Token Classification Framework by Consideration of Origins of Value and Mechanisms of Manifestation Thereof

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1 Abstract

Modern tokens take various forms; since their implementations often differ profoundly, obtaining a classification of them is desirable. Many classification frameworks have been published; however, they are very broad in scope and do not recognize the primacy of demand-side considerations, which we postulate here, instead opting for consideration of all token properties, including origins of user-extracted value, on an equal footing.

This paper analyzes existing classification frameworks and presents a novel one, emphasizing the origins of token value and the mechanisms by which these origins are realized. The resulting value is available to ecosystem participants as an economic incentive for participation in the actions defined by the ecosystem and serving as the basis for token mechanism design (such as, for instance, participation in new block production); exploration of the sources and realisation pathways of said value is deemed by us to be of paramount importance for token design especially, and is a focus of this paper.

A hierarchical three-level model is constructed and populated by analyzing a broad set of tokens. Examples of token classification according to the proposed framework are provided.

2 Prior work: modern state of token classification

A good amount of token classifications have been proposed in the past five years, starting with Oliveira's influential paper [4]. All of them, however, aim for a general descriptivist approach, seeking to subdivide the tokens according to all the properties that characterise them, technical, supply-related, etc. However, few, if any, emphasise the demand side, which we opine deserves a primary role in consideration of any token, as it forms a bottleneck for token utilisation, supply being wholly under the token creator's control and therefore adjustable at leisure. Hereafter an overview of select classifications is presented, attention being focused on the demand-side aspects, in order to elucidate the background for this study.

2.1 To Token or not to Token: Tools for Understanding Blockchain Tokens. Oliveira, 2018

Oliveira's paper on token classification is certainly one of the more influential and in-depth ones [4]. In it, the authors propose a classification of tokens according to four parameter groups: Technical, Functional, Governance, and Purpose. Technical parameters have to do with pure technical aspects of the layer and chain a token is deployed on and are, as such, wholly out of scope for our considerations. Functional parameters have to do with technical properties of a token, such as fungibility and spendability thereof; Governance parameters have to do with token supply model and the incentive system a token implies for the platform it is on; finally, under Purpose parameters the authors collect properties relating a high-level purpose of the token. The full table proposed by Oliveira *et al* is given at figure 1.

<table>
<tr><td rowspan="3">Purpose Parameters</td><td>Class</td><td colspan="3">Coin / Cryptocurrency</td><td colspan="2">Utility Token</td><td colspan="3">Tokenised Security</td></tr>
<tr><td>Function</td><td colspan="3">Asset-Based Token</td><td colspan="2">Usage Token</td><td colspan="3">Work Token</td></tr>
<tr><td>Role</td><td>Right</td><td colspan="2">Value Exchange</td><td>Toll</td><td>Reward</td><td colspan="2">Currency</td><td>Earnings</td></tr>
<tr><td rowspan="3">Governance Parameters</td><td>Representation</td><td colspan="3">Digital</td><td colspan="2">Physical</td><td colspan="3">Legal</td></tr>
<tr><td>Supply</td><td colspan="2">Schedule-based</td><td colspan="2">Pre-mined, scheduled distribution</td><td colspan="2">Pre-mined, one-off distribution</td><td colspan="2">Discretionary</td></tr>
<tr><td>Incentive System</td><td colspan="2">Enter Platform</td><td colspan="2">Use Platform</td><td colspan="2">Stay Long-Term</td><td colspan="2">Leave Platform</td></tr>
<tr><td rowspan="5">Functional Parameters</td><td>Spendability</td><td colspan="4">Spendable</td><td colspan="4">Non-Spendable</td></tr>
<tr><td>Tradability</td><td colspan="4">Tradable</td><td colspan="4">Non-Tradable</td></tr>
<tr><td>Burnability</td><td colspan="4">Burnable</td><td colspan="4">Non-Burnable</td></tr>
<tr><td>Expirability</td><td colspan="4">Expirable</td><td colspan="4">Non-Expirable</td></tr>
<tr><td>Fungibility</td><td colspan="4">Fungible</td><td colspan="4">Non-Fungible</td></tr>
<tr><td rowspan="2">Technical Parameters</td><td>Layer</td><td colspan="3">Blockchain (Native)</td><td colspan="2">Protocol (Non-Native)</td><td colspan="3">Application (dApp)</td></tr>
<tr><td>Chain</td><td colspan="2">New Chain new Code</td><td colspan="2">New Chain, forked Code</td><td colspan="2">Forked Chain, forked Code</td><td colspan="2">Issued on top of a protocol</td></tr>
</table>

Figure 1: Classification proposed by Oliveira *et al* [4]

Of all the parameter groups, Purpose parameters come the closest to a demand-side classification; however, they come off as a bit inconsistent, being separated into three subgroups with different aspects. The authors argue that "a one-dimensional classification of purpose is difficult to achieve due to the several value propositions of cryptographic tokens, as well as due to the multi-purpose ability which most tokens tend to exhibit currently", which is their reason for this separation [4]. However, as we hope to show, one can create a framework within which the characteristic multi-purpose nature of tokens can be realised by combining atomic units of value-originating purpose. The Functional parameter group is excellent, and, indeed, we adopt it with some changes for our own consideration of token technical details; it must also be noted that this proposal makes a step towards a hierarchical classification, wherein, as in real design processes, functional and technical parameters are subordinated to the value-originating purpose of the token, by introducing token Archetypes; however, the Purpose parameters enter the Archetype description as just that - parameters, and the main purposes of these prototypical tokens are not codified anywhere, forming a set of their own. Regardless, one may consider this paper, which has influenced a good deal of subsequent work, to propose a hierarchical classification also, albeit in a rudimentary form.

2.2 The Token Classification Framework: A multi-dimensional tool for understanding and classifying crypto tokens. Euler, 2018

The classification proposed by Euler is also aiming to attain a general description of a token as a member of several classes, considering it in all dimensions, even legal not being excluded [1]. A classification table due to Euler is given at figure 2.

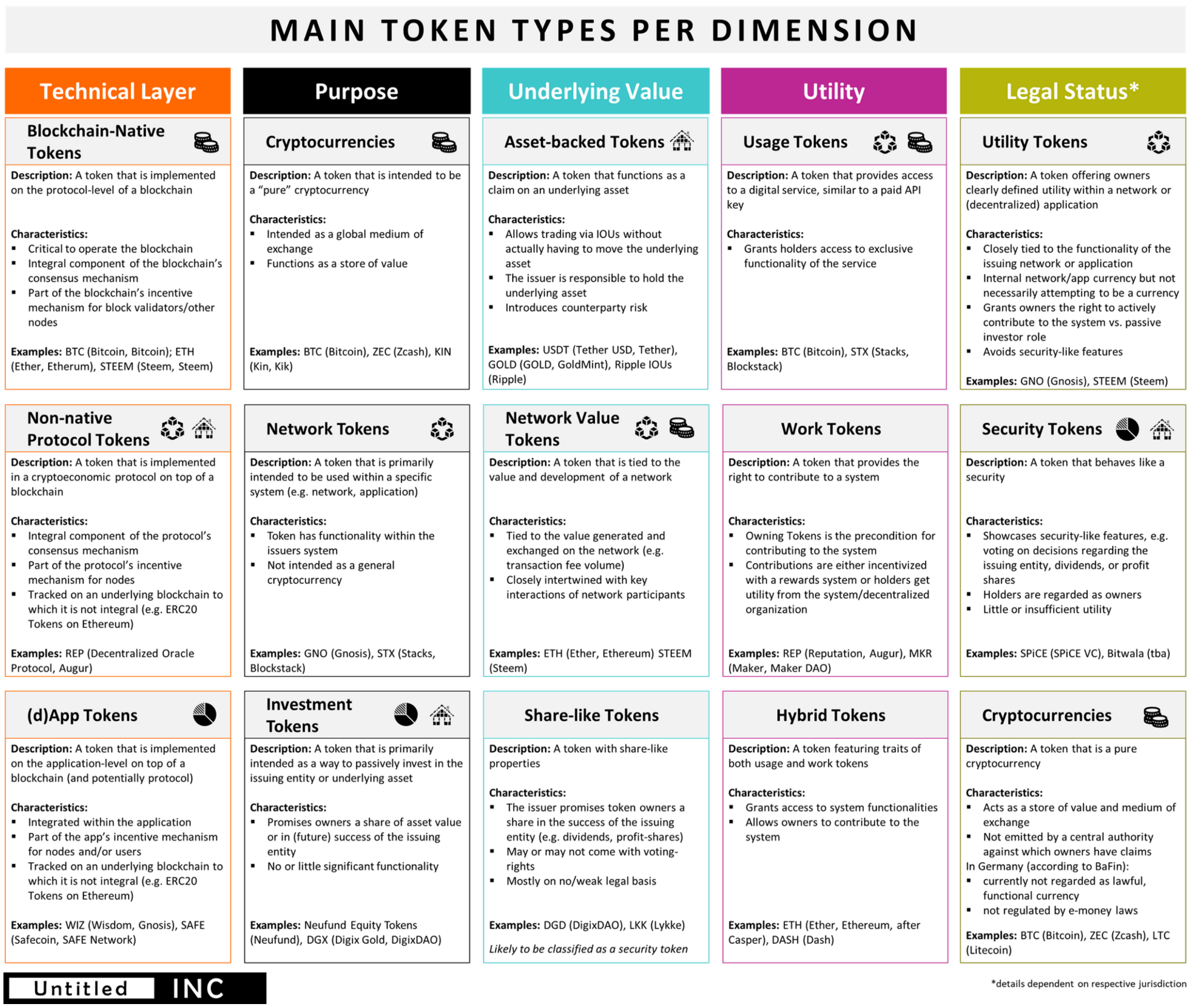

Figure 2: Classification proposed by Euler [1]

Much is shared with Oliveiri, who cited Euler and was influenced by his work. However, a separate focus on token value origin is also made, even if the results are lacking in depth. Here it can be seen that token value origin, however, is understood in a very narrow sense as monetary value, and while e.g., hedonic value Origin of Value (OoV), which we introduce later, can be argued to represent a network value token (as a token on some obscure network, however scarce, is hardly valuable by virtue of network obscurity: value is imparted onto hedonic value tokens by their recognition, which correlates perfectly with the network value), this designation is very general and not too helpful as a result. In addition, the OoVs are somewhat dispersed over other columns too (e.g., Euler's work token). Of the dimensions Euler recognized, only the Underlying Value and Utility have any relation to the demand side, and even then they can be argued to be much too general.

2.3 Cryptoasset Taxonomy Report. CryptoCompare, 2018

Another expansive work is the taxonomy report compiled by experts of CryptoCompare [3]. A good number of extant classifications is considered therein, but we expose purely the original contribution made. CryptoCompare's classification is again much broader in scope than just the supply side. Much like Oliveira, the authors separate archetypes, meant to encode particular common types of tokens, and certain "natural groupings" meant to represent general aspects thereof. Again in the vein of Oliveira *et al*, the archetypes occupy the top layer of the hierarchy, which is induced more strongly this time. Since we are most interested in demand-side classification, let us provide here the sole natural grouping recognized in the report that has to do with the demand side: that of a rationale to possess tokens, which unambiguously corresponds to the origin of value thereof, given here at figure 3.

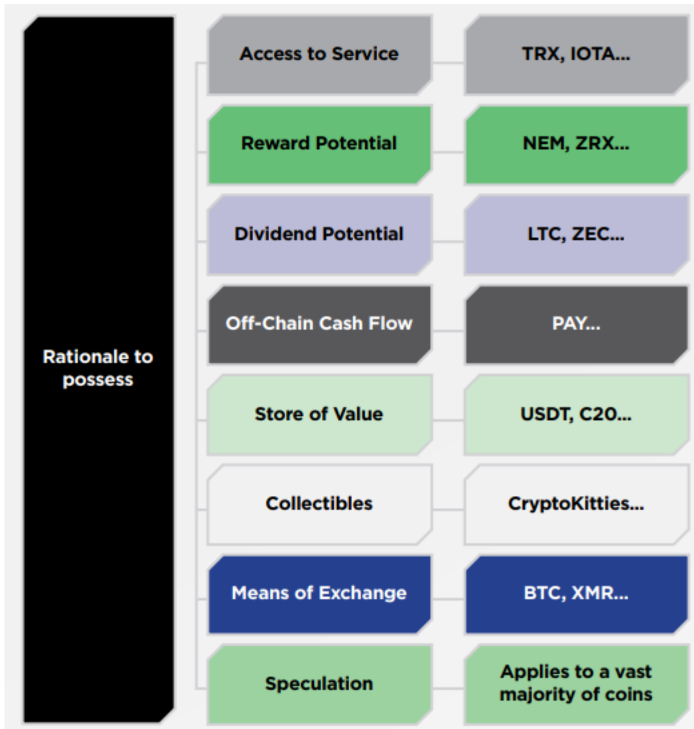

Figure 3: Classification proposed in the CryptoCompare report [3]

This classification is about as in-depth as Oliveira's, though it enjoys the additional property of recognizing the importance of the rationale to possess tokens, i.e, the origin of their value which imparts onto men the desire to obtain and use them. A more in-depth look will be provided in the comparison section where we cmpare our findings to prior art. It must be noted that, although a category of demand-side factors is recognized as worthy of distinction, there is little further development of the subordinate relations of technical details and said demand-side factors, even though the latter are naturally the bedrock of token design.

2.4 Tokenomics and blockchain tokens: A design-oriented morphological framework. Freni, 2022

The most recent work of the considered, Freni's classification system is built upon the preceding work, combining the systems proposed by other authors to obtain a general framework [2]. It is quite close in its content relating to the demand-side classification to Oliveira's and CryptoCompare's proposals; since we are only interested in the coverage of demand-side economics, we shall not reiterate what has been said of the two inspirations mentioned above. The entire classification, again broader than it is deep and this time lacking even the rudimentary hierarchy of Oliveira, is given at figure 4.

TECHNOLOGY				BEHAVIOR						COORDINATION			
Chain	**Permission**	**Number of Blockchains**	**Representation Type**	**Burnability**	**Expirability**	**Spendability**	**Fungibility**	**Divisibility**	**Tradability**	**Underlying Value**	**Supply Strategy**	**Incentive Enablers**	**Incentive Drivers**
New Chain, new code	Permissioned	Single Chain	Common	Burnable	Expirable	Spendable	Fungible	Fractional	Tradable	Asset-based	Schedule-based	Right to work	Get access (to content/service)
New Chain, forked code	Permissionless	Cross Chain	Unique	Non-Burnable	Non-Expirable	Non-Spendable	Non-Fungible	Whole	Non-Tradable	Network Value	Pre-mined scheduled distribution	Right to use	Get discount
Forked Chain, forked Code							Hybrid	Singleton	Delegable	Share-like	Pre-mined one-off distribution	Right to vote	Get revenue (increase existing business)
Issued on top of a protocol											Discretionary	Unit of account	Get reward (new economy creation)
											Matching demand	Medium of exchange	Dividend/Earning Potential (for holding or staking)
												Store of value	Appreciation potential (Speculation)
													Participate in governance
													Gain reputation

Figure 4: Classification proposed in the Freni *et al* paper [2]

We shall only be considering the incentive drivers and enablers, since they, in our opinion, are the best representations of the origins of a token's intrinsic value in the entire classification (Underlying Value, confusingly enough, is not that; rather, it describes the entity that drives the token's value and not the processes that underlie the token's ability to possess it.

2.5 Literarure review conclusion. Why should we care about origins of value?

A review of prior works readily shows that the modern classification thought is predominantly preoccupied with creation of broad classifications able to capture every facet of a token's characteristic property set. The hierarchical depth is quite low and usually not pronounced; sometimes it is non-existent, like in Euler's proposal, and sometimes it is seems rather ad-hoc, like in Oliveira's case. No special emphasis is placed on the demand-side factors, chiefly due to a desire of creation of an all-encompassing classification, and therefore the degree of distinction of this category varies, frequently failing to be atomic (as will be shown in the comparison section) and conflating origins of value and mechanisms by which these origins do yield value.

But why should we place special care at all on the demand side? We opine that it is a natural thing to do, considering the life cycle of a given token: unlike traditional currencies, it is fashioned and has attributes chosen for a specific purpose, with a set of goals to achieve. Since purpose is primary, and the attributes are chosen so as to be further it, it stands to reason that a hierarchical classification, where technicalities are subordinated to a token's purpose, quite like in Oliveira's archetype table, would be well-suited, at the very least for design of new tokens. But how is the purpose of a token encapsulated? Naturally, it is quantified in terms of its value to the holders: the very foundations of a token are inextricably linked with origins of its value, which need not be monetary only.

For this reason, we propose a classification based primarily on recognizing separate origins from which a token's value is derived. It is additionally hierarchical, with mechanisms that capture value - that is, general behavioural patterns that allow for the value of a token to be manifested and harnessed - subordinated to origins of value, and all technical particularities subordinated to the value-capturing mechanisms (also VCMs). In addition, since the atomicity of highest-level classes is an important factor in our considerations, the classification framework is also made modular, conferring to the user an ability to easily form his own VCMs or implementation patterns based on the Origins of Value (also OoVs), should a need arise.

It must be noted that the existence of Origins of Value themselves is conditioned on existence of some kind of *coordination value* in the network; by this term we denote the general value arising from the coordination of agent behaviour within the network, for instance, from engagement in Ethereum block production. Therefore, it is posited that the root of all value lies in promotion of some desirable agent behaviour, and Origins of Value are the principal pathways along which this promotion is carried out.

3 General points of consideration

3.1 On demand-side classification principles

Creation of a demand-side classification requires understanding of the origins of demand, that is, value that is yielded to users interacting with a token and compels them to seek out this interaction. Indubitably, therefrom a natural classification based on different answers to this question arises, repeated in many prior works under different names. However, all such classifications elucidate the role the token plays, and therefore the way whereby value is granted to the user, and not the origin of this value. We believe that a superior approach would be to depart from the predominant two-tiered classifications towards a three-tiered one, wherein the origins of value are separated from the mechanisms of activation thereof. For instance, such a model allows to ensure that no intersection between the origins of value occurs, that the common term is defined unambiguously, and that the reason for the token's existence is made plain. To that end, the proposed three-tiered classification takes the form of:

1. Origins of Value
2. Value Capturing Mechanisms

3. Patterns of Implementation

This classification is arrayed in order of diminishing abstractness and increasing atomisation; while the Origins of Value represent the most general sources that explain the possession of value by a token and are chosen so as not to intersect, Value-Capturing Mechanisms are, in essence, sets of possibly multiple Origins of Value whose value can be extracted via a specific behavioural pattern. Patterns of Implementation are even more specific, and only at this stage particularities of technical implementation appear. We opine that this structure of decreasing abstractness has the additional benefit of allowing a clearer view of the similarity between tokens with respect to their ways of generating value, even if details of implementation differ greatly. Finally, along with the listed descriptivist benefits, such a classification is a natural constructivist one; since token design is a hierarchical affair, and details of implementation are necessarily subordinated to the principal idea, at the core of which are one or several origins of value; the latter are naturally emergent as the first considerations at token design since they form the very basis for a new token's existence.

3.2 On Value

We have already considered value of a token and origins and activation pathways thereof as the principal way of classification in the proposed system. However, it is yet rather nebulous: what is value and its components?

An attractive option, which, coincidentally, bridges our theory with a rather popular game-theoretic approach to tokenomics, is to cast a token's value in terms of a formal optimisation problem; this is natural in the framework of rational economic agents. We propose the following form for it:

$$U = Q(p, x, s, t) - L(p, x, s, t)$$

Where Q represents the general utility of holding x tokens at price p, given the blockchain state s and the holding time t (where, it must be said, it is the time of specifically holding the token in its value-activation form). L, in turn, represents the general risk or general expense associated with the same. If U is negative, then the token is not worth holding and is, consequently, not held if all economic actors act optimally; if U is positive, however; then the token is held readily and appreciates. We disregard speculative value for reasons of it being non-specific and extrinsic; it is born purely out of suboptimality of market evaluations of tokens, and we, as shall be stated further, assume the induced optimisation problem solved at all times.

It becomes possible to cast the price and token distribution at any point in time as formal solutions to the following optimisation problem:

$$p^*, x^* = \arg\max_{p,x} U$$

Although this problem seems simple in form, the target function has a very much indeterminate form and is, as a rule, neither convex nor simple; for this reason, optimisation is purely formal and is assumed to be carried out by the market itself.

3.3 Classification overview

On the highest level, the tokens can be subdivided by their origins of value, which are defined as any broad phenomena that affect either the general utility, the general cost, or both. A hierarchical three-stage model can then be assembled, whereby origins of value are singled out, from the set of origins of value certain subsets that are in common use are composed (these subsets are termed value capturing mechanisms), and sets of value capturing mechanisms together with coding patterns implementing them form the tokens proper. In other words, value-capturing mechanisms (hence VCMs) are elements of the power set of the value origin set, and tokens are elements of the direct product of the power sets of the VCM set and the implementation pattern set.

4 Origins of Value

4.1 Origins of Value and origins of Loss

One can immediately notice that the general value function U that reflects the estimated value of a given token is decomposed in our theory into a purely nonnegative Value term and a purely nonpositive Loss term. To this end, we can also separate the Origins of Value, since they are atomic, into those that add to the Value term and those that add to the Loss term; we thereby introduce also origins of Loss, although we do not use this term further, labelling everything as Origins of Value.

It must be noted that Origins of Loss should not be understood as pure sinks of value that beget loss only; their pure loss-generation nature is from the holder's perspective only, since the holder is thereby exposed to additional risk or obligated to undertake action imposing expenditure of time and resources. However, the underlying system, in fact, is liable to derive value from it (e.g., decreasing the possible loss due to user misbehaviour and the resulting disruptions).

4.2 Summary

A summary of Origins of Value is given in Table 1.

Table 1. Summary of Origins of Value

Number	Origin of Value	Description
1	Value Transfer	Value is gained based on the involvement in transactions(settlements)
2	Future Cashflow	Future income stream exposed by the token, related to the use of the token in the protocol
3	Governance	Value begotten by exertion of influence on the management/distribution of limited resources
4	Access	Value begotten by purely granting access to a resource, but not compounding it with any additional utility
5	Representation	Value is extrinsically sourced and comes from representing a unit of some other asset
6	Hedonic Value	The value is begotten by social contract, e.g., as a result of popularity or other context not captured by the regular economic models
7	Risk Exposure	Generalised loss (in the probabilistic sense) corresponding to deliberate exposure to certain risks (of alienation or depreciation) acting as a necessary condition for activation of other origins of value
8	Conditional Action	Generalised loss corresponding to a need to carry out certain specific actions so that value is begotten (e.g., perform work)

4.3 Value transfer/Medium of Exchange

This origin of value represents the inherent value gained by the ability to be involved in transactions as a medium for the value of other assets; in other words, this origin of value corresponds to value begotten by the property of liquidity by definition thereof. It is a pure Value origin, having no Loss contribution, and its Value is a function of the blockchain state, holding amount, and price; it is not dependent on the holding time because the latter has no direct bearing on the principal function of the token with this OoV.

Although any value-holding token, in principle, can act as a medium of exchange by means of holding value, this origin encapsulates the tokens that gain value because of their *liquidity*: an illiquid value-holding token, while still formally possesing this origin, manifests it very faintly, and in such cases we prefer not to specify it. Rather, in line with our general desire to provide a framework amenable for design purposes especially, we emphasise this origin only for tokens where such a role enters the core functionality.

It must be noted that, although the wording of this origin implies that the value is begotten by token circulation only, tokens possessing this origin may assume the additional role of a Store of Value at a sufficiently long horizon, provided that the total supply is capped by algorithmic restriction of emission. This happens in cases when the token, bounded in both supply and emission, experiences a growth or at least preservation of demand. In other words, Store of Value can be considered as a special case of Medium of Exchange, when the total supply is bounded, and the demand is inelastic.

Furthermore, native tokens of various blockchains manifest another special property: they are used in transactions begotten by gas auctions, and as such play an additional role of controlling the allocation of space in any given block.

4.4 Future cashflow

This origin of value represents value stemming from a token's ability to unlock a certain income stream: where the Representation OoV grants value to a token because it stands for a given amount of extrinsically valuable goods, this OoV grants value to a token because it stands for a right to continuously receive an amount of extrinsically valuable goods in the future. As such, this OoV has no Loss contribution, and its Value contribution is dependent on the amount of tokens held, the state of the blockchain, and, in general, also the time of holding the token in its active form.

4.5 Governance

This origin of value represents value stemming from a right to influence distribution of finite resources that a token imparts. Such resources can be extremely general, from actual tokens to something intangible like an abstract governance decision. As such, it is another pure Value origin, whose Value is dependent on the amount of tokens held, the blockchain state, and the time of holding the tokens in their active form.

4.6 Access

This OoV encapsulates token value begotten by their granting access to a certain resource, in its barest form granting this access by virtue of simply being held. An example would be a token granting access to a private community resource. The only variable on which Value of such a token depends is the quantity held: it must exceed a certain threshold. In other words, the Value exhibits discontinuous behaviour best modeled by a Heaviside step function: it is zero when the amount of tokens is less than the threshold value and nonzero (but constant) otherwise.

4.7 Representation

This OoV encapsulates the value imparted to a token by an extrinsically valuable asset that is used to back the token; in essence, this OoV stems purely from the value of some extrinsically valuable asset, which the token is set to represent. As such, only the number of tokens held influences the Value of such a token to a holder.

4.8 Hedonic value

This OoV represents the value begotten by a pure social agreement; it represents the entire range between a holder's reputation's value (as is the case for personal NFTs) and the value of possessing a unique object that is agreed upon to be desirable (as is the case with famous NFT collections). This is the last pure Value origin, and its value is dependent on the number of tokens held and in general also the state of the blockchain.

4.9 Risk exposure

Normally possession of tokens by any party is quite secure, with only the price being set extrinsically. This origin of value corresponds to the token's function of being exposable to risk of alienation or uncontrollable (in the sense that the user temporarily relinquishes his ability to amortise it) depreciation as a necessary condition for activating of some other Origins of Value. While this may seem counterintuitive and does not indeed provide value to the token holder by itself, risk of alienation of tokens is an important economic regulator of behavior, since by imposing the demand for tokens to be exposed to such a risk, the gain from potential adversarial behaviour is correspondingly lessened by the total value of the tokens exposed. As such, this is a pure Loss OoV commonly seen in work protocols; loss thus begotten depends on all four variables we outlined.

4.10 Conditional action

This OoV represents loss incurred by other origins of the token value being conditioned on some action unrelated to the token itself (in which it differs from Risk exposure, which explicitly encapsulates probabilistic loss associated with actions upon tokens proper), such as participation in a given protocol or completion of certain tasks. The Loss term of this origin also depends on all four variables, though the actual form will vary greatly depending on the structure of conditionality.

4.11 Decomposition view

Labelling the outlined Origins of Value by ordinal numbers, we can decompose the general value function additively (δ_i is an indicator function, taking the value of unity or zero, depending on the presence of a given OoV):

$$U = Q - L = \Sigma \delta_i Q_i - \Sigma \delta_i L_i$$

5 OoV dependence on generalised coordinates

We summarise the dependence of Origins of Value on the generalised coordinates of p, x, s, t in Table 2.

Table 2. Dependence of Origins of Value on generalised coordinates

OoV	p	x	s	t
Value Transfer	+	+	+	-
Future Cashflow	-	+	+	+
Governance	-	+	+	+
Access	-	+	-	-
Representation	-	+	-	-
Hedonic Value	-	+	-	-
Risk Exposure	+	+	+	+
Conditional Action	+	+	+	+

6 Value Capturing Mechanisms

A Value Capturing Mecahnsism, as stated earlier, is a member of the power set of Origins of Value; it has to do with the pathway along which value begotten by a number of interacting Origins manifests. Therefore, whilst Origins of Value define where the value comes from, the VCM defines how this value is manifested. They can be said to define a token's behaviour. Though they are less atomic than OoVs, each still represents one function of a token, and thereby a single token need not possess one VCM only. Hereafter we list the most frequently employed VCMs.

6.1 Number of Value Capturing Mechanisms

Since each VCM is a member of OoV power set, there are (excluding the trivial member) $2^8 - 1 = 255$ possible distinct Value Capturing Mechanisms. We outline here only those that have been observed in our case study and can therefore be considered the most widespread ones.

6.2 Graphical representation of the Value Capturing Mechanisms

Since all VCMs arise from interactions within a set of OoVs, and OoVs of different sets do not interact (since then we can merge the sets to obtain a new VCM), we can graphically represent all VCMs as connected components of a graph; the nodes of this graph are OoVs (mind that one OoV can enter more than one component), and the edges represent interaction between said OoVs. This enables us to represent VCMs in a manner that is conducive to understanding and makes evident the interactions between OoVs that give rise to certain VCMs. We treat this representation at length in section 9.

6.3 Value transfer

OoVs: Value Transfer.

This VCM is very simple and derives the value of a token based on its unique involvement in the settlements that occur in a system. This VCM is intrinsic to native tokens of any chain, which act as a value transfer unit for network fee payments from network users to validators (network consensus participants).

6.4 Work token

OoVs: Future Cashflow; Risk Exposure; Conditional Action

A token with this VCM is staked into the protocol or otherwise exposed to slashing, after which tasks (necessary to perform network services) must be completed. Successfully completed tasks are rewarded. This reward can be thought of as the future cash flow for a token stake.

This VCM consists of three OoVs, one of which interacts with two others: the protocol participant must stake the token (thereby exposing it to risk of alienation) in order to participate, but must also participate (i.e., perform some action upon which the reward is contingent) in order to be rewarded.

6.5 Consensus token

OoVs: Future Cashflow; Risk Exposure; Conditional Action

This can be seen as a subset of Work token for a special nature of job (proposing and attesting to new blocks) and its consumer (largely unspecified, at least the entire set of chain users, but can be argued to include also the potential chain users; quite close to a public good, in fact). In addition, the natures of job owner and payment are also special: the chain itself acts as a job owner, as the job is set up by design in the initial chain logic; payment is likewise disbursed by the chain itself via a dedicated payment algorithm, which may include dedicated emission and fee collection.

6.6 Dividends token

OoVs: Future Cashflow

Unlike a Work token, a Dividends token requires no work to be performed and does not have to be exposed to risk of alienation to generate yield.

6.7 Representation token

OoVs: Representation

This VCM imparts value to a token by way of it serving as a (wrapped) representation of any other good, be it another token (stETH represents ETH in a validator's possession) or an off-chain good (USDT can be argued to represent USD).

6.8 Discount token

OoVs: Future Cashflow, Conditional Action

This VCM imparts value to a token through its ability to grant access to receive a limited amount of discounts on purchases from the company, DAO, or any type of blockchain-powered network [6]. The rebate itself can be argued to represent a form of future cash flow (since receiving a rebate is equivalent to paying full price and then being partially refunded).

6.9 Generalised governance token

OoVs: Governance, Conditional Action

This VCM gives value to a token by granting the ability to influence decisions of a DAO or protocol related to the allocation of limited resources (both monetary and non-monetary). One of the most common examples of managing limited resources is the allocation of incentives for issuing tokens to various pools or DAO treasury management.

6.10 Meta-token

OoVs: Representation, indirectly any

Can be seen as a generalisation of a Representation token which can wrap any number of tokens of any kind and compose them with arbitrary additional functionality. One example is a token of an index which combines different yield-bearing options; such a token effectively wraps tokens of all the underlying options (in some proportion corresponding to the proportions thereof held by the index) and composes them with the functionality of granting access to dividends from this index. Another example could be CVX, which can be understood to represent ownership in a large stake of CRV and compose this with the functionality of permitting voting on the distribution of Convex's share of veCRV voting power, effectively making indirect voting possible.

6.11 Hedonic value

OoVs: Hedonic value

This VCM adds value to a digital asset based on social agreement, context, or community opinion.

The Hedonic value tokens are often non-fungible, albeit they can be nominally fungible as well (e.g., Bitcoin from early wallets likely belonging to Satoshi, or, as a non-crypto example from computer science, Knuth dollars). To formalise the imperfect fungibility of such tokens stemming from additional value imparted onto them by social contract, we can use the definition due to Shorish *et al* [5]: the set of all BTC tokens is imperfectly fungible in that tokens (presumably) sent by Satoshi attain higher value when the sender is taken into account; this additional value is begotten by social contract only and is therefore purely hedonic.

6.12 Access token

OoVs: Access

This VCM imparts value to a token purely by means of granting access to some service or information outlet.

6.13 VCM summary

The widespread VCMs considered here together with OoVs exposed by them can be pictorially represented, as they are on figure 5.

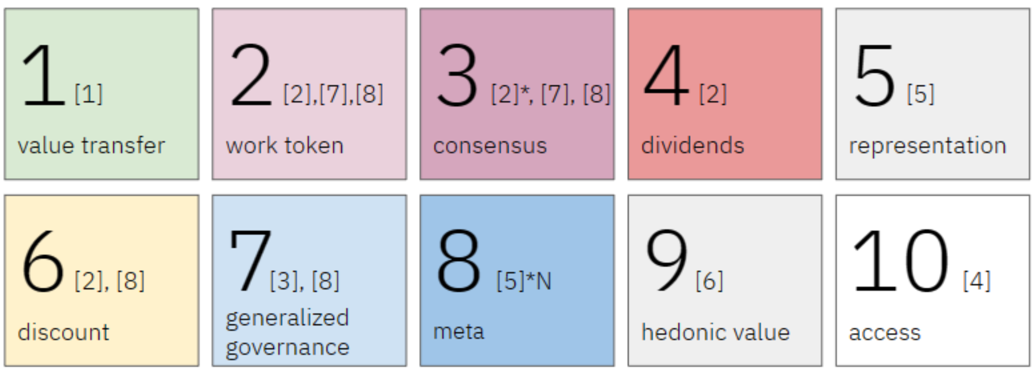

Figure 5: Pictorial representation of value-capturing mechanisms. Smaller numbers in brackets correspond to OoV numbering in Table 1

7 Comparison with classes distinguished in prior work

Having now outlined our OoV-VCM model, we can see how it compares with the demand-side classifications of the works we reviewed.

7.1 To Token or not to Token: Tools for Understanding Blockchain Tokens. Oliveira, 2018

We consider one by one the different purpose parameter groups. Firstly, consider the Function group.

1. Usage token corresponds to access OoV

2. Work token corresponds to a mixture of future cashflow, conditional action, and risk exposure (being a token that has a two-part cashflow activation mechanism: staking and working). It corresponds exactly to our definition of work token VCM.

3. Asset-backed token corresponds to the representation OoV

Now consider the Role group

1. "Right", i.e., right-granting tokens, span a wide selection of OoVs from access to future cashflow to even hedonic value (as a hedonic value token can certainly act as a membership proof). Governance, future cashflow, risk exposure (since it is done in order to attain some ability), conditional action, access, and hedonic value all can be cast as a right-granting token in particular implementations thereof.

2. Value exchange tokens are a clear counterpart of medium of exchange tokens

3. Toll tokens, that is, tokens used for platform usage payment, are not well represented by access tokens, since access tokens need to merely be held. We opine that the closest analogue in our model is conditional action, since while risk exposure entails exposing tokens to risks of alienation, toll tokens have alienation as a value activation condition. Alternatively, one can slot toll tokens under access OoV, since alienation is merely a mechanism that activates value, and it doesn't generate any value per se.

4. Function tokens are an umbrella designation under which a lot of our OoVs can be slotted: governance, risk exposure, conditional action, etc.

5. Currency tokens correspond to the exchange medium OoV

6. Earnings tokens correspond to the future cashflow OoV

Additionally, we can treat Oliveira's archetypes as corresponding to our VCMs. The archetype table is given at figure 6.

Archetype	Main Purposes	Description
Crypto-Currency	Currency	A token with the ambition to become a widespread digital form of currency. *(Cryptocurrency ; Asset-/Usage-/Work-Based ; Currency ; Digital ; Schedule-based / one-time fixed / discretionary ; Use Platform / Stay Long-Term ; Spendable ; Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; Fungible ; Blockchain Native ; New Chain New Code / New Chain Forked Code)*
Equity Token	Earnings, Store of Wealth	A token which confers to its holder a right to equity-related earnings, such as profit-sharing, application rents or platform fees. *(Tokenised Security ; Asset-/Usage-Based ; Toll / Earnings ; Physical/Digital/Legal ; Schedule-based / one-time fixed / discretionary ; Enter Platform / Use Platform / Stay Long-Term ; Non-Spendable ; (Non-)/Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; (Non-)/Fungible ; Blockchain Native / Protocol / dApp ; New/Forked Code , New / Forked Chain / on top of Protocol)*
Funding Token	Store of Wealth, Funding	A token which is perceived as a long-term investment from the holder's perspective, and as a financing vehicle for the project's team and/or the community (bounties). *(Tokenised Security / Utility Token ; Usage-/Work-Based ; Right / Value Exchange / Toll ; Physical/Digital ; Schedule-based / one-time fixed / discretionary ; Enter Platform / Use Platform / Stay Long-Term / Leave Platform ; (Non-)/Spendable ; Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; (Non-)/Fungible ; Blockchain Native / Protocol / dApp ; New/Forked Code , New / Forked Chain / on top of Protocol)*
Consensus Token	Validation Reward, Store-of-Wealth	A token which is used as a reward to nodes which ensure data validation and consensus. *(Utility Token ; Work-Based ; Right / Reward ; Digital ; Schedule-based / one-time fixed ; Enter Platform / Use Platform / Stay Long-Term / Leave Platform ; (Non-)/Spendable ; Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; (Non-)/Fungible ; Blockchain Native / Protocol ; New/Forked Code , New / Forked Chain)*
Work Token	Work Reward	A token which is used as reward to users who complete certain actions or exhibit certain behaviour. *(Utility Token ; Work-Based ; Right / Reward ; Digital ; Schedule-based / one-time fixed ; Enter Platform / Use Platform / Stay Long-Term / Leave Platform ; (Non-)/Spendable ; Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; (Non-)/Fungible ; Blockchain Native / Protocol / dApp ; New/Forked Code , New / Forked Chain / on top of protocol)*
Voting Token	Voting Right	A token which confers a voting right to its holder. *(Utility Token ; Asset-/Usage-Based ; Right ; Physical / Digital ; Schedule-based / one-time fixed / Discretionary ; Use Platform / Stay Long-Term ; Non-Spendable ; (Non-)/Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; (Non-)/Fungible ; Blockchain Native / Protocol / dApp ; New/Forked Code , New / Forked Chain / on top of protocol)*
Asset Token	Voting Right, Asset Ownership	A token which represents asset ownership. *(Utility Token / Tokenised Security ; Asset-Based ; Right / Toll ; Physical / Digital / Legal ; one-time fixed / Discretionary ; Enter Platform / Use Platform / Stay Long-Term ; Spendable ; (Non-)/Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; (Non-)/Fungible ; Blockchain Native / Protocol / dApp ; New/Forked Code , New / Forked Chain / on top of protocol)*
Payment Token	Payment	A token which is used as internal payment method in the application. *(Utility Token ; Usage-Based ; Right / Value Exchange; Digital ; schedule-based / one-time fixed; Enter Platform / Use Platform / Stay Long-Term ; Spendable ; Tradable ; (Non-)/Destroyable ; (Non-)/Expirable ; Fungible ; Blockchain Native / Protocol / dApp ; New/Forked Code , New / Forked Chain / on top of protocol)*

Figure 6: Archetypes due to Oliveira *et al* [4]

The correspondences are as follows:

1. Cryptocurrency corresponds to the value transfer VCM
2. Equity token corresponds to the dividends VCM
3. Funding token also corresponds to the dividends VCM
4. Consensus token corresponds to the consensus token VCM
5. Work token corresponds to the work token VCM
6. Voting token corresponds to the generalised governance VCM
7. Asset token corresponds to backing VCM
8. Payment token is best compared with, we opine, either a discount token VCM or, more generally, treated as an example of a meta VCM, whereby any custom app functionality can be enabled

7.2 Cryptoasset Taxonomy Report. CryptoCompare, 2018

The rationales to possess, decoupled from value origins themselves in CC report, nevertheless correspond to a good deal of what we selected as OoVs, lacking only governance (classification of it is explicitly deferred, citing general immaturity of the voting mechanisms that makes it hard to rule whether to consider governance purely a collective investment scheme (i.e., future cashflow) or not) and atomisation of the origins. Let us consider their OoV counterparts in our classification.

1. Access to service, defined as "Ownership of the cryptoasset provides access to a network to pay for decentralised storage or, perhaps, decentralised computing power", falls under conditional action, since the access OoV does not entail alienation of the token by our definition (being purely passive). Since tokens like ETH fall under Access to service (understandably so, since they are required to pay for gas), it may be sensible to cast this as an instance of medium of exchange too, since if a token is held to pay in a protocol, its value is conditioned on the ability to carry out this payment transaction.
2. Reward token, defined as "Ownership of the cryptoasset gives the right to a reward or the right to do some work for a reward by virtue of ownership", corresponds to a mixture of risk exposure and future cashflow, since staking is elaborated to fall under this designation; unlike in our system, no attempt is made to separate the cashflow side, which is shared with e.g., a dividend token, and the risks stemming from staking. It is, therefore, best suited to be cast as a value capture mechanism and not an OoV, as it is not atomic.
3. Dividend token, defined as "Ownership of the cryptoasset is required in order to benefit from the generation event of new cryptoassets", falls under future cashflow, being its most natural realisation.

4. Rights to off-chain cash flow also fall under future cashflow.
5. Store of value, defined as "Ownership of the cryptoasset represents a store of value relative to other assets", is a representation subcase.
6. Collectibles, defined as "Ownership of the cryptoasset is deemed to have value in its own right.", with a further elaboration that they "offer signalling akin to that of a status symbol", are clearly corresponding to hedonic value
7. Means of exchange, defined as "Ownership of the cryptoasset is for generic payment purposes.", corresponds to the exchange medium OoV
8. Speculation, defined as "Ownership of the cryptoasset is purely for the purpose of speculation.", corresponds to no origin of value in particular. Indeed, it can be argued as value not inherent to a token (and therefore out of purview of our classification) and instead purely conditioned on the market the token is in circulation on, for which reason it is of scant interest to us. Indeed, even the authors are hesitant to include it in their deep dive, recognizing that such a reason to possess a token is applicable to any token whatsoever.

7.3 Tokenomics and blockchain tokens: A design-oriented morphological framework. Freni, 2022

Though sharing a lot with other classifications by virtue of drawing from them heavily, Freni's framework possesses some distinct categories, like a voting token (recall: CryptoCompare judged governance mechanisms too immature to warrant a category of their own). origins of value/VCMs are encapsulated as incentive drivers/enablers (defined respectively as traits that promote desirable behaviour and traits that are needed for it to happen). Enablers are quite close to origins of value, though woefully incomplete:

1. Store of value corresponds to representation
2. Medium of Exchange corresponds to our eponymous OoV
3. Unit of exchange ("tokens can measure the value of something (e.g., services, assets, labor, liabilities), fulfilling the same corresponding function of money.") corresponds to representation again
4. Right to vote corresponds to governance
5. Rights to work and use are conditional action and future cashflow combined

, Incentive drivers are closer to VCMs; although "get access" seems like an access token, the paper specifies that the token needs to be used somehow for access to be provided (e.g., spent), which makes it a specific VCM of conditional action. Other drivers' counterparts are easily inferred by their names.

8 Creation and combination of value capturing mechanisms

As we have stated already, a token may manifest value via more than one value capturing mechanism. The question then arises: since the ten value-capturing mechanisms we described above form an obviously non-exhaustive list, what are the conditions for designation of new VCMs in token analysis or design? We opine that two cases are possible: in the first case, there is no extant VCM that captures the interacting origins of value of a token (for example, access to a resource by virtue of holding a token is conditioned on some on-chain action); it is not sufficient to merely cover all found or desired OoVs by a collection of VCMs: the OoV interactions must be preserved, since encapsulation of OoV interactions is the precise reason for separation of a VCM layer and its population by elements of the OoV power set. In the second case, an extant VCM exists, but the token under consideration has a sufficiently modified form of at least one OoV so that usage of the extant designation is made inconvenient. This measure is for convenience's sake only; for instance, a yield-bearing token that requires staking and some miscellaneous interaction to generate said yield would, under our VCM model, fit under a Work token. While technically correct from the classification standpoint, this designation would understandably disturb many users, for which reason in such a case it would be permissible to separate a distinct subtype of the Work token, wherein the Risk Exposure OoV takes a price-related form, that is, the risk is confined to potential token depreciation and not its alienation.

In short, it is recommended to create new VCMs when it is impossible to accurately represent the totality of OoV interaction for a token as a combination of extant VCMs; it is permissible to create VCM subtypes when a particularity of value capture requires emphasis; in all other cases, one ought to instead represent the token's mechanism as a combination of extant VCMs.

9 A method of accounting for OoVs at classification or design of tokens

Though both procedures are still essentially dependent on judgment of a human expert, we propose a procedure that furnishes a good visual aid and assists in selection of appropriate VCMs.

Firstly, the origins of value are to be identified. We can scarcely offer a general algorithm to adhere to at this step; this is a pure work of judgment and comparison to known other tokens. This is true in the classificaiton case; in the design case, it is easier because the origins are selected *ab initio*.

We can, however, offer some advice on origin identification for design of tokens. The first step is identification of goals and problems the ecosystem has, and a selection of policies necessary to satisfy or fix them (e.g., adding node staking if it is desired to incentivise consistent performance and disincentivise malicious behaviour); afterwards, one ought to study the closest analogues and determine the origins of value they introduce and the mechanisms by which these origins manifest value. An inverse approach is also feasible: instead of starting from the problem at hand, one may ruminate on the consequences of introducing a particular OoV into the system and consider what policies may follow thence and what mechanisms ought to be employed to manifest the emergent value.

Secondly, VCMs are to be selected. At this stage, we introduce the promised visual aid. It is convenient to consider the OoVs as a graph, which will have more than one connected component in general. In this graph, nodes correspond to origins of value, and edges represent relations of dependency: if a token conditionally exposes future cashflows, its graph will possess an edge between the OoVs of Future Cashflow and Conditional Action. In this work, we propose an undirected graph; consideration of directed graphs in order to achieve a finer control over subtyping of VCMs is an attractive direction for future work.

It must be noted that a graph may possess more than one node corresponding to the same origin of value; this can happen if, e.g., activation of Governance and Future Cashflow both depends on Conditional Action, but this action is of qualitatively different kinds. If we wish to emphasize so, we will obtain a graph comprised of two connected components, where two distinct nodes, each in its own CC, will correspond to Conditional Action.

Having obtained a graph, one may then recover the VCMs by considering the connected components; each VCM shall correspond to one connected component; thereby it is made easy to see what VCMs to use and gauge whether introduction of new mechanisms is in order.

9.1 Examples

Let us consider, for example, the Ethereum token. It has a dual purpose: on one hand, it is used as a medium of exchange (in particular, of value transfer from network users to agents ensuring the network operation, i.e., validators); on the other hand, it also plays a part in controlling the access to the consensus mechanism of PoS Ethereum. Moreover, being a special (native) token, it plays a role in controlling the blockspace allocation. Let us denote the Origins of Value at play for each purpose.

Evidently, the Value Transfer origin of value corresponds to the eponymous way of ETH's usage, including blockspace allocation (see the corresponding OoV). When the token is used in consensus protocol, however, it can be shown to manifest value according to a number of origins: since it has to be staked and can be slashed, it possesses the Risk Exposure Origin of Value; since it provides rewards, it possesses the Future Cashflow Origin of Value; finally, since Future Cashflow is conditioned not only on risk exposure, but also on performance of work for the network, it additionally possesses the Conditional Action Origin of Value.

The above exposition makes it clear that Risk Exposure, Conditional Action, and Future Cashflow must form one connected component, as Future Cashflow is conditioned on both, and Value of Transfer must form another. See figure 7

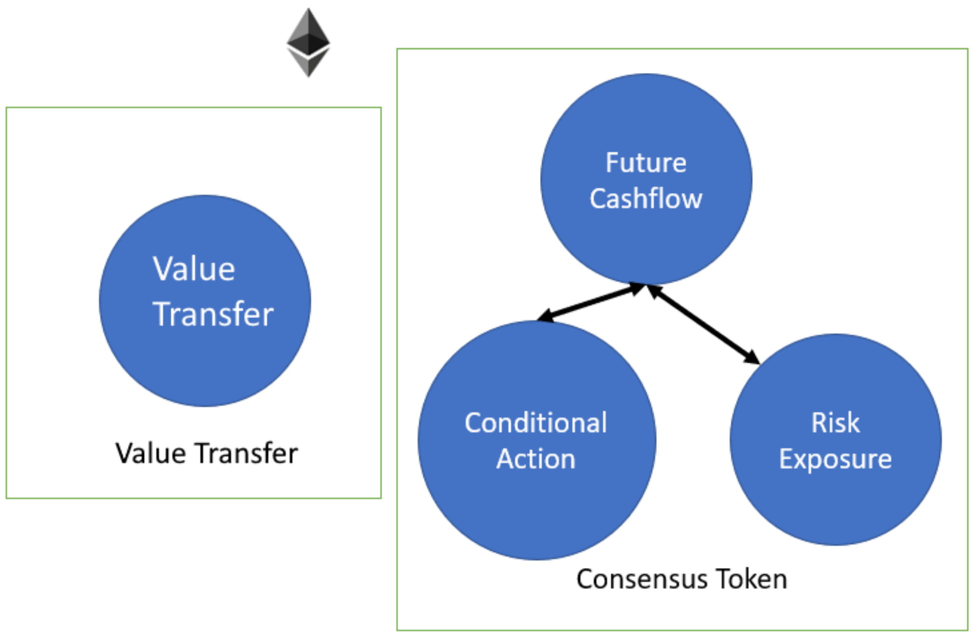

Figure 7: Graph representation of ETH's Origins of Value, divided into connected components representing VCMs

Since each connected component must correspond to a distinct VCM, the only thing left is to designate the VCMs. It naturally follows that Value Transfer corresponds to the eponymous VCM, and the other three OoVs - to a Work Token (in case of ETH, a Consensus Token).

Another, slightly more complicated, example is the BNB token, whose VCM-divided OoV graph is given on figure 8.

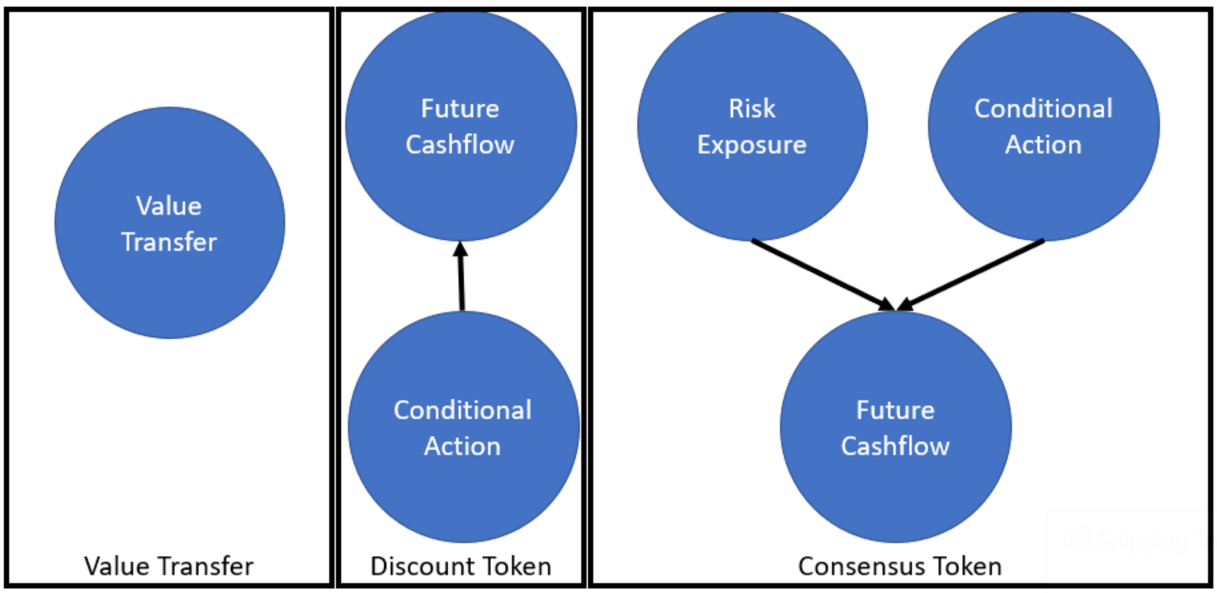

Figure 8: Graph representation of BNB's Origins of Value, divided into connected components representing VCMs

The difference between ETH, which is the consensus token of Ethereum Mainnet, and BNB, which serves as the consensus token of BNB Smart Chain, is that BNB additionally has a number of cashflows conditioned on user action, but not entailing risk exposure, such as allowing payment of trading fees on Binance with a discount. As such, a third VCM must be recognized: that of a Discount Token.

10 A workflow and an example of novel token design

Now equipped with a classification of embodiments of coordination mechanisms and realisations thereof, we can further recommend a general workflow for *de novo* token design:

1. Define a system the token is integrated into; define for it the

    (a) interacting agents
    (b) principal value and information flows
    (c) key system metrics
2. Recognise the system goals and issues; define the metrics to be maximised and the issues to be avoided
3. Determine correct (leading to metric maximisation and goal fulfillment) and incorrect (leading to a decrease in metrics or manifestation of an attack) agent behaviour
4. Determine a way of agent coordination so that correct behaviour is incentivised and incorrect behaviour is disincentivised
5. Knowing the above, propose mechanisms of agent coordination. Recognise Origins of Value therefrom.
6. Group interacting Origins of Value (see section 9). Recognise extant or introduce new Value Capturing Mechanisms.
7. Construct or select an implementation pattern based on the selected VCMs.
8. Select the necessary model and operational parameters based on system analysis and simulation.

10.1 Example

Let us give a simple example of application of the above workflow. Suppose we wish to integrate a token into a network of nodes for decentralised signing of transactions.

Clearly, the principal flow of value there is task execution, and metrics of interest are the number of tasks the network executed, the number of tasks the networks failed to execute on time, and sums of cost of no execution for both task groups (i.e., the total value the network brought to its clients and the total loss the network engendered by defaulting on its obligations, respectively).

We therefore wish to maximise the number and sum of cost of no execution for executed tasks and minimise them for failed tasks; to achieve this, we wish to reward agent behaviour that leads to task execution (i.e., disburse conditional rewards) and introduce penalties for misbehaviour (i.e., impose financial losses onto malicious actors).

We then recognize that the following Origins of Value arise from this proposition:

1. Future Cashflow - since the agents are rewarded for task execution, participation in the network exposes to them a cashflow embodied by said rewards
2. Conditional Action - since agent reward is conditioned upon task execution as a necessary criterion

3. Risk Exposure - since we wish to impose financial losses onto malicious actors, we require them to first make their tokens available for alienation in case of slashing, as there is no other way to impose said losses.

Having selected the Origins of Value, we further recognise that Future Cashflow interacts with both other Origins (since it is conditioned on task execution and activated by exposing tokens to a risk of alienation; in fact, one can argue that the activating nature of risk exposure also implies a connection between it and Conditional Action). See a graphical representation on figure 9

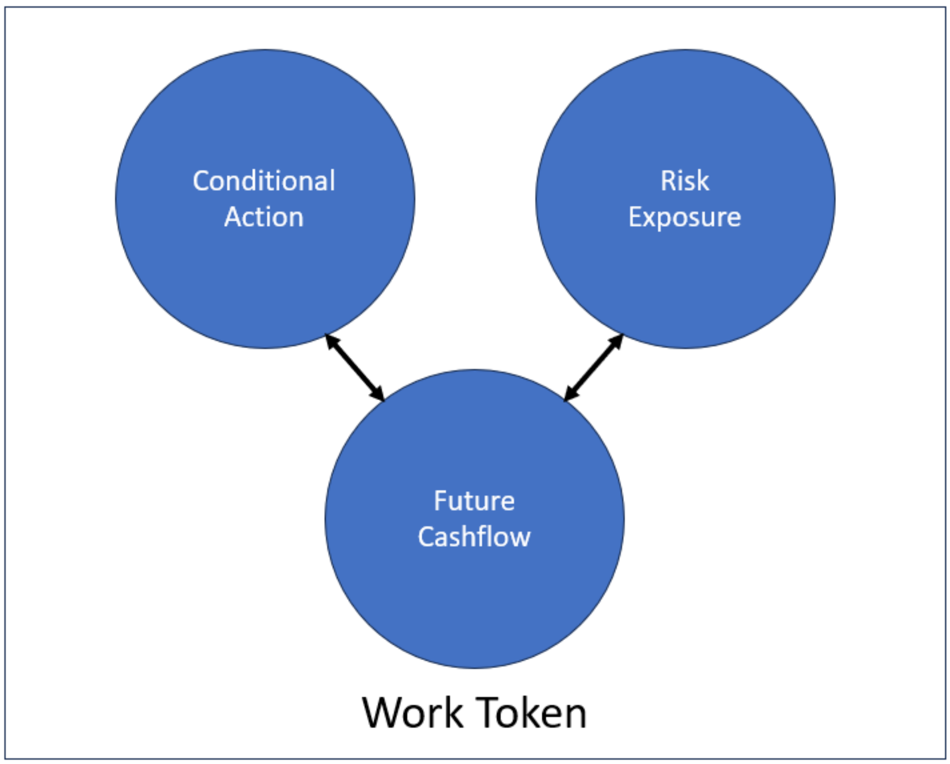

Figure 9: Graph representation of the example token's Origins of Value, divided into connected components representing VCMs

We recognise that, since the three Origins form a connected component (see the graph), a Value Capturing Mechanism must be selected for their joint realisation; consulting the list of mechanisms we described, we recognise the Work Token VCM.

11 Implementation patterns

In our three-tiered system, the implementation patterns occupy the lowest tier and correspond to the most detailed token description; indeed, patterns correspond not to abstract origins of value or their ways of manifestation, but rather to concrete tokens, or, rather, groups thereof, united by common technical details. An implementation pattern is a combination of an element of the VCM power set and a number of properties, data structures and algorithms that furnish a working token by implementing the VCMs.

The relation between VCMs and patterns, therefore, can be seen as inheritance in programming: any particular token realising this or that value-capturing mechanism necessarily inherits the properties and structures demanded by the VCM in question (though it is free to also define its own additional properties and structures).

Below we give a number of patterns, which we index by an archetypal (chosen rather arbitrarily) token. This allows us to speak of ETH-like or MKR-like tokens. Note that this means that the implementation patterns have as their scope not only the token proper, but also the necessary infrastructure for its operation (i.e., other smart contracts deployed so that the token design goals are fulfilled).

11.1 Tabulated examples

Herein we give an abridged example of model application of a number of well-known tokens. In some of the considered cases, novel VCMs are recognised; however, they are not described in the VCM section because they are not commonly used. Refer to Table 3.

Table 3. Token classification examples

Token	OoVs	VCMs	Implementation Pattern	Comments
BTC	1	Value Transfer	Original PoW Bitcoin Blockchain	
ETH	1, 2, 7, 8	Value Transfer, Consensus Token	Ethereum 2.0 PoS system with EIP1559	The original Ethereum PoS consensus
stETH	5	Representation	Lido rebasing staked ETH	The original implementation for granting the Ethereum consesnsus participation proceeds in a gasless way via token rebase model
WBTC	5	Representation	Simple ERC20 version of BTC	ERC20 BTC backed by BTC on Bitcoin with KYC/AML when minting
DAI	5	Representation	Collaterazied debt position	First CDP-based stablecoin

cETH	5	Representation	LP token of a lending pool in Compound	
USDC	5	Representation	ERC20 contract controlled by the Circle, the USDC issuer	
UNI	3, 8	Governance	Compound governance	Uniswap uses Compound governance implementation
LINK	1, 2, 7, 8	Work Token, Value Transfer	LINK implementation of a work token (with payments in a protocol native token)	
FIL	1, 2, 3, 7, 8	Blockchain service network	A file storage blockchain network	A new mechanism having attributes of a consensus and a work token, where block proposers are also the network service providers (file storage)
LPT	2, 7, 8	Work Token	Work token with delegation option and slashing	Livepeer original implementation of work token with delegation option
LDO	3, 8	Governance	DAO governance token	
FXS	2, 3, 5, 8	Governance, Representation, Dividend Token	Frax Share model	
MKR	2, 3, 8	Governance, Dividend Token	Original MKR governance and protocol fee burining implementation	Indirect dividends via MKR token burning as protocol fee payment (DAI's CDPs interest rate)
AAVE	2, 3, 7, 8	Pooled Insurance + Governance	Original AAVE implementation of governance and protocol pooled insurance (the Safety Module)	
CRV	2, 3, 7, 8	veToken	ve token model by Curve	The original voter-escrowed model with governance rights granted proportionally to the duration of the token lock-up
CVX	2, 3, 5, 8	Metagovernance	CVX meta-governance implementation	The original model based on accumulating veCRV and transferring voting rights to vlCVX token holders
LQTY	2	Dividend Token	Pure dividend token granting pro rata shares of protocol income	LQTY original implementation of governance-minimized protocol token

BANK	3, 4, 8	Access Token, Governance	Simple Snapshot governance	tiered community access

12 Token technical traits

Following [4], we list the technical traits a token can possess (moving delegability to a class of its own and introducing a mintability class to broadly represent the supply strategy). These traits are summarised in Table 4.

Table 4. Technical traits of tokens

Property	Value	Summary
Burnability	Burnable	Can be burned (i.e., removed from circulation)
Burnability	Non-burnable	Cannot be burned
Expirability	Expirable	Has a predetermined lifetime and is automatically burned at its end
Expirability	Non-expirable	Is not automatically burned after a certain period of time
Spendability	SPendable	A token can be spent within the ecosystem to pay for gas or services (note: we opine that this property can well be combined with the property of tradability, since spending is a form of ownership change)
Spendability	Non-spendable	Cannot be spent
Fungibility	Fungible	It is possible to interchange instances of the token
Fungibility	Non-fungible	It is impossible to interchange instances of the token
Fungibility	Hybrid	Non-fungible except within defined subsets (i.e., tokens are fungible within the subsets, but not between them)
Divisibility	Fractional	Can be subdivided into sub-unity parts
Divisibility	Whole	Indivisibile
Divisibility	Singleton	A special case of a whole token: only one token instance exists, and it is whole.
Tradability	Tradable	Token ownership can be changed at will
Tradability	Non-tradable	Token ownership cannot be changed at will (e.g., the token is vote-locked)
Delegability	Delegable	Rights begotten by ownership of a token can be transferred (delegated)
Delegability	Non-delegable	Rights cannot be transferred
Mintability	Mintable	New tokens can enter the circulation from nothing (i.e., be minted; this means the supply can increase)
Mintability	Non-mintable	The supply cannot increase

13 Summary of Hierarchy Proposed Herein

The tripartite hierarchical structure we propose can be illustrated by figure 10. Figure 11 provides additionally an example of OoV-VCM-Pattern dependency hierarchy for a particular token (BNB).

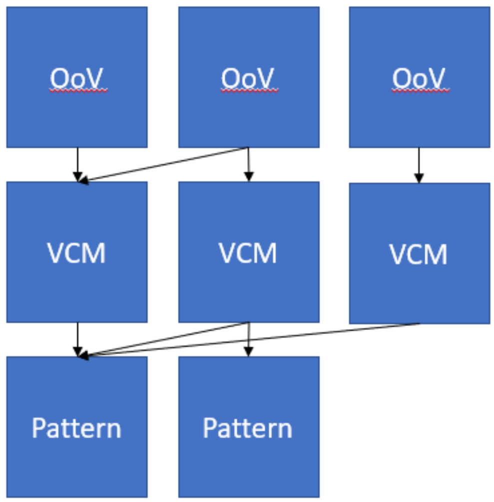

Figure 10: Schematic representation of the proposed hierarchy, arrows indicating subordination

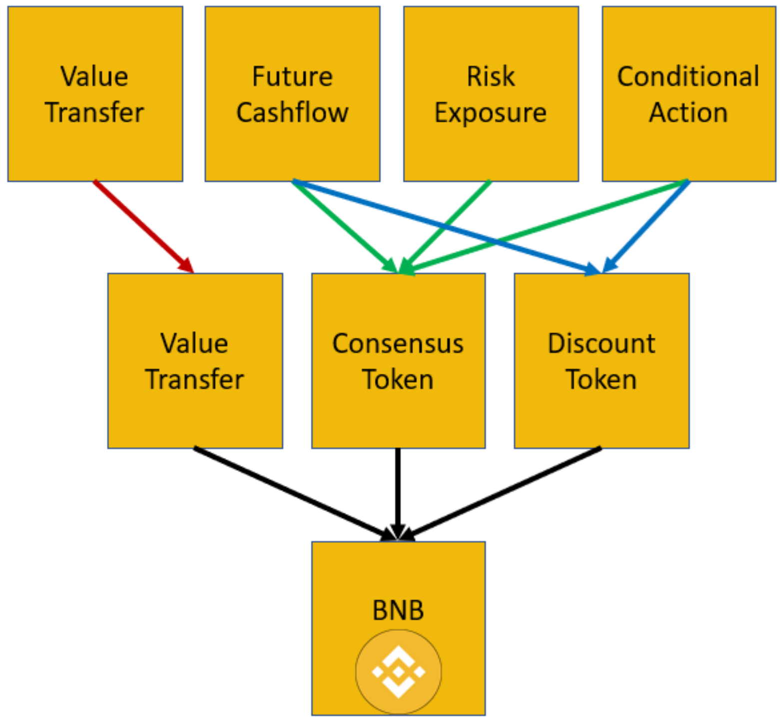

Figure 11: Dependency hierarchy of BNB. OoV-VCM dependencies are colour-coded for convenience.

14 Conclusion

Herein we consider a novel hierarchical demand-side classification of tokens according to their origins of value, value-capturing mechanisms manifesting them, and particular token implementation patterns (much resembling archetypes of certain extant frameworks) representing combinations thereof that constitute a given token or a group of technically similar tokens.

A comparison with existing classifications shows that ours is more atomic in that individual Origins of Value, judged to be the bedrock on which the entire token design process rests as they dictate the behavioural and technical needs of the token in question, are indivisible, unlike their closest counterparts in extant frameworks.

Furthermore, a method of determining the necessity of constructing new VCMs is given, and a formal optimisation problem treatment of value origination is considered; furthermore, a novel concept of an origin of loss (i.e., an origin of purely negative value) is introduced. The application of a new classification was demonstrated for both directions of application: (1) designing the token functions for the model system (2) decomposing well-known examples of tokens into OoV and VCMs.

[**Conflicts of Interest**] There are no conflicts of interest to declare.

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