can engage with. With this in mind, let $v(t)$ be the number of videos that can be watched by an individual fan and let $r(t)$ be the per video reward rate. We set $\lambda = \lambda(r, v)$. Finally, let $\mu(t)$ be the fraction of fans that are engaged with a given creator at time t.

The overall rate $R(t)$ at which fans receive tokens from the system can be written as:

$$R(t) = \mu(t)\lambda(r, v)N(t). \tag{1}$$

The value of $R(t)$ is also the inflow rate for the system treasury and captures the movement of tokens into the vesting contract system. We suppose that at $t = 0$, the value $\mu(0) = 0$, and initially, no tokens flow into the vesting contract.

Let $V(t)$ be the balance of tokens in the vesting contract system. Initially, $V(0) = 0$ and tokens flow into the system via $R(t)$. Tokens move out based on either the current balance (milestone payments) or through a salary-like constant payment. Let $\theta(t)$ be the instantaneous fraction of the current balance that is paid to the creator's personal wallet, and suppose that $\kappa(t)$ is a constant drip-like salary payment. Putting these variables together, we can write the first order equation:

$$\frac{dV}{dt} = \mu(t)\lambda(r, v)N(t) - \theta(t)V(t) - \kappa(t). \tag{2}$$

Eq. (2) describes the general dynamics of the vesting contract system with four key parameters $\mu(t), \lambda(t), \theta(t)$ and $\kappa(t)$, as well as the auxiliary parameters r and v which relate to overall content production and valuation in terms of tokenized rewards. At equilibrium $dV/dt = 0$ and we have the equilibrium balance condition:

$$V(t) = \theta^{-1}(t)\left[\mu(t)\lambda(r, v)N(t) - \kappa(t)\right]. \tag{3}$$

At this level, inflows and outflows from the contract system will cancel each other out. The contract balance can be found by integration:

$$V(t) = \exp\left(-\int \theta(t)dt\right) \int \left[\mu(t)\lambda(r,v)N(t) - \kappa(t)\right] dt. \tag{4}$$

Finally, an additional variation that we will use as well is to add a global multiplier that increases the overall rate of the creator's earnings. In this case, let $\phi(t)$ be the global multiplier. We rewrite Eq. (4) as follows:

$$V(t) = \exp\left(-\int \phi(t)\theta(t)dt\right) \int \left[\mu(t)\lambda(r,v)N(t) - \phi(t)\kappa(t)\right] dt. \tag{5}$$

In the remainder of this section, we will explore the model presented in Eqs. (4) and (5) and discuss the detailed contract dynamics that (at the time of writing) are intended to be implemented in the XCAD system.

10 Proposed Vesting Contracts

Note. These contracts are still under development and subject to change.

10.1 Long and Short Term Reserves

The implemented contracts have more detail than the model that was used above. In particular, there were a number of considerations for early-stage content creators and slower adoption rates where, for example, the economy is generating fewer than 100,000 tokens per time period.

First off, the vesting contract system is split into two reserves that hold funds for different purposes. The total balance $V(t)$ at any given time still holds, but $V(t) = V_s(t) + V_l(t)$ where $V_s(t)$ is the balance in a short term reserve, and $V_l(t)$ is the balance in a long term reserve. Funds that flow into the contract are split based on the current values in the short and long-term reserves.

- If $V_s(t) \leq 10^5$ creator tokens, then 80% of incoming funds flow into the short-term reserve and 20% of incoming funds flow into the long-term reserve.

- If $V_S(t) \geq 10^5$ creator tokens, then 20% of incoming funds flow into the short-term reserve, and 80% of incoming funds flow into the long-term reserve.

This switching rule helps to regulate the balance of the short-term reserve at the very early stage of the creator's career. Once tokens have accumulated in the short-term reserve and the flow of tokens in the ecosystem is sufficient to support a balance of $V_s(t) \geq 10^5$ tokens, then the focus moves to the long-term reserve - and, in turn, toward long term incentives for creators.

10.2 Creator Payments

There are two basic approaches to creator payments in the design: The first is that creators are paid tokens on a consistent basis for their current level of fan engagement. So, for example, each month, if possible, a payment of a fixed amount of tokens is made. This amount is deducted from the short-term reserve. On the other hand, creators who consistently hit incentivized targets and milestones are rewarded percentage payouts from the long-term reserve.

Additionally, there are some caveats that govern the reserves. Tokens flow from the long-term reserve to the short-term reserve in order to keep a consistent short-term reserve balance. If a payment of 10,000 tokens is paid from the short-term reserve and there is sufficient balance in the long-term reserve to top up the short-term reserve, then a transfer from the long-term reserve to the short-term reserve will occur. This supports the vesting contract systems to first build up the short-term reserve to get over the minimum of 100,000 tokens.

A consequence of this top-up approach is that the long-term reserve in the early stages will take more time to build up in value, and so milestone payments will be more difficult to access. In some sense, creators will have to 'unlock' milestone payments by ensuring that there is first sufficient token flow generation to cover their basic payments.

The base payment algorithm works as follows: Given an initial base payment b. If the short-term reserve is able to pay the amount b, then it will attempt to do so. If the short-term reserve is unable to payout the amount b, then the amount will be reduced by a factor ν where $0 < \nu \leq 0.5$, and the reserve will attempt to pay νb. Eventually, an amount that can be paid will be found, and a new base payment rate will be established: After the short-term reserve is able to payout the amount $\nu^k b$, where k is determined by the number of iterations, the new base payout rate is set to $2\nu^k b$, for example.

10.3 Milestone Payments

Milestone payments act as longer-term incentives for creators. As content is released into the open and private access areas, creators themselves unlock achievements. This is to create an ongoing gearing mechanism for creators that follows the value drivers in the economy. Each milestone is based on *ad hoc* specifications that make sense from a business perspective for the platform, and these are out of the scope of the discussion here. However, in order to take milestones into account, we suppose that they are either in the form of a fixed payment that is deducted from the balance of the long-term vesting contract or in the form of a percentage payout from the longer-term vesting contract reserve. For these reasons, the key parameter for milestone payments is $\theta(t)$, but milestones can also affect the values for $\kappa(t)$ too - if they are preset token payout amounts.

10.4 Multipliers

An important factor in designing incentive mechanisms is that agents have skin in the game, and there is buy-in from the parties that are engaged. This can be done in a multitude of ways - usually involving some form of locked collateral, in some form or the other. With this in mind, part of the proposed design for the system is a multiplier that affects a creator's payout on the basis of locked XCAD tokens as collateral.

Suppose M is the maximum collateral that a creator can stake (in XCAD) in order to get their personalized token deployed and start building their private creator economy. If the creator stakes M tokens, then the creator gets a multiplier bonus - in terms of token payouts, say, for example, $\phi = 2$, and doubles their base earnings at any given time. If the creator only comes up with only, for example, $\frac{1}{2}M$. Then the earnings get a multiplicative factor $\phi = 1$. And, finally, if the creator has as a staked amount $\frac{1}{4}M$, then $\phi = 0.5$. The amount M will vary from creator to creator, but the key idea is that this ensures that the creator is (i) vested in the process by locking up collateral, as much as users lock up collateral to help launch the CLO and (ii) is risk aligned with the XCAD platform and, for example, could lose collateral if there is a need for the system stabilize the creator's token price during a dumping event. This protects the user base and the content creator by guaranteeing alignment between parties.

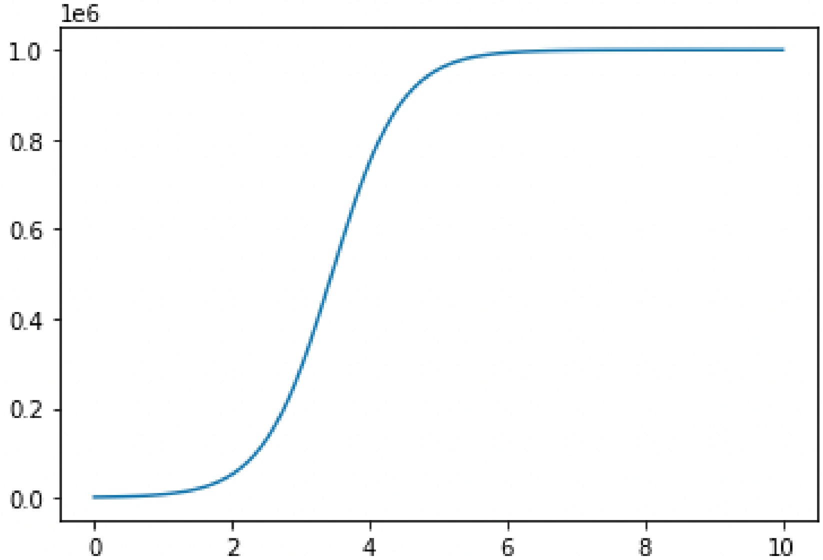

Figure 8: Fanbase Growth via a Logistic Equation Model. The population stabilizes at one million viewers as the audience size.

11 Vesting Contract Simulation

In order to simulate the vesting contracts, Eq. (5) was translated into Python code with simulations run over an interval of 10 years. The starting point was to suppose that a population of users $N(t)$ follows a logistic model [1]. This allows us to imagine the creator economy as a bootstrapped system that ultimately reaches a stable point - once the audience level saturates. For each audience member, there is an average token payout made per time interval, and the token payout then triggers rewards for both the platform and transfers into the vesting contract. The vesting contract system then slowly reallocates tokens to the content creator so that there is slow inflation. Figure fbg depicts the logistic growth model for a creator with around one million users. Notice that the fan base really starts to expand after the second year.

Figure 9. shows the rate at which the vesting contract fills up as the fan base grows. Eventually, this reaches an instantaneous rate of roughly 120,000 tokens per time step (day) - the red line. The green line is a creator drawn down from only one source and set at a constant rate. This, for example, could be for a creator that publishes a lot of content initially but then slows down and does not reach further milestones. Figure 5. Illustrates the idea of a salary-like payment that corresponds to weekly or monthly payments of a set amount. The economy is earning tokens at

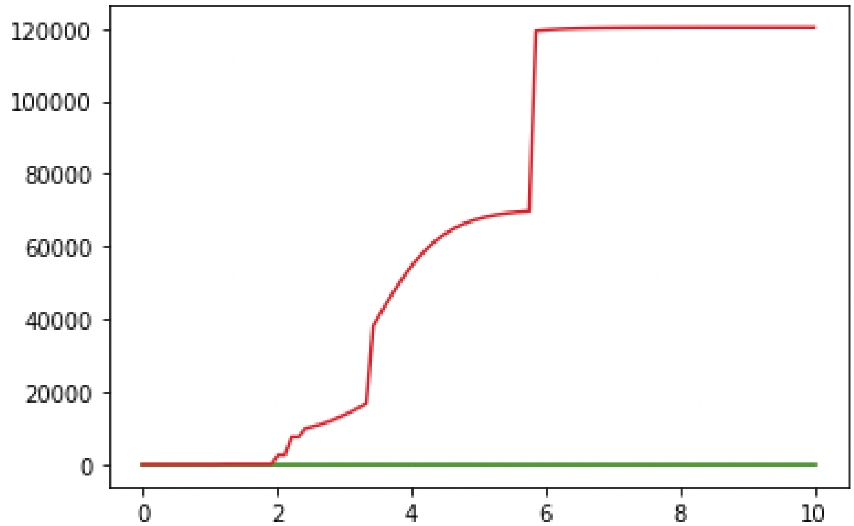

Figure 9: Vesting Contract Behaviour. The red line represents inflow and the green outflow from a simple continuous payment.

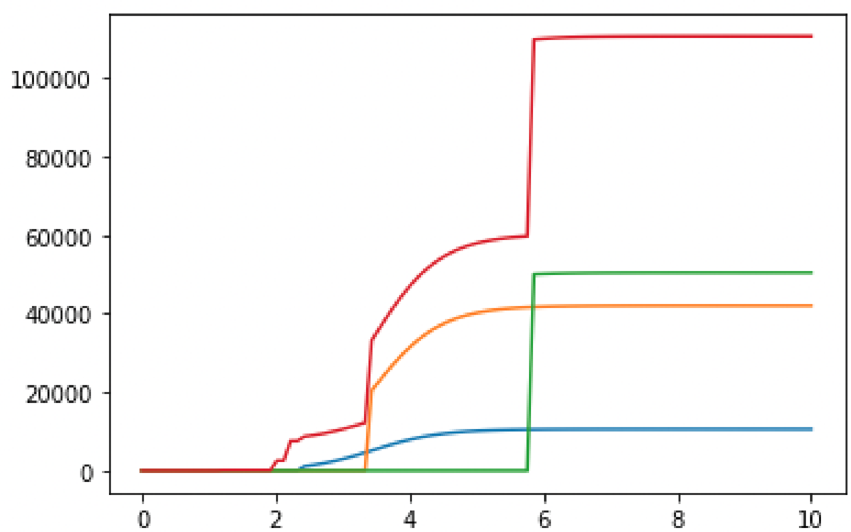

Figure 10: This figure shows multiple milestones being reached by the creator. The red line is the vesting contract balance, and the other lines represent payments based on fan base size and engagement, a continuous inflow-based payment (blue), and a large *ad hoc* bonus payment (green).

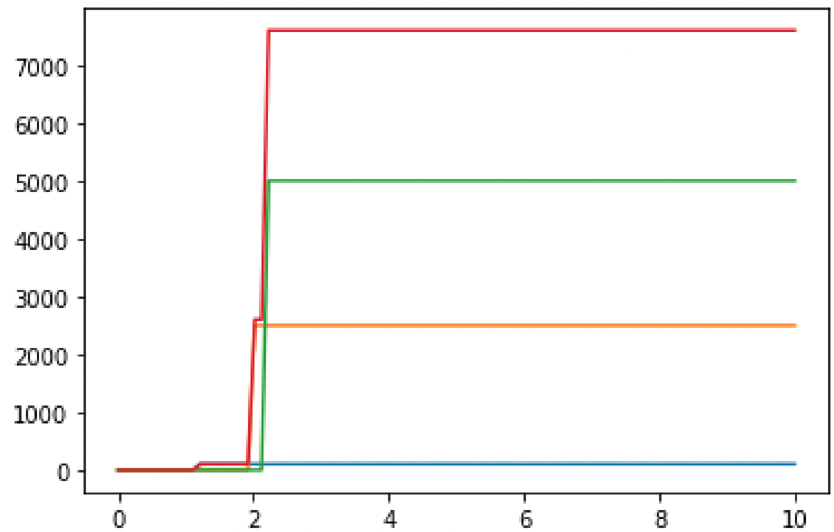

Figure 11: Salary Payments: A strategy to guarantee the creator consistent token income at a steady rate is to allow for a base salary style payment or multiple such payments that run in parallel once the early set of milestones has been cleared.

a rate of 120,000 per period in the later stages and only paying out around 7,000 tokens in this salary payment. The key driver for the creator in terms of earnings is to raise the value of the tokens they hold by producing more content to earn more tokens and hit further system-defined milestones.

12 Summary of Results

This report is a summary of the initial model and research that went into developing the XCAD network tokenomics. The underlying premise of XCAD is to democratize the engagement between creators, fans, and the platform. This involves building a multitude of systems that are designed to manage the engagement through an economy and in a decentralized way. This paper is intended for educational and informative purposes only, and the actual design and implementation of the system or systems, in reality, are subject to change as we continue to research and develop the conceptual framework for Web 3.0 content creation economics.

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