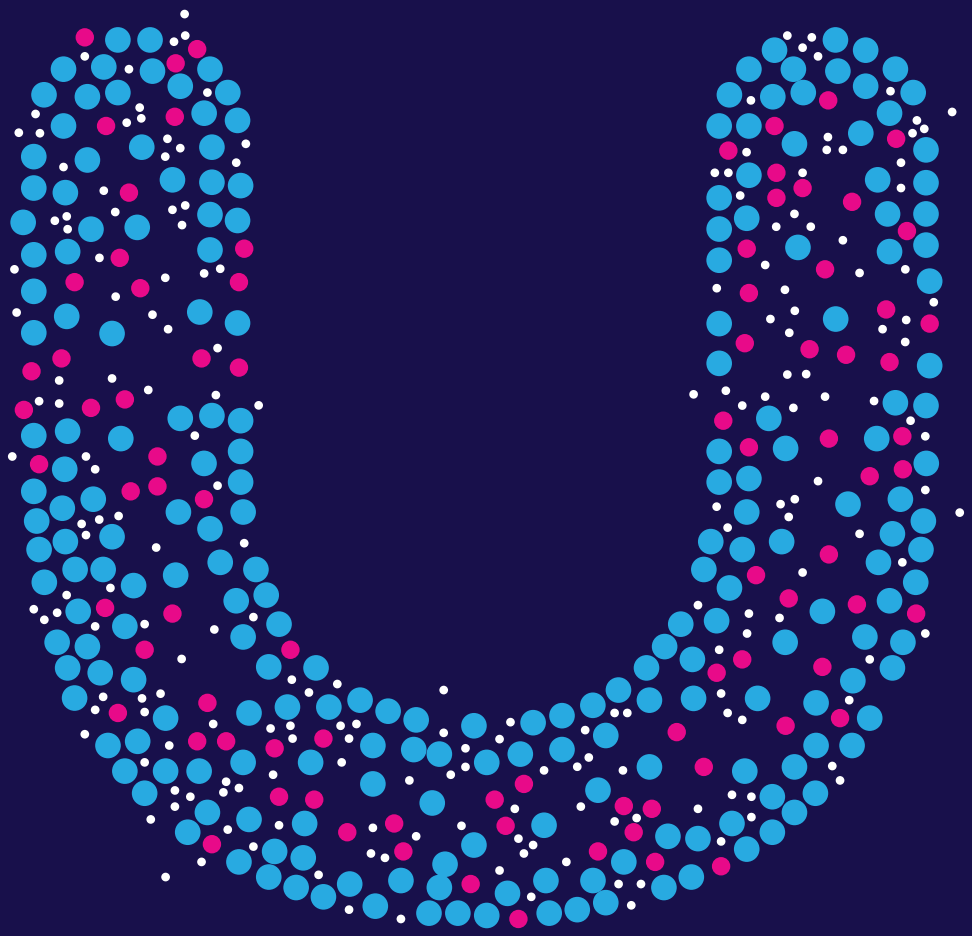


project ubu

The world's first fully fledged decentralised currency that delivers free and guaranteed income to all citizens without relying on taxation.

SEPTEMBER 2017

Contents

Section 1

02

“Like slavery and apartheid, poverty is not natural. It is man-made and can be overcome and eradicated by the actions of human beings.”

Nelson Mandela

1.The tragedy of exclusion

Poverty in perspective

While global poverty has been on a sharp decline by all measures for 200 years, the World Bank estimates 766 million people (10.7 percent of the world's population) were living in extreme poverty[1] in 2013. This is forecast to drop to 9,6% by 2015.

In a little over a decade China successfully lifted 720 million people out of extreme poverty, accounting for by far the greatest leap forward. But extreme poverty is only one measure - many institutions measure a broad swathe of other criteria such as access to water, sanitation, energy, shelter, health-care, education, economic activity, justice, etc.

"There are many ways in which researchers and policymakers try to measure welfare. In this entry we focus mainly on welfare as measured by 'monetized' consumption and income, following the approach used by the World Bank. However, as we emphasise throughout, this is only one of many aspects that we need to consider when discussing poverty. In other entries in Our World in Data we discuss evidence that allows tracking progress in other aspects of welfare that are not captured by standard economic indicators. This broad perspective on global development is at the heart of our publication[2]."

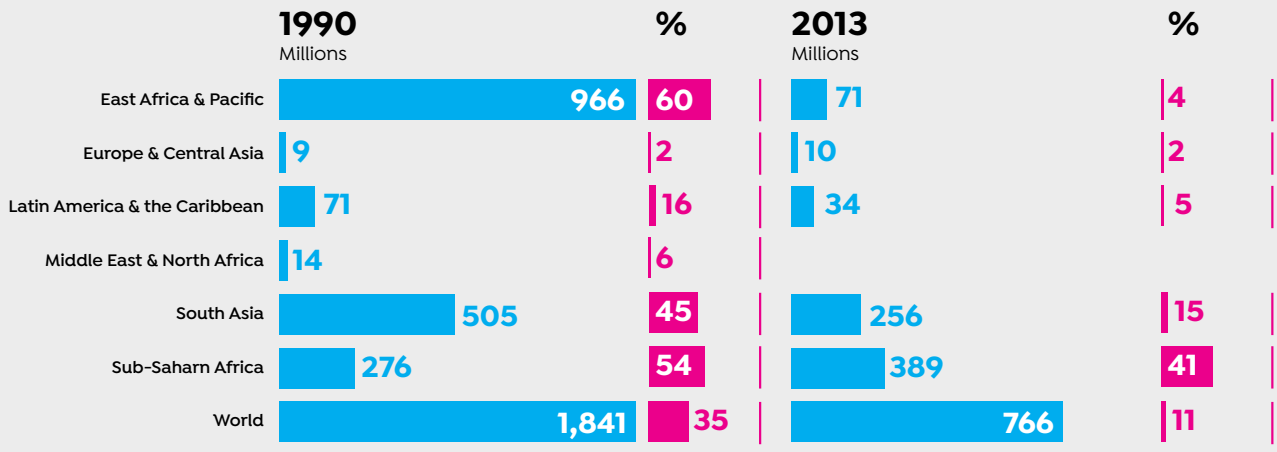


Figure 1: Global poverty measure 2013/1990. Source: World Bank. 2017. Atlas of Sustainable Development Goals 2017: World Development Indicators. Washington, DC: World Bank. doi:10.1596/978-1-4648-1080-0. License: Creative Commons Attribution CC BY 3.0 IGO

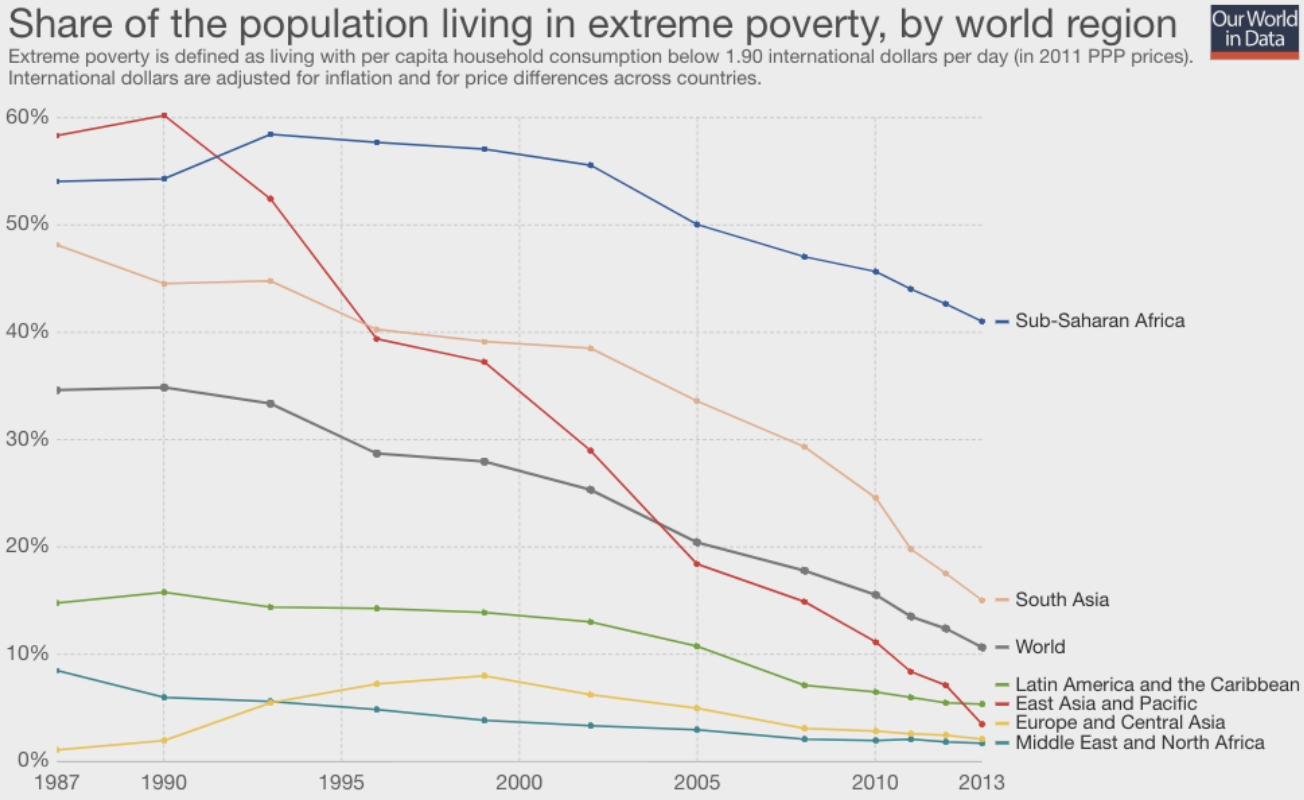
[1]The World Bank definition of extreme poverty is people living on <$1,90 international/day by 2011 PPP (purchasing power parity).

[2]Max Roser and Esteban Ortiz-Ospina (2017) – 'Global Extreme Poverty'. Published online at OurWorldInData.org. Retrieved from: https://ourworldindata.org/extreme-poverty/

Section 1

01

Why Project UBU?



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Despite these great strides, Sub-Saharan Africa and South Asia account for 685 million poverty stricken people alone, 84% of the global total. There are multiple reasons for this, but the underlying correlation across boundaries and throughout history is that between national income and poverty.

Researchers have compared how much changes in inequality matter for poverty reduction relative to economic growth. David Dollar and Aart Kraay studied this link between growth, inequality and poverty reduction in a widely-cited paper in 2002, the title being the summary of their finding: 'Growth is good for the poor[4]'.

National prosperity is a strong predictor of extreme poverty at the individual level. The data shows that there is no country with a GDP per capita higher than int$15,000 in which more than 5% of the population lives in extreme poverty. And in most countries with GDP per capita below int$4,000, between one quarter and three quarters of the population lives in extreme poverty[5].

[3] Max Roser and Esteban Ortiz-Ospina (2017) – 'Global Extreme Poverty'. Published online at OurWorldInData.org. Retrieved from: https://ourworldindata.org/extreme-poverty/
[4] Dollar, David and Aart Kray (2002) – Growth is Good for the Poor. In Journal of Economic Growth. September 2002, Volume 7, Issue 3, pp 195–225.
[5] Max Roser and Esteban Ortiz-Ospina (2017) – 'Global Extreme Poverty'. Published online at OurWorldInData.org. Retrieved from: https://ourworldindata.org/extreme-poverty/

Income inequality and instability

Earlier IMF work has shown that income inequality matters for growth and its sustainability. Much analysis suggests that the income distribution itself matters for growth as well. Specifically, if the income share of the top 20 percent (the rich) increases, then GDP growth actually declines over the medium term, suggesting that the benefits do not trickle down. In contrast, an increase in the income share of the bottom 20 percent (the poor) is associated with higher GDP growth. The poor and the middle class matter the most for growth via several interrelated economic, social, and political channels[6].

Concomitant social damage and the threat to economically active classes

The pernicious effects of poverty can be found across the spectrum of social ills - substance abuse, illiteracy, domestic violence, fundamentalism, mental and physical ill-health, child mortality, etc. The great political systems of recent history - capitalism and communism and religiously organised states seem to have reached limits in their ability to present a system in which citizens continue to move out of poverty and disaffection and onto a path in which better lives for their children can be clearly seen. Capitalism has had particularly good success for short periods of time or under constrained conditions (the US in the 1950's and the smaller states of Northern Europe in more recent times), while the other systems have seen the relatively quick collapse of institutions and promised personal freedoms (Russia and China). Reasons for this inability of political systems to sustain betterment have been widely debated, but analysis is difficult, given the opaque nature of behavioural economics within different cultures. When added to the history of citizens turning on their systems and governments out of frustration or anger in a violent procession of coups and revolutions, we end up with a combustive mixture which threatens the disaffected and economically active classes alike. And when added to the certainty of disappearing job opportunities under the cloak of machine learning and AI and robotics, we can glimpse a potentially apocalyptic future for large portions of the globe.

However, a clear fact remains - families who have access to food and shelter and perhaps a small amount of discretionary income are more likely to have better outcomes than families who don't. It is not necessary to unravel the merits of the political systems and technological changes to chase this simple goal.

Why a solution cannot be created by centralised monetary systems

There have been many initiatives that have delivered a universal basic income to citizens (see http://bit.ly/2gPUNwR for references). However, all of these are state-sponsored initiatives, meaning that the very same centralised institutions that have been unable to provide for its citizens have undertaken a redistribution of tax revenue to fund a UBI. We suggest that state-funded UBIs suffer from several fatal flaws. The first is that whatever inefficiencies in governance, government or political system ended up with a poverty problem, remain. It is the centralised nature of state-UBIs that ensure this, with glaring examples like the grant system in

[6]Dabla-Norris, Kochhar, Ricka, Suphaphiphat &Tsounta (2015) - Causes and Consequences of Income Inequality: A Global Perspective. International Monetary Fund, https://www.imf.org/external/pubs/ft/sdn/2015/sdn1513.pdf

South Africa, which is rife with wastage and corruption. The second flaw is that the price of the state grant is derived from other state programs, immediately raising the spectre of robbing Peter to pay Paul. Although constrained experiments in state guaranteed income have clearly shown their efficacy in constrained test groups and for individual families. we maintain that that these are unsustainable on a large scale.

The philosophy of decentralised UBI as a unique solution to the problem

Project UBU rests on the principle that a UBI should be decentralised, building an ecosystem that organically uncovers trapped or moribund assets and allows free access to them via a blockchain secured substrate. It is estimated that in some areas of the economy (such as produced food), up to 30% of assets are wasted or discarded. The only barrier to accessing these assets is an efficient distribution and payment system wherein citizens can use issued tokens in exchange for these assets, allowing vendors and service providers a system to gain an outlet for trapped assets while attracting a greater retail footfall, while giving previously excluded citizens a way to participate in the economy without taxing the fiscus.

Section 2

07

Executive Summary

Overview

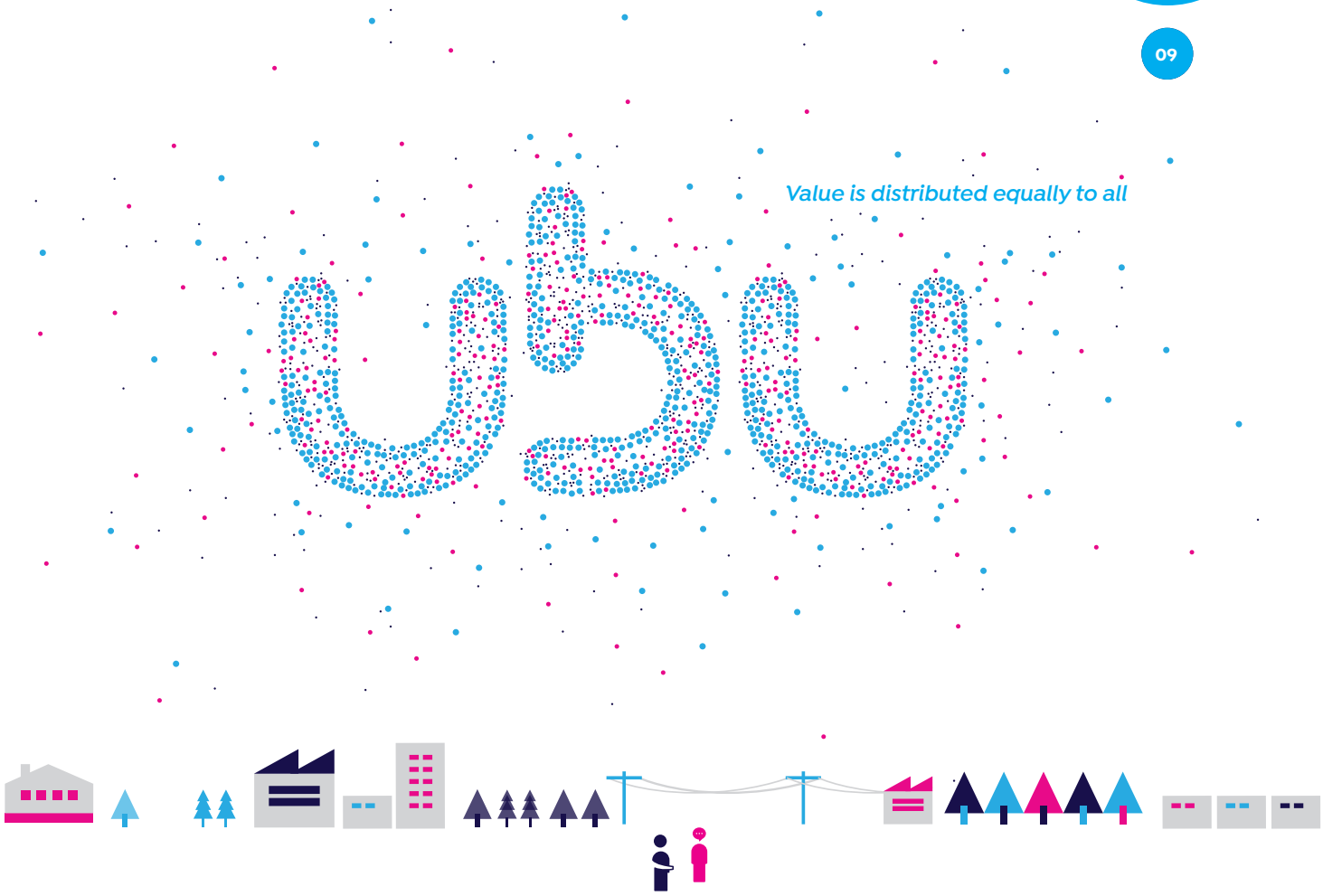
This document describes the social narrative, economic foundation and associated mathematics for the UBU cryptotoken, developed as an exchange token for the Universal Basic Income initiative known as Project UBU (projectubu.com). The document further describes the UBX derivative cryptotoken (to be issued via an ITO) and its relationship to the UBU token.

Abstract

Project UBU was created to address a fundamental disparity in our economic system in which a significant segment of society is excluded from the economy resulting in poverty, poor education, poor life expectancy and political and social exclusion. This has led to a devaluing of a class of human beings who are excluded from access to resources, and the attendant social damage which is inflicted on them - lack of opportunities, lack of hope and a constant assault on their dignity. Much has been written on this phenomenon, and evidence of this disparity in some countries is dispiriting. Here in South Africa, the home of this project, the country is a microcosm of this insidious global exclusion. Even in wealthier countries, new technologies like automation and AI portend the disappearance of many formerly safe employment sectors.

Distributed ledger technology provides a unique opportunity to build a response to this problem. Pairing this technology with a citizen/vendor/treasury transaction flow and a robustly and mathematically modelled economics, Project UBU will address this critical global challenge, offering a solution independent of any centralised authority. Project UBU can reverse the cycle of the dependence mentality and thus enable a completely different set of possibilities for humanity - an inclusive economy that benefits all participants and reduces economic, social and political instability.

To this end, Project UBU has designed an ecosystem to enable a token-of-exchange between citizens and providers of goods and services, which is issued at no cost and equally to all citizens. As this token starts to gain traction across market segments and geographic areas, it will naturally migrate to a token-of-value (or a cryptocurrency, as has been seen in other cryptotoken-based initiatives), specifically as the token is imbued with real and perceived value.



Economic exclusion is at the root of social, economic & political instability. Project UBU offers a unique solution to enable economic inclusion.

The UBU token acquires value because of its ability to solve the urgent unserved need of efficiently reallocating inefficiently allocated resources using the present monetary system, as has been adequately demonstrated by its inability to address massive wastage amongst producers and enduring economic exclusion for billions of citizens. Its value is the dividend that accrues to the UBU system as a result of the improvement of this efficiency, and that value is distributed equally to all people instead of accruing to only a few.

GLOSSARY

Project UBU
The entire venture

UBI
Universal basic income: a form of social welfare where citizens receive a regular income, most often funded from state tax coffers

Citizen
Any human being who is verified and elects to receive UBUs

Vendor
A person or entity that elects to accept UBUs in exchange for goods or services

UBU Core
Legal entity establishing & managing the project

UBU Sphere
Every component of the project's ecosystem

UBU
Token of exchange that the ecosystem creates and issues at no cost to citizens for purposes of trading with vendors for goods & services

UBX
Derivative ERC-20 cryptotoken

Treasury
The decentralised token issuing and dissipation algorithm

Background

The economy is comprised of economically active people who are nodes in a trading network, exchanging goods and services with each other. Money introduces a mechanism to facilitate this exchange, and flows in the opposite direction. Along with language, money/tokens-of-exchange are as old as humanity itself.

Ancient forms of money were decentralised and included everything from seashells in Polynesia to baboon bones in Africa. In the modern economy the provision of money is controlled by governments, and central and commercial banks. The value of money is determined by the size of the economy and the supply of that money.

As already noted, there are large number of people who are denied access to the economy by circumstances of birth. This has a destabilising effect on the economic network, resulting in the inefficient allocation of resources. For instance, one-third of all food produced in the world is wasted (flwproto-col.org). An inclusive economy will more efficiently exploit production and distribution, given the well-understood network effect of more active nodes, as proven mathematically by the co-inventor of the internet, Robert Metcalf. Metcalf's Law states that "the value of a network increases exponentially with the number of nodes." Since the current monetary system has proven incapable of achieving this, a substantially different system is required. The UBU ecosystem provides a complementary mechanism - more people in the economy, resulting in more nodes in the network, resulting in more efficient allocation of resources, resulting in a concomitant increase in network stability.

This new system is designed to be decentralised, autonomous and issued equally to all citizens. To avoid hyperinflation, it works the opposite way to the current money system with a perpetual and constant dissipation rate, described in more detail later. This mimics natural physical systems like heat energy: if you don't use it, you lose it. The dissipating units go back to the decentralised system for later reissue.

Since they operate in the same markets, there is ultimately exchangeability between the classical monetary systems and UBU.

Key Differentiators

The UBU and UBX are uniquely differentiated from other crypto tokens across a spread of fundamental economic and implementation principles. They are summarised here, and described in more detail below.

• The UBU Sphere was conceived and developed over the last two years. It is not conceptware or a set of designs. It is fully operational in Beta mode in South Africa. Seed funding for this initiative was received from Norwegian investors.

• It is based on a unique economic model of free, equal and regular token distribution to every citizen, and regular dissipation of citizen accounts if tokens are unused. The mathematics underpinning the economic model are fully described in the yellow paper in Section 11.

• This UBI initiative is entirely independent of government or any other centralised organisation, and unlike conventional UBI projects, does not rely on taxation or donations.

• The UBU token has been specifically designed to facilitate a universal basic income, allowing exchange of tokens for inefficient or moribund assets trapped within all economic ecosystems.

• The issue/dissipate principle is designed to encourage spending rather than hoarding, which is stimulative to economies.

• The UBX has been designed as a derivative instrument to fund further development and rollout of UBU, based on the promissory issue of UBUs at a future date, governed by a mathematical relationship between the UBU and UBX.

• As the network of citizens and vendors and association grows, UBUs will attract their own independent value, and migrate from tokens of exchange to tokens of value.

Product Description

Under development since Q4, 2016 and now operational in Beta Test phase, the UBUsphere is a triangular economic structure that uses digital tokens (UBUs) to facilitate trade and exchange between citizens, vendors and the UBU Treasury.

The system is currently being migrated from a test blockchain to Ethereum's blockchain to enable trusted validation of transactions. At the core of the system is the daily provision of UBUs from a Treasury smart contract, at no cost to citizen e-wallets. The e-wallet dissipates value if UBUs remain unspent, in accordance with economic and mathematical principles described in the yellow paper. This approach encourages transaction velocity (which is economy stimulative), restrains inflation and prevents hoarding. This 'issue and dissipate' economic model differentiates this system from pure cryptocurrency plays.

Simplified view of the UBU ecosystem

Vendors receive UBUs from citizens either remotely or at point-of-sale. UBUs may be used by vendors to provide incentive for advertised discounts, excess inventory, minimally spoiled or moribund stock, donor or charity aid, dead loyalty points, close-to-expiry goods, donated value like medical clinic services, etc.

The UBU Sphere, which commenced operation in September 2017 with live vendors, will be upgraded and refined within controlled regional rollouts, carefully matching citizen uptake with vendor acquisition.

To this end, the system is fundamentally differentiated from any other blockchain-enabled cryptocurrency ecosystems as follows:

- Citizen e-wallets, available as a smartphone or feature phone application, will be issued with UBUs

on a continuous and equal basis, and with no effort or payment required on the part of the citizen other than agreeing to participate.

• UBUs will automatically dissipate from wallets on a continuous and consistent basis, conforming to an inflation-stabilising set of mathematical algorithms described below, and ensuring an incentive towards transacting rather than hoarding.

• Vendors will be incentivised to offer trapped, moribund and marginal assets as exchangeable product during the token-of-exchange phase of the project.

• The entire ecosystem (app, wallets, blockchain, citizen base, treasury and vendor base) is currently undergoing Beta testing. It will be operated, monitored, fine-tuned and hardened in token-exchange mode long before the token is floated onto public crypto-exchanges. In that way, UBU will be offered as a public cryptocurrency with a fully tested and operating citizen/vendor commercial ecosystem, rather than simply as a white-paper.

• Project UBU is offering a participating derivative product, UBX, which delivers a set number of UBUs in the future according to a formula described later in this document. UBX will be made available in an Initial Token Offering (ITO) to commence on 19 September 2017. While Project UBU has been conceived and developed over the last 18 months and beta tested in September 2017, the funds raised from the ITO will serve to exhaustively test and harden the ecosystem, and to expand geographic footprint and vendor and citizen bases, prior to a migration to public crypto exchanges during Q2 2018.

The mathematical and economic underpinning of the UBUsphere, the UBX ITO, and their interrelationship follows, as well as screenshots of the UBU e-wallet app and backend portals.

The UBU Sphere

Purpose

Every part of the UBU system described in these pages is designed to integrate with every other part in order to achieve one singular purpose: Build the value of the UBU and its use as a universal basic income currency that is freely issued to everyone.

Section Introduction

This section addresses the key economic flows attributable to UBU and should be read in aconjunction with the other parts of the paper, but in particular the Mathematical White Paper which forms a part of this paper and which introduces the mathematical formalism underpinning the value proposition for UBU.

After defining a few key terms which will be introduced during the course of the discussion, we discuss firstly the two primary tokens UBU and UBX that form part of UBU and then proceed to examine how the tokens will be applied in the physical world to the rollout of UBU.

Preamble and Definitions:

Entity and activity grouping definitions:

UBU Sphere
The collection of entities that can ensure the development and sustenance of the UBU ecosystem, including Core, Foundation, Recruit and Transact.

UBU Core
The founding business of UBU. Its responsibility is to build the value of the UBU and maximize the number of citizens participating.

Foundation
The entity created to enable and direct investment into key aspects of UBU Sphere, principally to bootstrap value in the UBU.

Recruit
The collection of activities required to recruit citizens and vendors.

Transact
The activities required to ensure security and immutability of UBU transaction flow, and to ensure that transaction costs are paid for.

Timing and related Definitions:

MVP Phase
The initial setup of UBU, including the delivery of a minimum viable product in the form of a mobile app and integrated vendor portal on a blockchain test platform – to September 2017

Phase 1
The initial Beta test phase with use cases being tested in defined communities, and in which pre-enrolment of citizens is actively encouraged to enable a more comprehensive and useful rollout in Phase 2

Phase 2
Commencement of the full UBU system on the Commercial Release Date on the Ethereum blockchain and capable at deployment at scale sufficient to deliver the Citizen Target

Citizen Target
The number of citizens, being 500 Million, targeted to be achieved in the Target Term.

Target Term
Ten years from Commercial Release Date

Commercial Release Date
1 April 2018

ITO
Initial Token Offering: The offering of UBX tokens to holders of other cryptocurrencies

Citizen
Any real person who has agreed to participate in UBU

Vendor
Any entity that offers to exchange goods and services for UBUs

UBU
A cryptotoken issued free to citizens in an electronic wallet on a regular basis and which dissipates from the electronic wallet according to a defined formulation.

UBX
An unit instrument derived from the UBU which delivers a specified number of UBUs per UBX to the electronic wallet of the UBX holder on a monthly basis in perpetuity and where the specified number of deliverable UBUs is calculated according to a S-I-S type formulation

We note that:

• It is possible that people may choose to purchase UBX and that they would do so with the expectation that the price of the UBX may rise over time

• The perception of the price of the UBX is solely determined by the market expectation of the value of the UBU as and when it becomes useful as a unit of exchange for goods and services

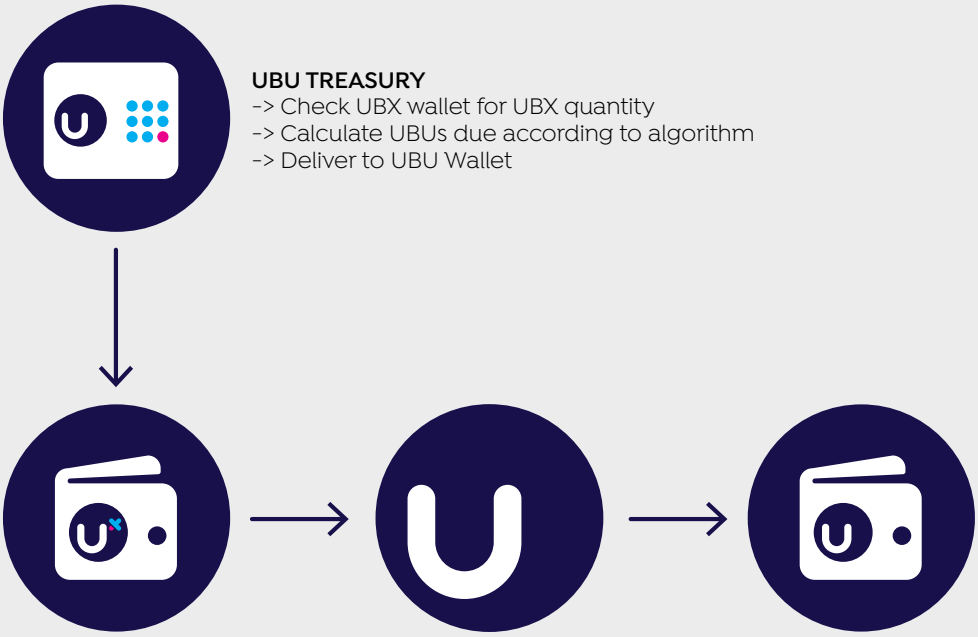
• The UBX does not rely on the effort of others as its payment in UBUs is strictly formulaic and the formula has no human effort related parameter.

UBU & UBX

As set out in more detail in this paper, the UBU system comprises a number of parts and two fundamental tokens.

The first and primary token is the UBU which is a token of exchange issued equally to all natural persons (called citizens) and which is assured a natural limit in total supply by virtue of a dissipation mechanism. Identity verification is mandatory to avoid duplicate citizens. Dual key authentication is via a combination of identity number/social security/passport number and 10 digit mobile number.

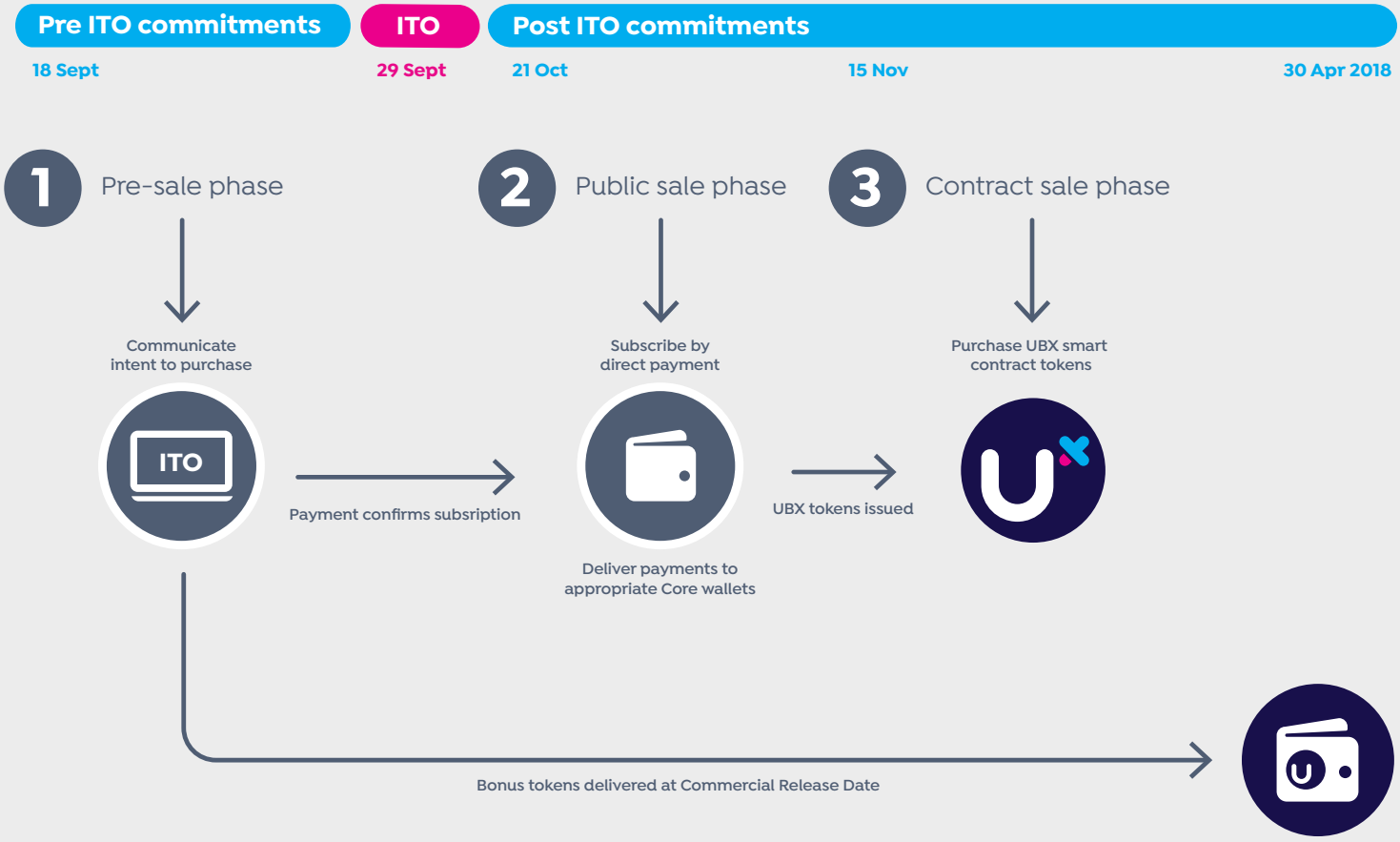
The second token, built on the value of the primary UBU token, is the UBX token which delivers UBUs to the holder on a formulaically determined basis, as described further herein. It is the UBX token which will be offered in an Initial Token Offering as detailed in this paper and which will be used to fund and incentivise the deployment of the UBU system.
We discuss firstly the payment curve by which UBUs will be paid to UBX in the future and then lead into a method by which a value can be ascribed to the UBU and the UBX.



UBX Initial Token Offering

The following diagram illustrates the flow of UBUs to UBX tokens and the process applicable to the three phases of the ITO, namely the Pre-Sale, Public Sale and Contract Sale phases.

TIMELINE



UBX payment curve

To assess its potential, UBU must formulate a method to predict how successful it will be in recruiting citizens. Citizens don't have to pay anything to join, but do have to actively do something – i.e. they must actively register via the e-wallet application. The greater the number of citizens, the greater the acceptance of UBUs as a medium of exchange, the more Vendors come aboard, and the more citizens will want to participate.

Accordingly, a predictive model used in epidemiology can be used and may be formulated using an S-I-S type epidemic where existing citizens enroll (or infect) new citizens from among a pool of susceptible potentials.

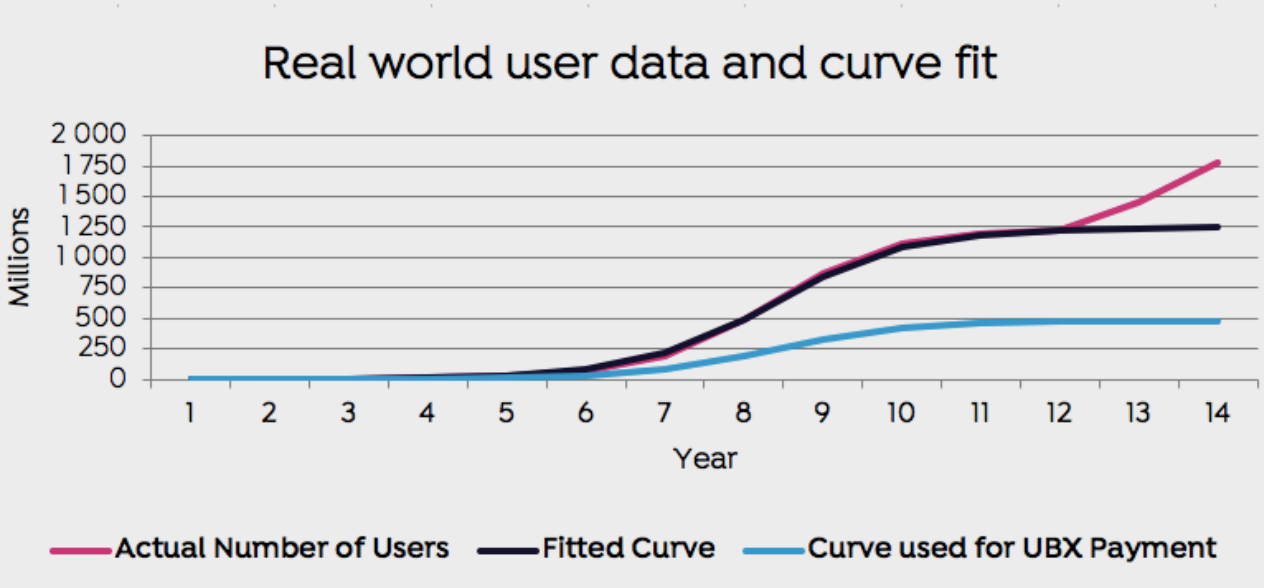
We gathered the data of a number of comparative "internet phenomenon" growth models, and selected Facebook as the most applicable data set for comparison, the reason being that Facebook did not require any fee to join, and had a utility for users that grew with time (i.e. as Facebook grew people came to the idea that it was more and more useful so more and more people joined it). The S-I-S model was used to establish parameters that applied to Facebook, and then a revised model using a likely "pool of susceptible potentials" was generated on which to base the UBX payment profile.

500 Million citizens was selected as a pool size for the following reasons:

• The population of Africa will exceed 1 Billion during the Target Term, and Africa has the greatest need.

• If half the population of Africa is too large, we can consider the population of global poor – over 3 Billion people live on less than $2.50/day, so a 500 Million target would represent 1/6th of that.

The results and model are shown in the chart below:



UBX payment Formula

The following formula is used to determine the payment of UBUs (N(t)) to an UBX

$$N(t) = P \times n_0 \frac{(\beta-\gamma)e^{(\beta-\gamma)t}}{\beta-\gamma+\beta n_0 e^{(\beta-\gamma)t}}.$$

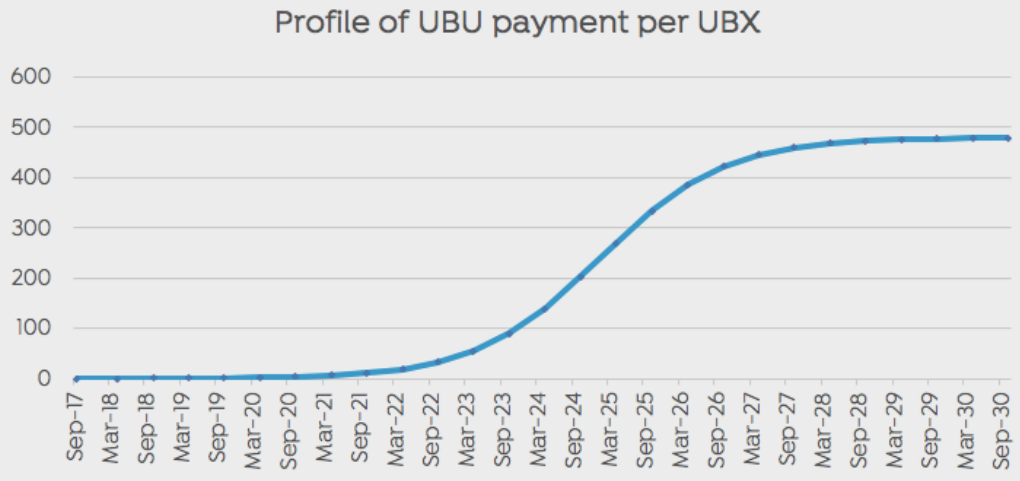
A base UBX is also deducted to allow for the fact that at the outset there are no citizens, and the S-I-S formulation above cannot commence with zero. The following factors are used.

Factor	Parameter
B (Beta) - Gain probability	1.20
y (gamma) - Loss probability	0.05
No (proportion of population at the start)	0.00020
Base UBX	-99,979

And a total Population P of 500 Million is set.

UBX Payment Profile

Based on the above formulation, commencing the end of the month after the Commercial Release Date (i.e. from the end of May 2018) each UBX will be paid a monthly number of UBUs set out in the following chart.



UBX Price in UBU

The UBX can be priced in UBUs in much the same way that a dollar denominated bond is priced in dollars, or dollar denominated equity (stock or shares) is also priced in dollars.

The UBX can, amongst other methods, be priced using well known present value metrics against a discount rate.

As an example, using a discount rate of 50% per annum (which would be regarded as an exceptional rate of return), an UBU price of 879 UBU per UBX is indicated. At, say, a slightly lower 40% per annum discount rate, a price of 1,649 UBU per UBX would be indicated.

In order to assess the potential value of an UBX in a fiat currency, it is necessary for a view to be formed of what value an UBU would have as an exchange token for real goods and services.

UBU Value and UBX price

As set out in section 5.2 of the mathematical part of the yellow paper, the goal of project UBU is to bootstrap the value of the UBU token. At the outset, the value is very little because the set of property rights that can be exchanged for tokens is zero or very small. But as the number of vendors increases and the property rights that are transferable using UBUs increases, this leads to a fungibility of UBU and fiat currency.

This fungibility may be regarded as the "price" of UBU and will depend on the expectations of the market.

A base level argument can be applied to assign an initial price to UBU in fiat (or other tokens).
A value proposition for UBU is that using the UBU wallet, a vendor can disseminate offers to a market of participants. The price of access to that market is that the vendor must be prepared to sell something in UBUs. In many ways, this is similar to what the major online marketing platforms such as Google and Facebook do with techniques such as adwords. Every click-through that results in a user visiting an advertiser's page, is charged at a particular rate – in Facebook's instance, this averages globally at $0.38 per click-through.

Similarly, a vendor using the UBU app could regard the presence of a citizen in store as a click-through event worthy of $0.38. If that vendor were the only competitor for the citizen's UBU spend for the day, and on the basis that the citizen gets 100 UBUs per day, then each UBU could be said to be worth a minimum of $0.38 / 100 or $0.0038 per UBU.

It can be argued that getting a user in store is worth far more than a click-through. Depending on how the market and society decide to allocate property rights to the UBU, it could take on a far larger value. For example, if the aim were to lift all people above a poverty line of $2-50 per day, then a value of $2-50 / 100 or $0.025/UBU might be assigned.

Similarly, we might consider the world per capita GDP as a reasonable basis for price. In 2015, this number was $15,800 per capita per year which is more than $43 per person day, indicating that a far larger number could be assigned to a token such as an UBU in an expanded economy.

Ultimately the market and users of the UBU will make a choice as to the reasonableness of the price proposition for the UBU.

For the purposes of this document, an UBX price between $3.34 (i.e. 0.38 cents per UBU and a 50% p.a. discount rate) and $16.50 (i.e. 0.01 cents per UBU and a 40% p.a. discount rate) seems reasonable and is accordingly the reason the ITO sale price is set at $5 per UBX.

However, as will be apparent from examining the Excel model, the price of UBX could be as much as $6 324 if the market accepts a value of $0.43 per UBU and a discount rate of 15%. This should not be read as a claim that the price of UBX will rise to such levels, but rather to illustrate that the price of the UBX, because of the way it is formulated, is very sensitive to the two key underlying parameters of UBU price and discount rate.

This is by design. The UBU is intended to be a stable currency so that it has utility as a unit of exchange. The UBX on the other hand is formulated to behave in a much more volatile manner because it is this volatility that can drive significant price changes and thus returns for speculators and buyers of UBX who correctly time the market.

Issuance of UBUs

UBU are issued to two classes of recipients

· Citizens

· The UBU Sphere

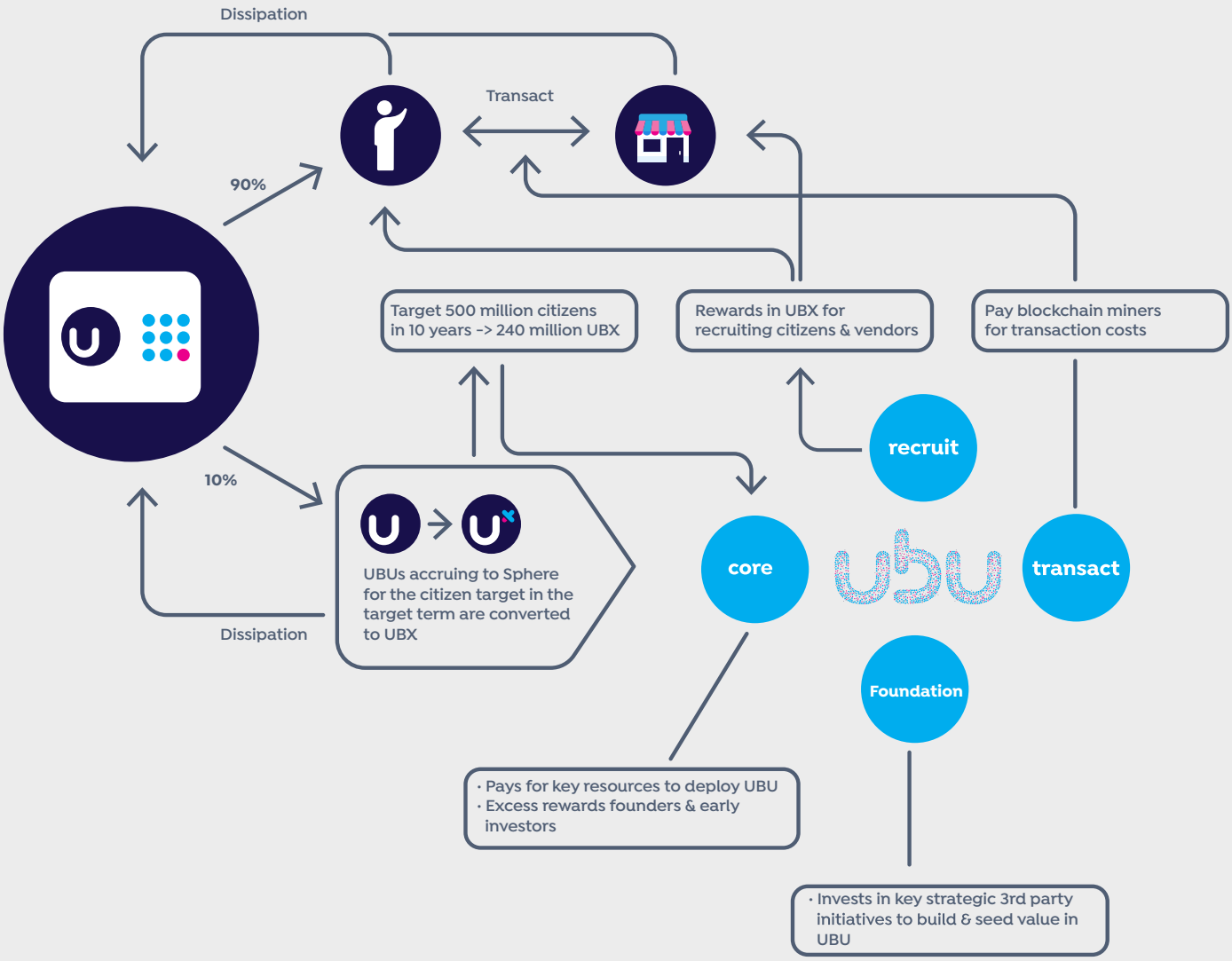
Citizens receive UBUs as they are the primary value driver and it is they that the UBU system is designed to benefit. As has also been shown in the mathematical part of this paper, limiting issue to citizens creates a natural limit to the total number of UBUs that can be in circulation because of the dissipation mechanism.

In order to create value for citizens the chicken-and-egg conundrum of provision of real property rights must be solved. In order to achieve this, a further issue of UBUs to the entire enabling environment of UBUs is activated. The enabling environment is collectively known as the UBU Sphere. The issuance of UBUs to the Sphere is based on the total number of citizens in the system. These UBUs are then parceled into the UBX as described above to create an instrument more useful to securing the adoption of citizens, vendors and bootstrapping projects.

Building the UBU System

In order to deliver on the promise of UBU, the system must be configured to have the best possible organisational structure to deliver on the various aspects that will make it a success. We have chosen to call the UBU system parts the UBU Sphere. It is the intention to enable the UBU as an operating system free from the control of anyone as soon as possible – in what is known as a Decentralised Autonomous Organisation or DAO. However, in order to get to that point, there are numerous social and structural activities that will need to work well together first.

The following diagram illustrates the overall structure and flows of UBU and UBX and the operating parts of the Sphere, which are discussed in more detail below.



Division of the Sphere

The Sphere is divided into four key operating areas which we call Sphere Entities:

1. UBU Core which is tasked to
· Developing the systems required for the UBU; and
· Bootstrap the value of the UBU as a unit of exchange; and
(Ensure the maximum use of the UBU as represented by the maximization of the number of citizens; and
· Ensure that UBUs and UBXs are allocated to Sphere Entities in accordance with what is set out herein; and
· Ensure that other than as required for practical early stage operating considerations, UBU operates as a Distributed Autonomous Organisation

2. UBU Recruit is tasked to
· Recruit citizens
· Recruit vendors

3. UBU Transact which must
· Ensure that transaction costs are affordable in the context of the UBU
· Ensure that transaction costs for the UBU can be funded within the UBU system

4. UBU Foundation which will
· Raise capital necessary for any bootstrapping projects required for the UBU - primarily by way of UBX issued from the allocation made to UBU Core.
· Utilise UBUs that might be donated for further social good

UBU Core and UBU Foundation are registered companies set up in South Africa in full compliance with South African laws and operating in accordance with the good corporate governance procedures of that country.

UBU Recruit and UBU Transact are notional entities for the allocation of UBUs and UBXs to recruiters and transacting agents as set out further herein.

Issue of UBU to Citizens and Sphere
UBUs will be issued on the following basis to recipient classes
· 100 UBUs per day to each Citizen
· 11 UBUs per day to the Sphere issued on a per citizen basis

The 11 UBUs issued to the Sphere will be assigned to the Sphere Entities as follows:
· UBU Core – 3 UBUs per citizen per day
· UBU Recruit – 3 UBUs per citizen per day
· UBU Transact – 3 UBUs per citizen per day
· UBU Foundation – 2 UBUs per citizen per day (under the control of UBU Core)

Assignment of UBUs to UBX

The table below shows in the modeling that for a citizen base of 500 Million achieved before the year 2030, that a total of 241 Million UBX can be issued to the Sphere without compromising the allocation of net UBUs that will be issued by the Treasury to the sphere, either over that time period, or in the future. This calculation considers that UBUs issued to Sphere wallets dissipate in the same manner as UBUs issued to Citizen wallets.

UBUs to UBXs

Total UBUs accruing to Sphere (Millions)	8 613 076
Total UBUs dissipating from Sphere (Millions)	-2 372 083
UBUs available for allocation to UBX (Millions)	6 240 993
UBUs allocated per UBX	25 942
Allocatable UBX (Millions)	241

Assigning UBX to Sphere entities

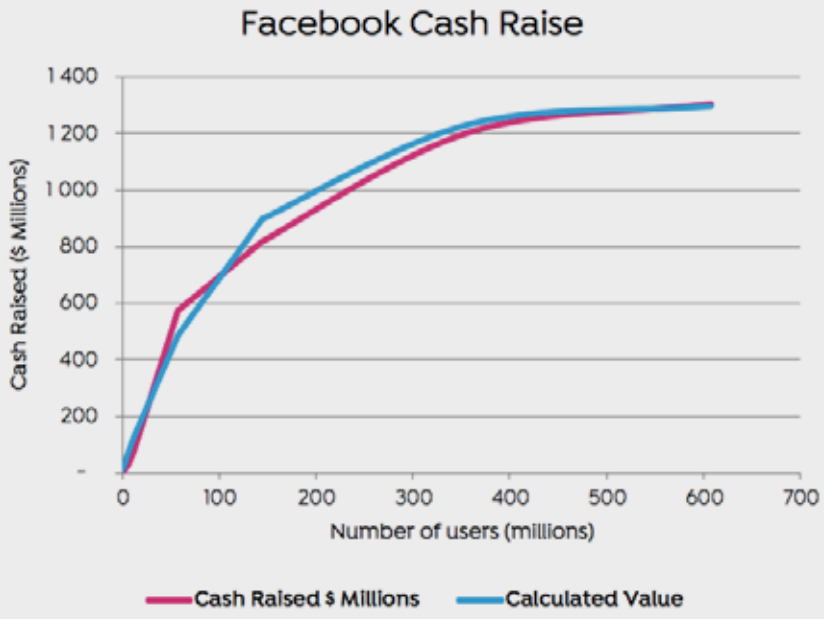
Sphere entities are thus assigned the following UBXs in order to enable the UBU system to be built out

- UBU Core – 66 Million UBX
- UBU Recruit – 66 Million UBX
- UBU Transact – 66 Million UBX
- UBU Foundation – 42 Million UBX (to be held by UBU Core and issued as required to Foundation)

Capital requirement for the UBU Sphere and capacity of UBX to meet it

How much capital will UBU Core require in order to develop and roll out its systems, and to bootstrap the value of the UBU unit? As a proxy, we again consider the market requirements of entities with a similar growth dynamic. In the example below, for consistency we again consider Facebook.

In rolling out Facebook considerable capital was deployed, as shown by the following chart. The raw data was overlaid with an exponential curve formulation which was fitted using the least squares method:



This formulation indicates that for a rollout to 500 Million citizens, UBU Sphere would require a total of $1,300 Million, or a total cost per citizen averaging at $2.60 per person. This only captures the capital that was raised, and does not cover income generated since the capital raising ceased so the actual operating conditions may well be very different. We do not know how much it will cost to deploy to our target citizen base, so the above formulation is the closest approximation that we can make at this stage. However we wish to make an assessment of the possibility of achieving that using the value metrics we have established above.

The three parts of UBU Sphere that effectively deploy or can deploy UBX to the acquisition of citizens (and related activities) are Core, Recruit and Foundation. Transact is not included as that is a pure transaction related cost to be deployed when the UBU itself transacts.

On this basis, 174 Million UBX can be deployed in pursuit of recruiting 500 Million citizens.
On the basis that $1,300 Million is required, that indicates an average price of $7.47 per UBX must be achieved. As shown above, we consider that a reasonable UBX price of between $3.34 and $16.50 should be achievable over the time frame required for such capital deployment which ought to satisfy the capital requirement for rollout.

UBU Recruit

UBU Recruit is a notional entity set up initially by UBU Core. Its purpose is to establish the mechanisms and assign rewards (in UBX) to enable the rapid recruitment of both citizens and vendors. A comprehensive rewards mechanism ensures that people are incentivized to recruit citizens, and that citizens are incentivized to introduce and recruit other citizens. Any person or entity that recruits another citizen is entitled to receive UBXs for that recruitment activity on the basis of 1 UBX per citizen recruited, although a halving mechanism is established to reward the early growth of the network. The idea is that in the early stages the network of citizens will predominantly grow through the introductory activities of others already in the network – in a similar manner to the epidemiological growth process discussed earlier. Later on, as the reward diminishes, the network grows predominantly of its own volition and due to the usefulness of the UBU as a means of exchange for real goods and services.

The detail of this plan is discussed on the UBU website and in other documentation, but is covered in brief here in order to understand the impact of the recruitment philosophy on the UBX.

We distinguish between two classes of recruitment
· Recruitment of citizens
· Recruitment of vendors

Citizens or vendors can be recruited directly by anyone wishing to do so. However, some people may also wish to become what are termed “nodes”. A node is a person or entity that has decided to make a business of recruiting citizens and/or vendors and in order to do so has fulfilled certain criteria.

A node is analogous to a miner in a cryptocurrency sense.

Recruitment of citizens will be rewarded as follows:
· Payment of 4 UBX per recruited citizen to the recruiter, this number will halve for every doubling of the number of citizens beyond the Commercial Release date.
· A node receives one quarter of the UBX paid in total to the network controlled by the node

· A node that recruits and trains other nodes is entitled to 20% of the UBX received by the recruited node.

This results in 8 Million of the 66 Million UBX allocated to Recruit being utilized in citizen recruitment activities

Total UBUs accruing to Recruit (Millions)	768 246
Total UBUs dissipating from Recruit (Millions)	-548 801
UBUs available for allocation to UBX (Millions)	219 445
UBUs allocated per UBX	25 942
Allocatable UBX (Millions)	8

However, should it transpire that double the expected citizen acquisition rate is achieved, then the compensation plan would require paying out 31 Million UBX.

The vendor compensation plan works in a similar fashion, but also looks to reward the scale of vendor adoption of the UBU so is a more complex process than needs to be set out here. In Summary, the 64 Million UBX allocated to Recruit is sufficient to ensure that the compensation plan can be accommodated.

UBU Foundation

As set out above, at the outset the set of property rights that can be assigned to UBU will be very small or zero. It will therefore be essential to "light the fire" of the system by setting up projects to start and then increase the set of property rights that can be assigned to UBUs. This is not unique and is a process followed by all currencies, fiat or otherwise, at the inception of their value journey.

The purpose of UBU Foundation is to deploy UBX to support the general endeavours of UBU Core, but primarily to set up schemes that can enable, seed or bootstrap value exchange propositions within societies where the UBU is still nascent or where it may be struggling to take hold. In other words, to commence the process of assigning property rights to UBU.

For example, UBU Core is presently working within a trial community near Johannesburg in South Africa. A piece of land has been allocated on which it is hoped to be able to build a 1,000-person orphanage (South Africa has an enormous orphan child problem). In addition to government and donor funding the project requires $3-30 per child per day to provide for the care and housing, clothing, feeding, medical care and teaching needs of the children.

The Foundation team evaluate the project and consider that although the UBU presently may only have a value of, say, 2cents (meaning a total UBU possible contribution of $2.00 per day per child), by seeding an investment of $5 Million into the project, it can help to lift the perceived value of the UBUs per citizen to the required $3-30 per day which would be required to make the project sustainable in the longer term.

In order to do this, Foundation applies to UBU Core for 312,000 of its allocated UBX at the then prevailing price at $16 each to raise the $5 Million capital required. This capital is then granted to the promoters of the project who then use it alongside the conventional funding to build out the proposed orphanage. The Orphans themselves then give the UBUs to which they are entitled to the Orphanage which the orphanage then uses to purchase other goods and services (alongside the stuff it will use fiat currency to purchase).

Foundation does not earn a direct return from the UBUs, but rather has the mandate to invest on the basis that its investments will contribute to the rise in price of the UBU.

Foundation will be managed and operated by a third party specialist manager with the appropriate credentials required for such a task. The manager will be appointed by the trustees of the UBU Foundation Trust. Foundation is presently constituted as a private special purpose company in South Africa and the single shareholder at this point is Bridge Capital Advisors (Pty) Ltd. Bridge are specialist advisors and also sponsoring brokers to the Johannesburg Stock Exchange.

Bridge Capital created the UBU Foundation on behalf of UBU Core and as such is the sole shareholder at this point. Bridge will transfer the shareholding that it has in UBU Foundation to the UBU Foundation Trust, which is to be a good purpose trust, as soon as practicable after the ITO as possible.

In time, UBU Foundation will also seek to attract additional donations, perhaps in UBUs, perhaps in other cryptos or fiat currency, and will also seek to utilise these funds for a greater social good purpose.

UBU price **1** **$ cent**

	UBU	$	Tx Fee$	Transactions	Fees $
Weekly Issue	700	7,00	0,004	1	0,004
Assumed Ave Transaction Size	50	0,50	0,006	14	0,084
Total Value traded	700	7.00		Total	0,088
Tx Cost	8,80	0,088			
Tx Cost %	1,3%				
UBU/Day	1,26				

The Initial Token Offering and deployment

In order to permit Core to deploy real-world resources in the form of staff and other resources to delivery of the promise of UBU, it will need to raise capital. A number of crypto tokens have successfully used the online "crowd funding" marketplace for cryptocurrencies to raise capital for their endeavours, and Core intends to do the same. Importantly, unlike many tokens offered, Core will be using the proceeds entirely in the furtherance of the business of UBU and only to the extent that that is achieved will the founders and shareholders be rewarded. This is set out below.

UBU Core

UBU Core is the founding entity of UBU. Its founders and investors have already spent, in the 30 months to September 2017, $1.79 Million on delivering the MVP of which $538,000 (30%) has been in cash. The remainder has been expended in unpaid services or contractual services whereby contractors and staff will be paid in UBX on a success basis at the time of the ITO.

UBU Core was established in November 2016 and formally constituted as a limited liability Company according to the laws of South Africa in April 2017. It has defined the following operating periods:

· The MVP (Minimum Viable Product) - This was the initial development period leading up to the end of September 2017 during which the initial wallets and other operating activities would be developed ready for testing in Phase 2

· Phase 1 – The period between MVP and Commercial Release in April 2018

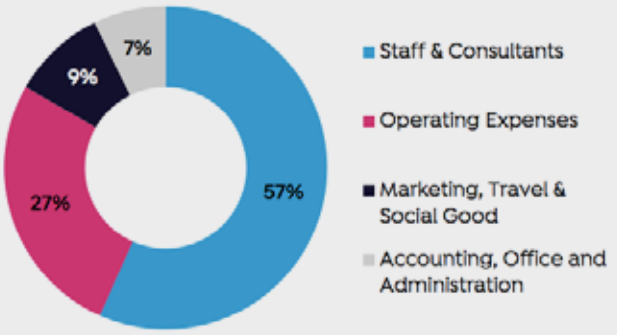
· Phase 2 - Commercial Release and Operations where the whole system is ready for mass adoption at scale, and 18 months of operations is included.

Investment, Expenses & Token Sale Proceeds

UBU Core expenses and forecast expenses

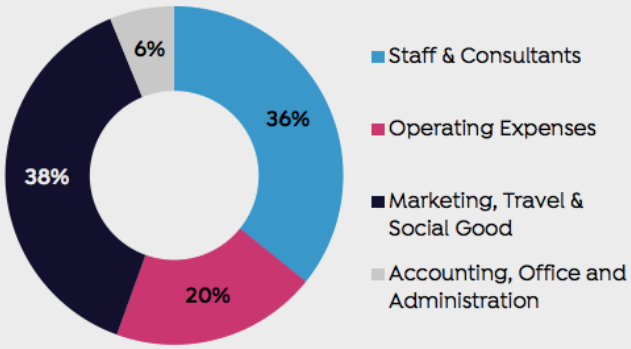
Core has funded the MVP with expenses totalling $1.04 Million as follows:

Expenses up to MVP



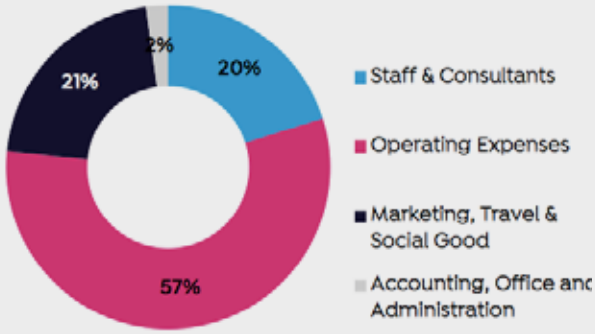
In the following 6 months to Commercial Release in April 2018, the expenses are forecast to be a further $1.5 Million as follows:

Forecast Expenses - Operations Phase



In the 18 months after Commercial Release in April 2018, the expenses are forecast to be a further $38 Million as follows:

Forecast Expenses - Phase 2



UBU Core Capital requirements – Minimum and Maximum in the ITO

The capital requirements set out in the previous section indicate that a total of $39.5 Million will be required to take UBU from the current status of MVP to full operations over a 24 month period. $1.5 Million will be required to attain Commercial Release and the balance in the 18 months thereafter.

However, there are tax and regulatory uncertainties about how UBX will be treated from an income and Value Added Tax perspective. Accordingly, the required cash must be grossed up by both the VAT rate of 14% and the corporate tax rate of 28%, resulting in a maximum raise of $58 Million.

Accordingly UBU Core will, in the period of the ITO, seek to attain a minimum raise of $1.5 Million and a maximum of $58 Million. If the minimum is not raised successfully, then any capital received pursuant to the ITO will be returned to the prospective buyers.

Note that UBU Core is the only entity that will be selling UBX during the ITO. Foundation will be able to sell the UBX allocated to it into the market only on an as needed basis to support the aims of UBU Core and its own mandate. Similarly, UBX allocated in terms of the Recruit or Transact process will be issued according to the performance set out in those sections and will not be available ab initio to be sold to the market.

Allocation to UBU Core shareholders and lock-up periods.

As set out above, Sphere will need to deploy $1,300 Million or UBX 174 Million in order to attain the target of 500 million citizens, but that this will come from the allocation to Core, Recruit and Foundation.

UBX 66 Million must be deployed by Core to attain 500 million citizens. To the extent that the price of UBX exceeds expectations, or in other words that fewer UBX need to be sold by Core to achieve its objectives, the excess can be deployed to the shareholders of UBU Core. The excess deployable to shareholders will be determined by the company in conjunction with its auditors and in accordance with prudent accounting practises taking into account the forward looking requirements of the company. Excess allocations will be determined in excess determination periods the first of which will be Commercial Release, and every 6 months thereafter. During Phase 2, UBX delivered to shareholders of Core will be locked up for a period of 6 months from the time of issue to shareholders.

Issue of UBX to Staff, Consultants and Investors

A total of 511,159 UBX – representing 3.8% of the ITO issue - will be issued to Staff and Investors in Project UBU. This represents a $ price per UBX of $3-50 per issue (i.e $1.79 Million / 511,159 UBX) and is a 30% discount to the expected initial UBX price of $5.00.

The UBX issued to these parties be issued as follows:
· 30% on 1 November 2017
· 30% on 1 April 2018 (the Commercial release date)
· 40% on 1 November 2018

Maximum Tokens offered, Target raise and phase split of allocations.

A maximum of 13.3 Million UBX tokens will be issued during the three phases of the ITO period (excluding Bonus UBX). This should create sufficient funding to raise the required minimum of $1.5 Million and the target of $60 Million. Token issue is limited on a per period basis and any tokens not taken up during a phase will be added to the tokens that are available in the follow-on phases.

Tokens are allocated to the phases as follows:

MVP Staff and Investor issue	3,8%
Pre-Sale	30,1%
ITO Public Sale	33,8%
Contract Sale	36,1%

Total Tokens to be created and allocations to various parties

As set out above, a total of 240 Million UBX tokens are created initially to enable the UBU system to be deployed to 500 Million people. No more UBX tokens will be issued until 80% of the target of 500 Million citizens has been achieved – anticipated in 2025. Once this milestone is attained, a further 240 Million UBX can be issued with the allocation of UBXs that are then issued being deployed in exactly the same ratio as the UBX that will be deployed now and in the period up to the attainment of 500 Million citizens. Thereafter further issuance of UBX tokens can be made on the same basis.

UBU Tokens are issued as follows:

	Distributed immediately (millions)			Distributed over the operations period (ten years) (millions)				
	UBX allocation (millions)	Staff and initial investors	ITO Investors	Est distribution to Core shareholder	Retained for later deployment	Charities and UBU price support	Blockchain transaction costs	Citizen & Vendor Recruitment
Core	66	0,51	13,3	2	50,19			
Transact	66						66	
Recruit	66							66
Foundation	42					42		
TOTAL	240	0,51	13,30	2,00	50,19	42,00	66,00	66,00
% allocation		**0,2%**	**5,5%**	**0,8%**	**20,9%**	**17,5%**	**27,5%**	**27,5%**

Transact and Recruit are rewarded with UBX on an as-earned basis. 66 Million are allocated to Core, and a further 42 million are allocated to Core for the purpose of being deployed to Foundation to support the key value and price building activities of the UBU – primarily through charitable and commercial endeavours to seed the value of the UBU in the market place.

Core is obliged to deploy the 66 Million UBX in the furtherance of its objectives as the originating business entity of Project UBU. To the extent that UBU Core can demonstrate to its board and its auditors on a prudent forward looking basis that it does not need to sell more UBX to the public, then, and only then will any excess UBX be delivered to UBU Core shareholders as a form of dividend. However, at the outset, Core will issue 13.3 Million UBX plus an additional 511 thousand which are issued to investors and staff in lieu of cash invested and unpaid services provided.

UBU Core Staff, Investors and Shareholders will thus initially be entitled to a total of 1% of the UBX issuance although, depending on how successfully and efficiently Core performs its business, it will have the possibility of accessing another 20.9% in the future. On the assumption that a mature UBU Core business will in future be able to deploy 30% of these to its shareholders (IE that it will spend 70% of them on the businesses operations costs), then a further 6% of UBX will accrue to the Core shareholders, bringing the total net allocation of UBX to Core to 7% of the total issuance of UBX.

Organisation Structure

The shareholding of UBU Core and its structural arrangements in relation to the other parts of UBU and the UBU Sphere are set out below:

Beneficial Shareholding

38,0%	Global Voice Norway
9,5%	Dudley Baylis
9,5%	Justin McCarthy
9,5%	Douglas Reed
7,2%	Steven Sidley
7,2%	Bridge Capital Advisors
5,0%	Shumbashaba Community Trust
5,0%	Gracepoint Methodist Church
2,4%	Charles Marais
1,5%	Millard Arnold
1,5%	North Quotient
1,5%	Phantom Design
1,2%	Andrew Baylis
1,0%	Owe Nythun

Advisors and Service Providers

The following firms are advisors and service providers to Project UBU

Corporate Advisors: Bridge Capital Advisors Ltd www.bridgecapital.co.za

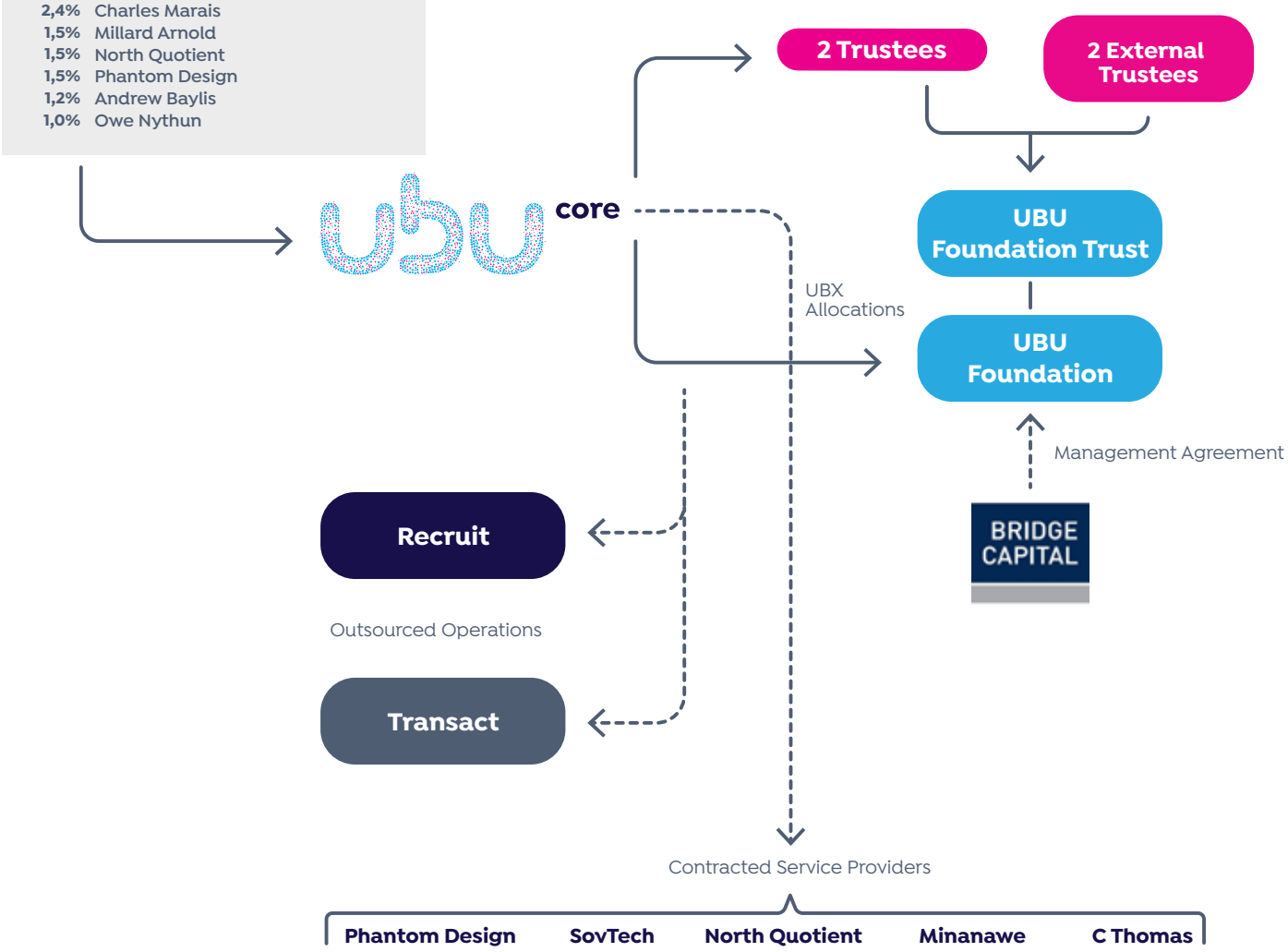
Legal Advisors: Hogan Lovells (Johannesburg) https://www.hoganlovells.com

Blockchain Advisors: Gavin Marshall https://sharebit.io

ITO and Crypto Advisors: Simon Dingle https://phantom.design/

Mathematicians: Viroshan Naicker http://www.north-quotient.com/

Software: SovTech https://sov.tech/



e-Wallet & Associated Product Suite

System architecture, functional architecture and process flow

The diagrams below demonstrate some examples of the system architecture, functionality and processes. This is not a complete technical description of the product, but serves to indicate some of work undertaken by the technical team during the design and specification phase

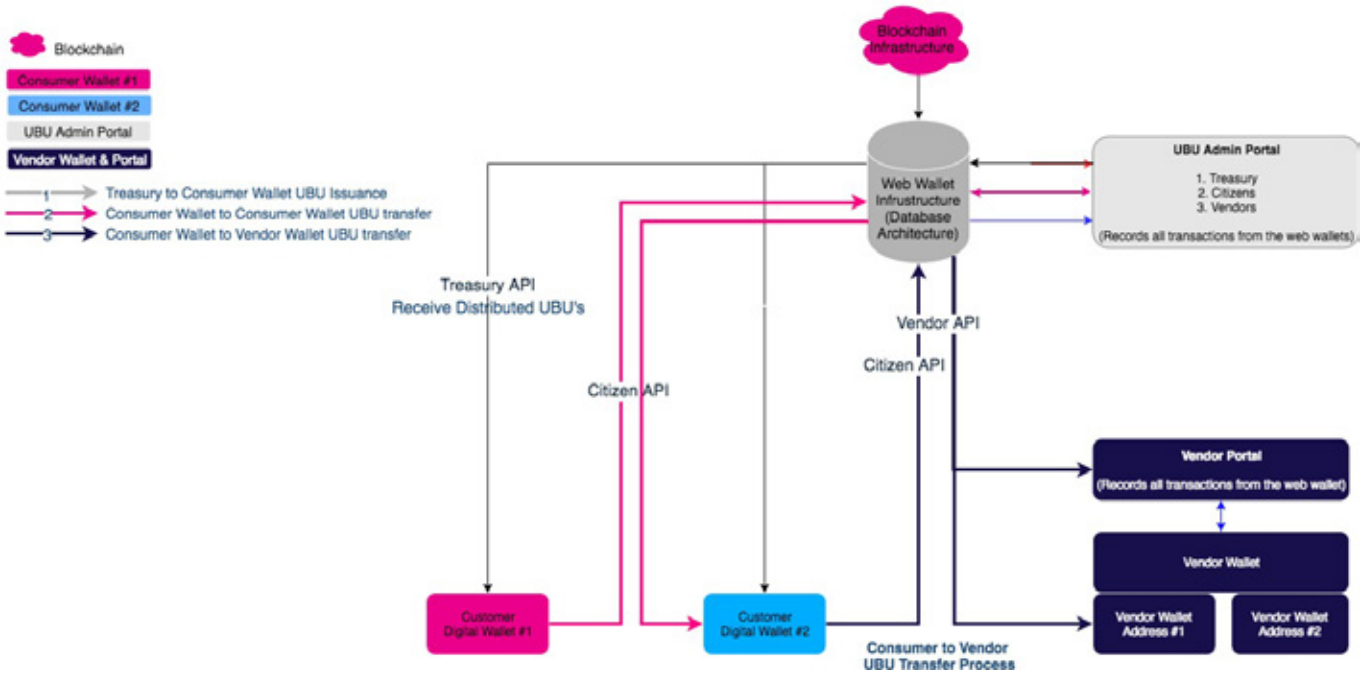


Image 1: Major transactional flows

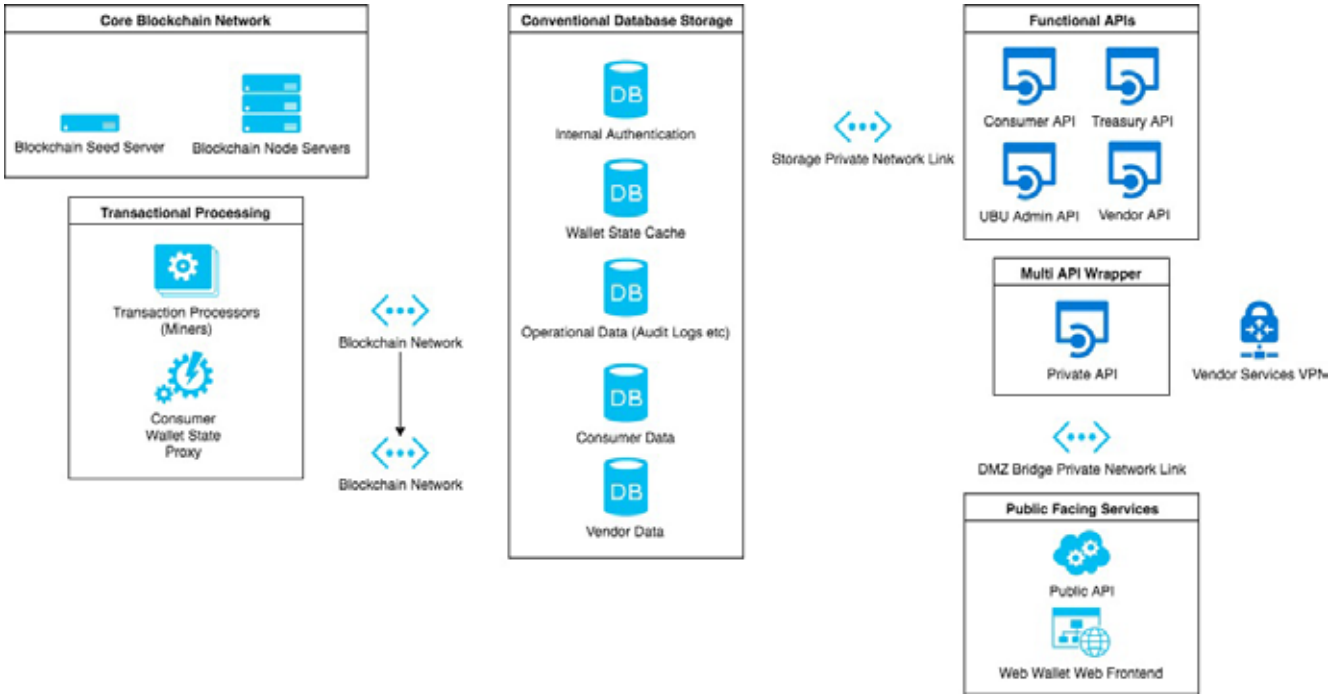


Image 2: System architecture components

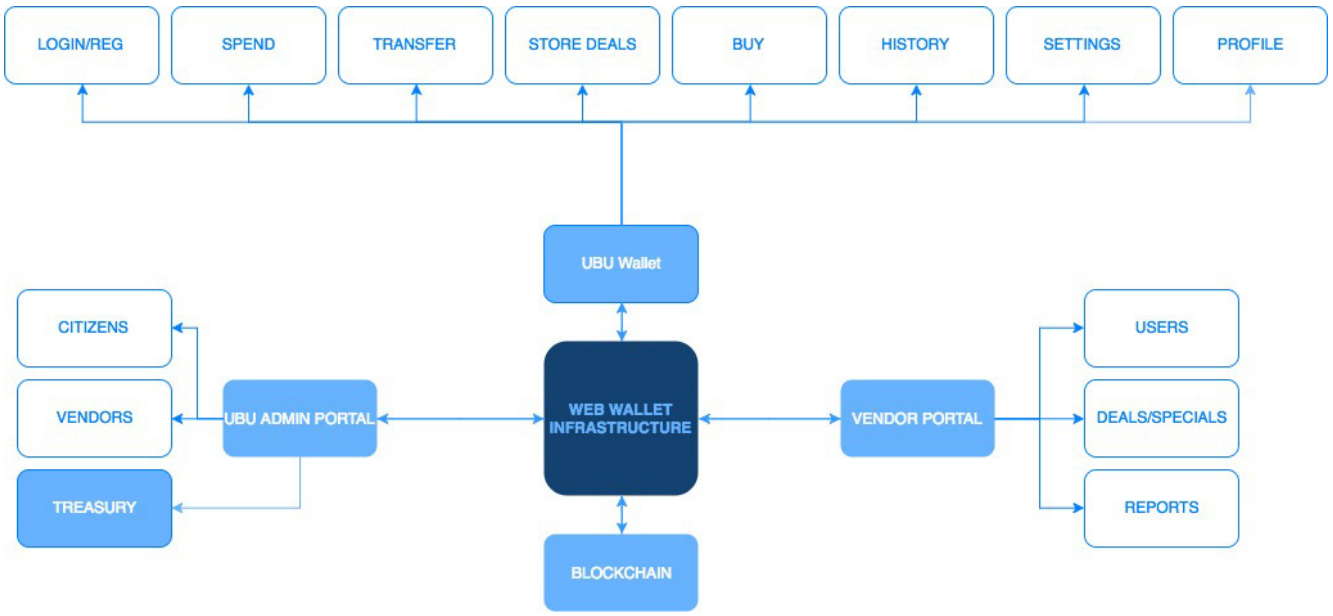


Image 3: Technical Blueprint & User Flow

Citizen application

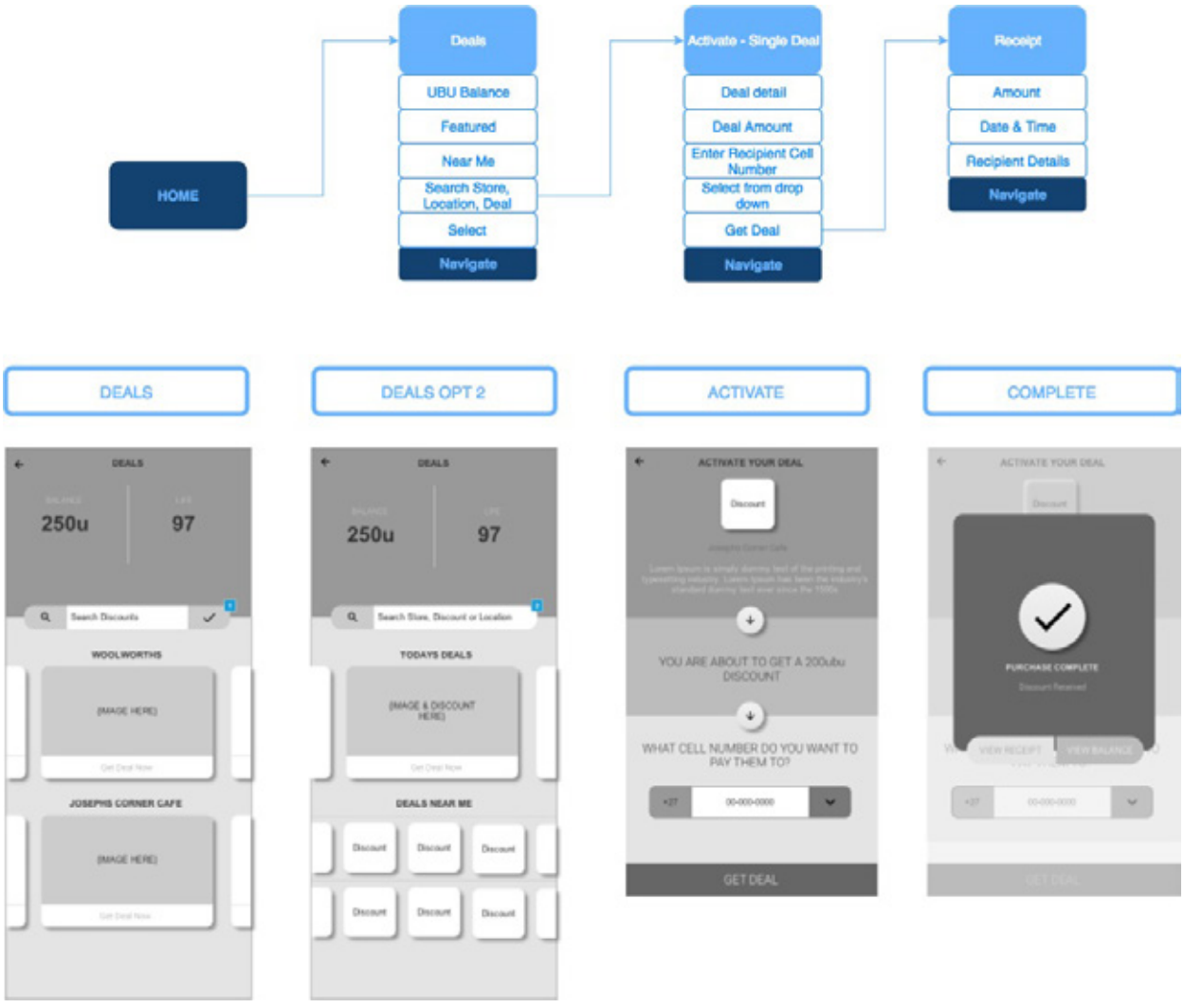
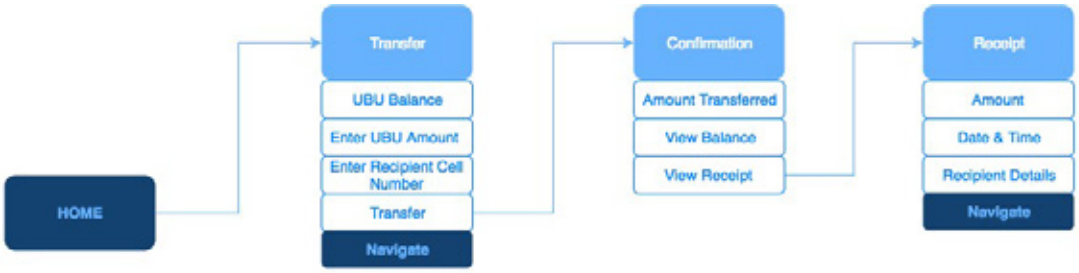


Image 4: Spending UBUs

Citizen application



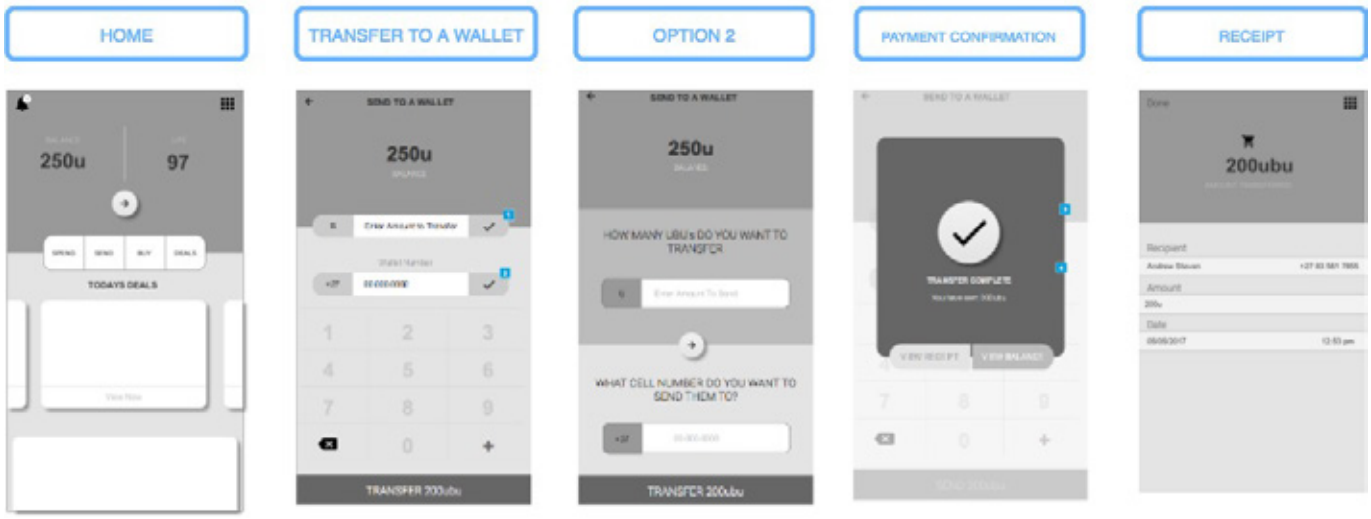


Image 5: Transferring UBUs

Citizen application

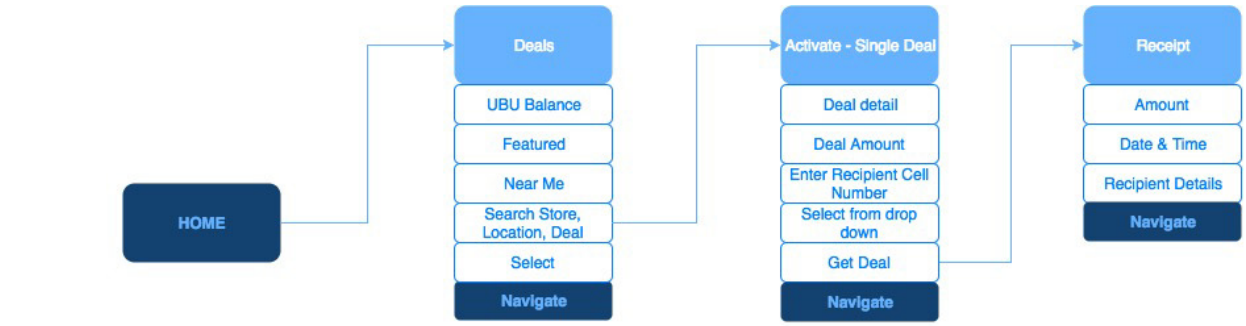
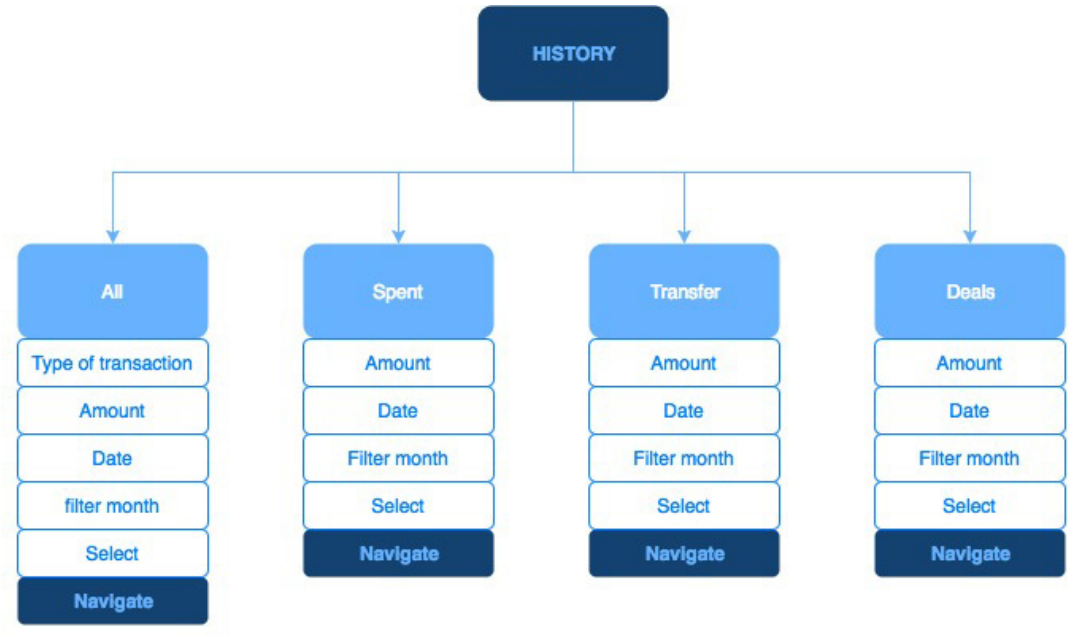


Image 6: Deals

Citizen application



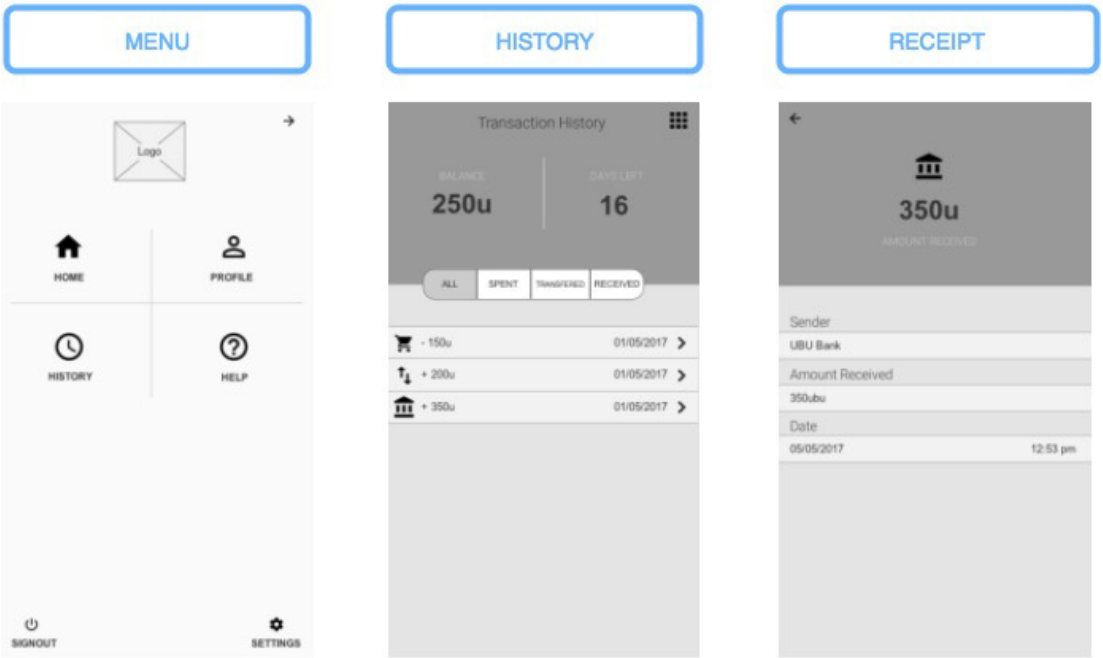


Image 7: Transactional History

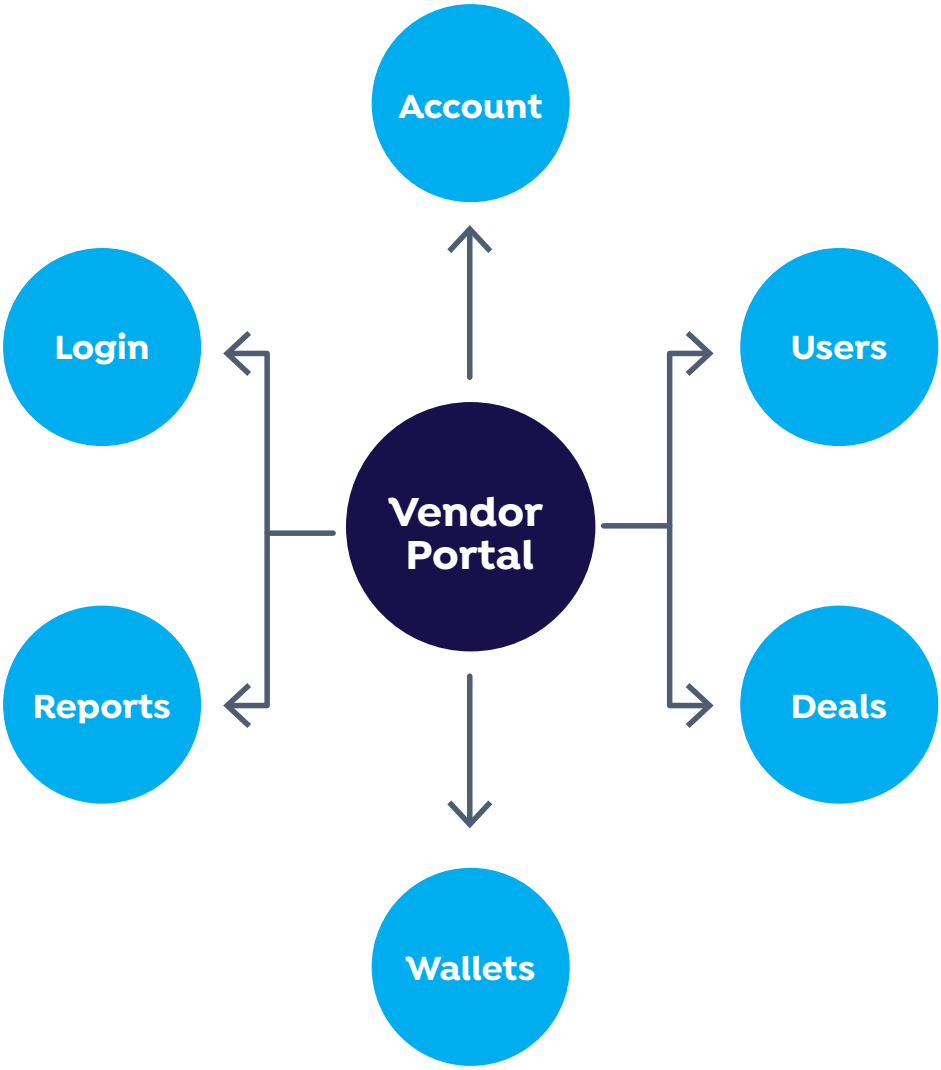
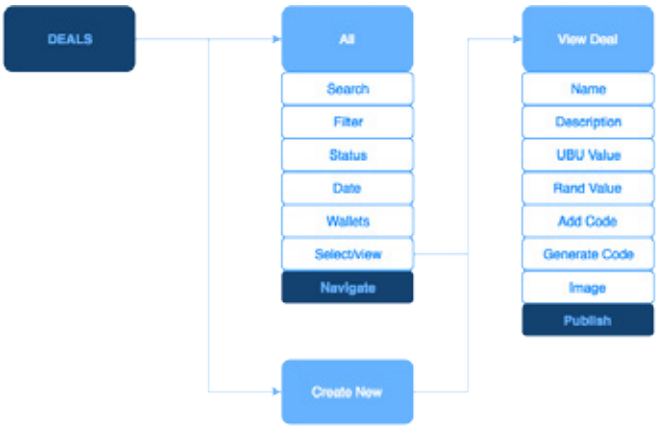


Image 8: Vendor Portal

Vendor Functionality



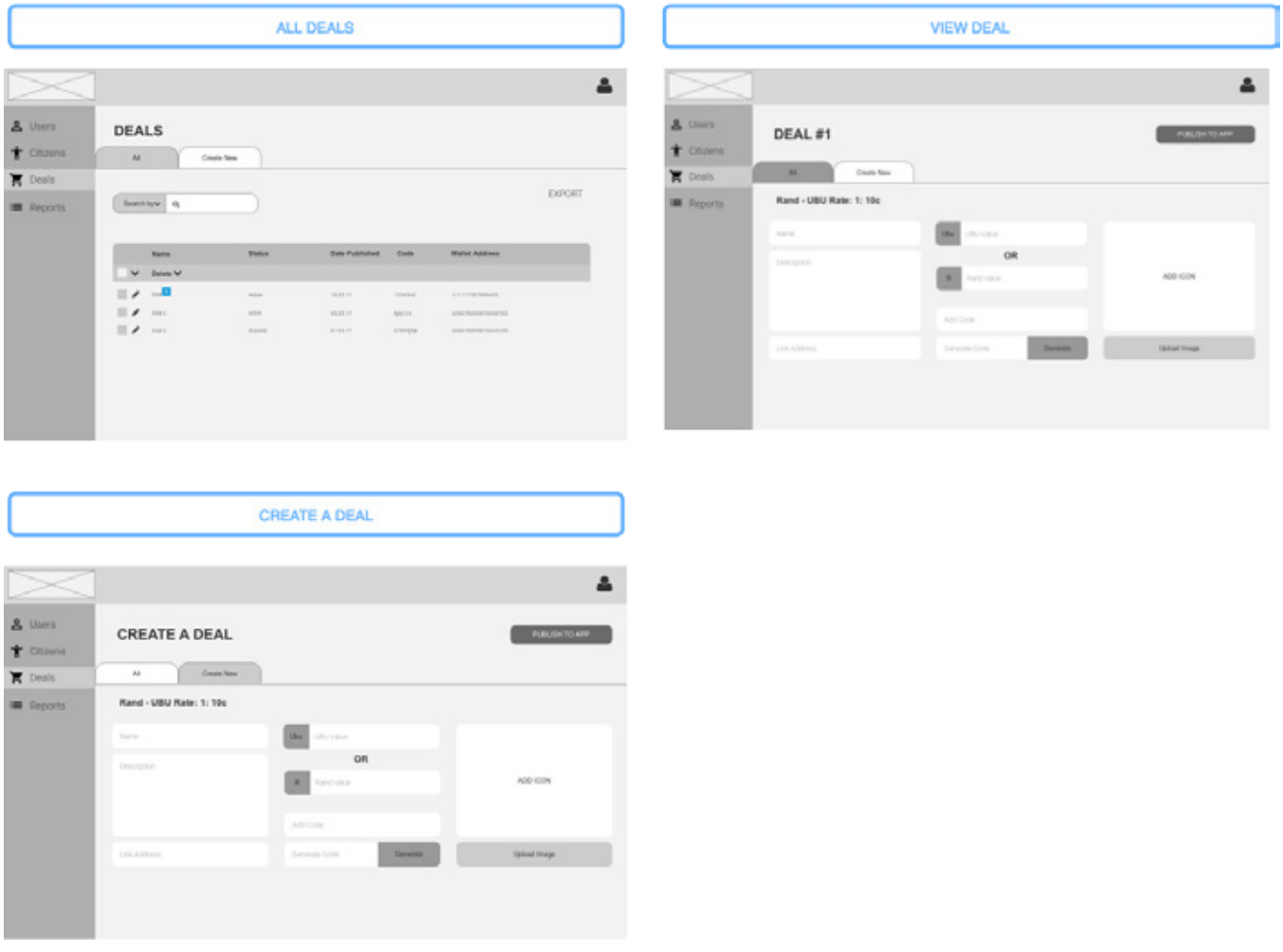
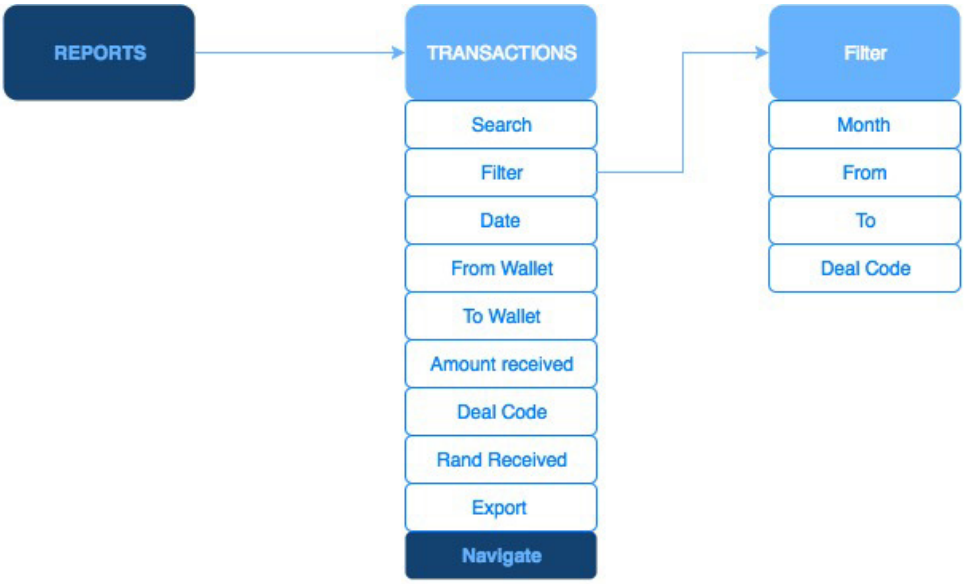


Image 9: Vendor Deal Loading

Vendor Functionality



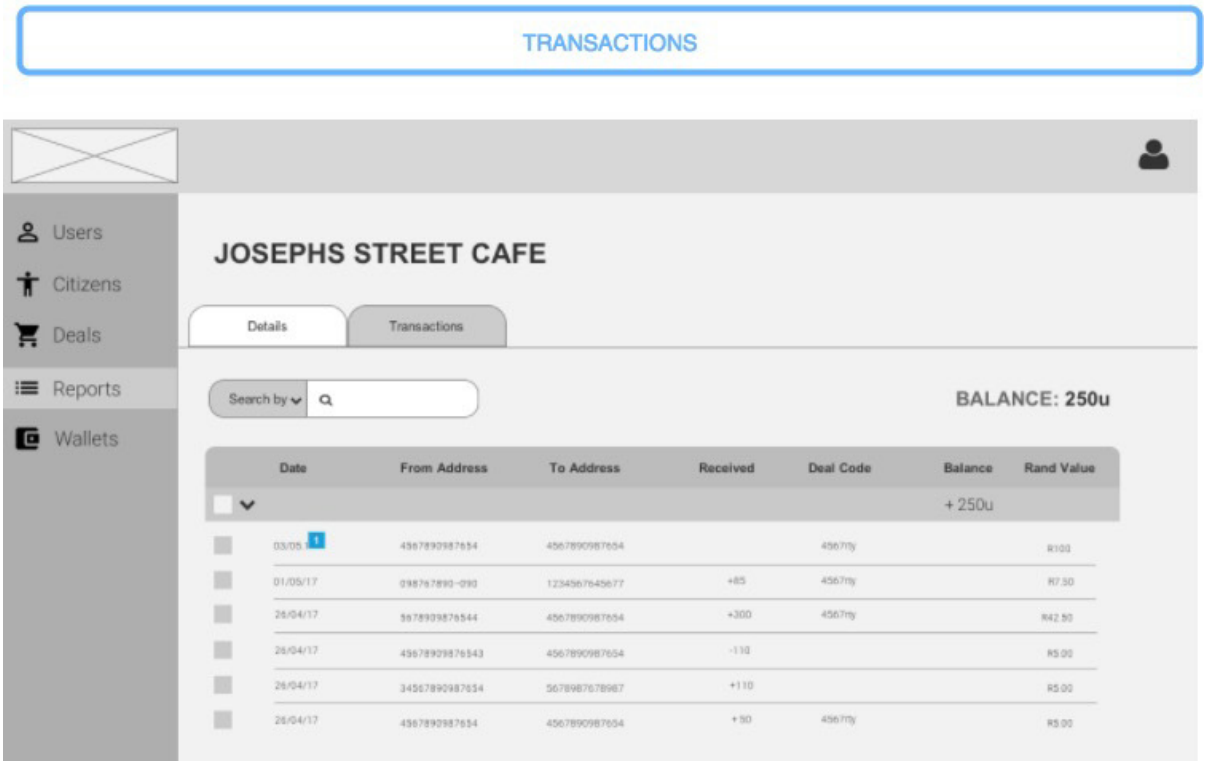
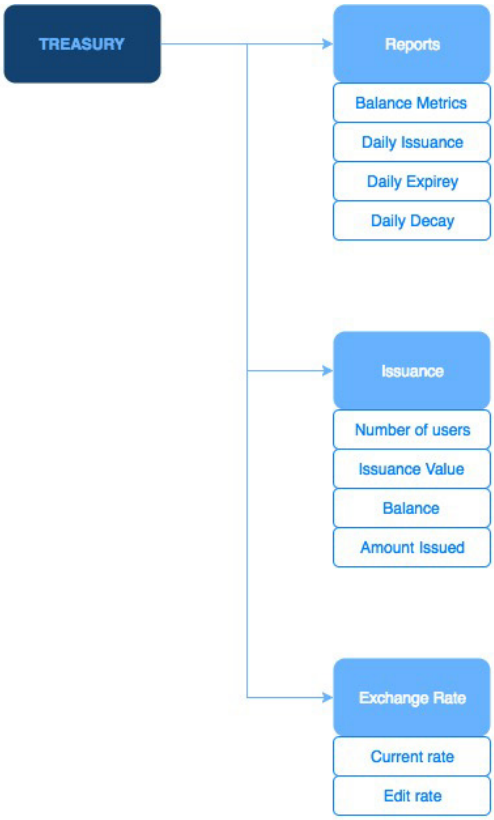
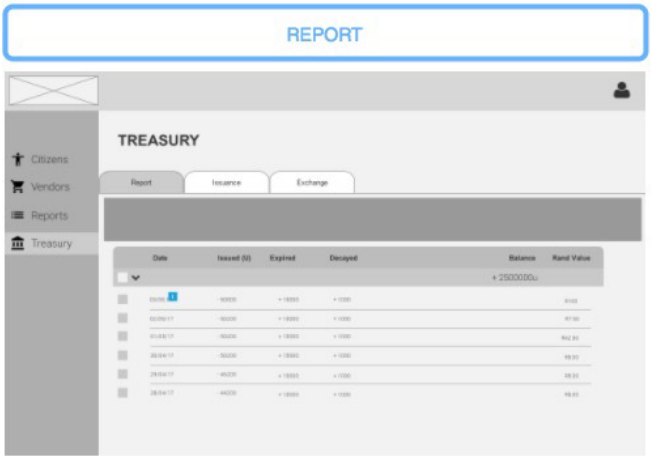


Image 10: Vendor reporting

Vendor Functionality





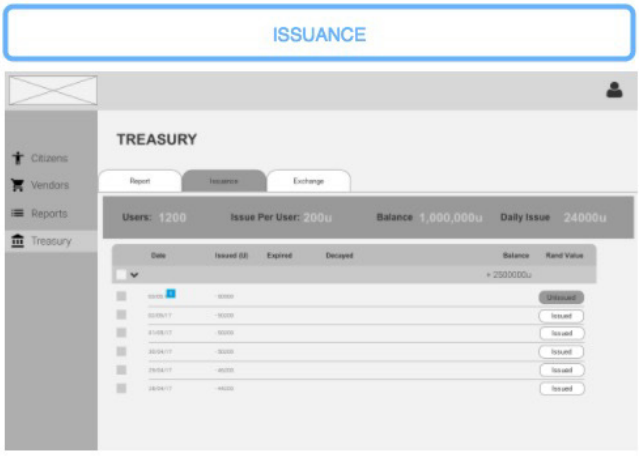
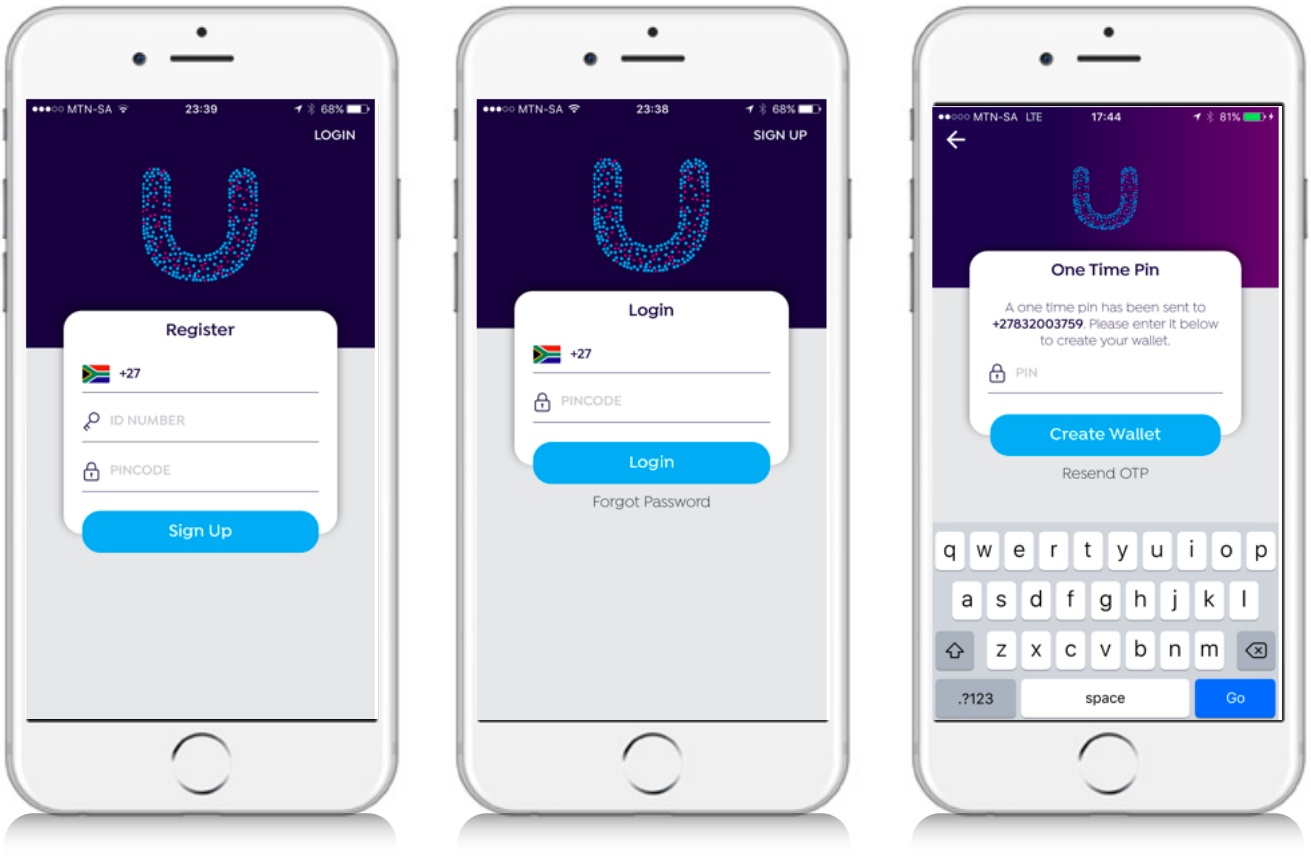
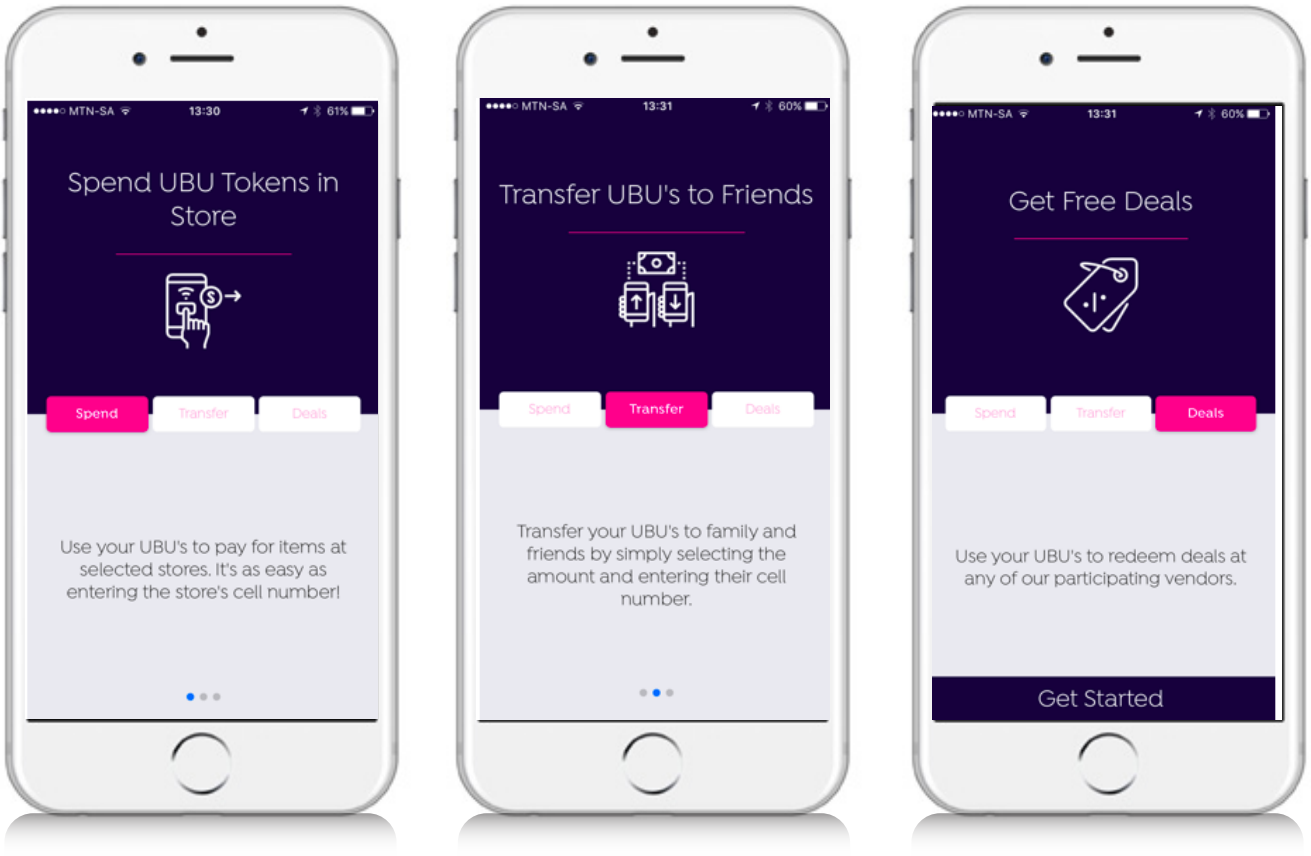


Image 11: Treasury architecture

Getting started on the UBU smartphone app



Getting started on the UBU smartphone app



Getting started on the UBU feature phone

Simple USSD interface for old and new feature phones

Legal & Regulatory

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Regulation of crypto tokens varies considerably from one jurisdiction to another and purchasers from the following jurisdictions (while making no warranty, representations and/or undertakings in relation to any other jurisdictions) are specifically notified that it may not be lawful for them to purchase the UBX in these jurisdictions and that accordingly the UBX is specifically not offered to persons from such jurisdictions. Given the continually changing nature of regulations pertaining to cryptocurrencies and crypto tokens, the list below is not exhaustive:

United States
Canada
China

UBU Yellow Paper

Tokens and Universal Basic Units

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Disclaimer: The idea of a self-sustaining universal basic income is in and of itself the property of UBUcore (PTY) Ltd, having originated with Dudley Baylis, Project UBU's founder. This document was commissioned by UBUcore for the express purposes of providing the mathematical and economic evidence in support of the idea. The supporting arguments contained herein have been arrived at independently, albeit in consultation with UBUcore. Rights to publish this work in the academic field have been granted by UBUcore to Viroshan Naicker and North Quotient (PTY) Ltd. All other rights to re-brand, publish and distribute this work are reserved.

Abstract

Cryptotokens and currencies have irrevocably altered our notions of money and value. Over the last few years the advent of Bitcoin, Ethereum and their derivatives have created new economic possibilities while disrupting embedded intuitions about money and finance. The invention of blockchain and distributed ledger technology has negated the need for third parties to verify transactions in digital payments systems. As a developing new technology, novel research is required to understand cryptotokens as information processing systems that store, assign and distribute property rights to economic agents. In this vein, the present paper has two aims: The first is to introduce and develop a framework for describing token systems as tools for storing economic information and property rights; the second is to apply this framework to a specific cryptotoken system: the Universal Basic Unit or UBU. The UBU token is the basis of Project UBU (`www.projectubu.com`); a global scale universal basic income system, conceived as a cryptotoken, that operates using autonomous blockchain protocols. To this end, we prove several results concerning abstract token systems and integrate these results into understanding the UBU and its derivative the UBX.

1 Introduction

Cryptotokens and currencies have irrevocably altered our notions of money and value. Over the last few years the advent of Bitcoin, Ethereum and their derivatives have created new economic possibilities while disrupting embedded intuitions about money and finance. The invention of blockchain and distributed ledger technology which solves, computationally, the *Byzantine General's Problem* negates the need for third parties such as banks to verify transaction records in digital payments networks [7, 9, 13, 14, 15]. Thus, economic agents may carry out peer to peer transactions digitally as if they had exchanged hard currency in cash.

Bitcoin, the original cryptotoken, started off as an experimental accounting system which tracked, in a public ledger, the exchanges of Bitcoin tokens between participants [9]. More specifically, the Bitcoin ledger was the first implementation of the blockchain protocol to verify transaction records: The transactions took place digitally, over the internet, as Bitcoin tokens moved between anonymous wallets. The work of verifying the transaction record and implementing the blockchain protocol was done by 'miners' who were awarded new Bitcoins by the software in exchange for solving a computational transaction problem.

The ideas behind Bitcoin were extremely innovative: Not only was the Bitcoin network a novel payments system, but, since private identities could be separated from public wallets, it also gave users anonymity. Further, it enabled worldwide token transfers for minimal transaction costs. This inherent utility gave the Bitcoin a value as an economic tool. In time, as a broader community adopted the use of the Bitcoin and as speculators took interest in the token as an investment, Bitcoin took on a dollar value becoming fungible with conventional fiat money.

In the wake of Bitcoin's success story various other cryptotokens were invented by using and modifying the original blockchain protocol [14]. By far the most valuable and well known of these is Ethereum; a system for creating and executing smart contracts. In contrast to Bitcoin as a purely payments network, the Ethereum network is a platform for building multi-purpose cryptotokens which give the holder specific rights that are encoded into the Ethereum contract. Ether, the token awarded for computational work done in the Ethereum network, has also attained fungibility with fiat currency.

For most people these 'information products and services' are a challenge to our intuitions about money and value. How can they be equivalent to 'real' money? And, is it money if it is not backed by the armatures of government, a central treasury and a financial system? It may be argued that the deeper question is, what is money anyway? The tokens that we use to facilitate our day to day economic lives are imbued with a value from society. It is the acceptance of these tokens as a means of value storage that give them a status as tools for exchange. Further, in light of this novel technology which challenges our preconceived intuitions novel research and ideas for information products that are based on the blockchain protocol are required.

The present paper has two aims: The first aim is to develop a framework for describing token systems as tools for storing economic information and property rights. Thereafter,

the second aim is to apply this framework to study a specific cryptotoken system: the Universal Basic Unit or UBU token[1] [16].

The UBU is the fundamental building block of Project UBU which aims to use the blockchain protocol to deliver a global scale universal basic income [16]. The UBU is an issued token not a mined one, and behaves differently from usual cryptotokens. Moreover, in order to raise funds to jump-start the project, the UBX token, a derivative product based on the UBU, has also been proposed. The major questions for stake holders relate to inflation and the supply of UBUs, economic value and the fungibility of the UBU with conventional fiat money and the valuation of the UBX instrument. It is these questions that the present paper attempts to answer. In particular, we prove several theorems about the UBU, the UBX and abstract token systems.

The paper is structured as follows: Section 2 introduces several ideas concerning abstract token systems. Section 3 introduces and outlines Project UBU which is responsible for the creating value in the UBU and UBX. Section 4 includes a number of proofs which show that despite it being a universal basic income the supply of UBUs converges in the long term. Section 5 addresses questions of fungibility between the UBU and fiat currencies, as well as presenting several results on the UBX derivative. In terms of mathematical notation and symbols, we follow [1]. As general references on macroeconomics we follow [2] and for difference equations [5].

2 Tokens into Property Rights

Monetary economies use cash, coins, and digital records as systems of tokens in order to account for the exchange of rights between individuals. These 'money' tokens in themselves usually have little intrinsic value but, by social consensus, they represent a type of *metagood* that encodes a contract between the bearer and the society in which the token is accepted as a store of value. In particular, in that society, the token may be exchanged for available token denominated property rights at agreed upon ratios or 'prices'. In these terms, a monetary economy, as opposed to a barter economy, separates into distinct parts: a token system which facilitates indirect exchange, encodes and stores value; and an underlying real economy which generates and creates property rights that may be transferred between economic agents and exchanged for tokens.

The allocation of tokens as place holders for property rights is ubiquitous in human society: Bus tickets, plane tickets, telephone airtime, casino chips and cloud computing access are all examples of tokenized property rights where once off exchangeable tokens give an agent the right to use property. As token systems go, monetary economic systems are by far the most widespread. Human societies have used a variety of items including cowrie shells, gold coins, diamonds, pearls, paper and digital records and, now, digital currencies to act as the 'tokens' in the system. A natural question to ask is, what abstract properties make an effective monetary token? The following four properties are, arguably, necessary and sufficient.

[1] UBU is pronounced *oooboo* and its derivative the UBX is pronounced *oooboo-ex*.

Property P1. *Scarcity. Tokens that are too easy to find cannot store value. Items which are common, for example, sand, do not make for good tokens because they are too easily found by economic agents outside of the context of market exchange agreements. Further, tokens necessarily must be difficult to duplicate by agents, so as to maintain the scarcity condition.*

Property P2. *Transferability. Markets reallocate property rights between agents, these rights are necessarily transferable. Consequently, the tokens that represent these rights need also be transferable. Non-transferable items such as tattoos do not make for good monetary tokens.*

Property P3. *Durability. Since tokens move continually between economic agents, they are required to be durable: Perishable items and items that wear out easily cannot store value over many exchanges. Cigarettes make suitable money tokens in prison communities, but only if one ignores their use rights.*

Property P4. *Unitisation. Monetary tokens are expected to represent a wide spectrum and a variety of property rights. Tokens quantify these property rights. Thus, an effective monetary token needs to be divisible into identical units that hold and store value across a spectrum. Further, tokens may have different physical representations: paper, coins, electronic data but there is a basic economic fungibility between these representations at unit level.*

Tokens with these properties become units of value storage and 'money' when they are imbued with social trust. It is the assignment of property rights to a particular token that gives it a value in a given society. Furthermore, the loss of this trust causes the token to revert to its original status as 'just a token'. On the other hand, tokens such as cigarettes and gold have their own 'use' value embedded into the token. These contrasting notions of value motivate the following definitions.

Definition D1. *Intrinsic value. The intrinsic value of a token is the consumption value of a token independent of the society which ascribes value to it.*

Definition D2. *Extrinsic value. The value of a token which is ascribed to it by a society; the token represents an equivalence class of property rights allocated to the token by social consensus.*

Definition D3. *Allocatable property right. An allocatable property right is a good or a service which can be allocated to an economic agent, so that the economic agent may claim ownership or exclusive access to the agent specific utility benefits of consuming that good or service.*

The next property marks the essential difference between a monetary token and a token that is equivalent to 'monopoly money'.

Property P5. *Social trust. In order for a token system to act as a store of value, it necessarily needs to be trusted, by social consensus, to store and encode generic allocatable property rights. It is this trust that creates economic fungibility between tokens and an*

underlying 'real' economy. Moreover, if the token is trusted, then quantitative units of the token define an equivalence class of allocatable property rights.

At this stage it is worth pointing out that cryptotoken and cryptocurrency systems virtually guarantee Properties P2, P3 and P4 above through the use of blockchain technology [9, 14, 15]: Tokens in peer to peer electronic exchange systems are eminently (and perfectly) transferable and do not rely on third party verification to guarantee that an exchange of tokens has taken place; a given blockchain is durable to the extent that those responsible for maintaining the integrity of the transaction record continue to do so; and a blockchain based token system can be adjusted so that token units denominated up to arbitrary decimal places can be used to represent allocatable property rights.

Beyond the basic features of blockchain technology, the missing elements to turn a token system into a currency are scarcity and strict rules which govern the supply of tokens. In fiat economies the role of regulating the money supply lies with central banks and government. Furthermore, governments allocate property rights to tokens by law through the declaration of a particular set of tokens as 'legal tender'. Social consensus and the acceptance of these tokens as a medium of exchange within a given geopolitical region gives a token the status of 'money'. In fact social consensus is stronger than legal consensus as many national currencies have failed simply because people lost faith in the ability of the currency to represent and store value. Examples such as the Weimar Deutschmark and the Zimbabwean dollar are well documented.

In the Bitcoin example, the supply of tokens is related to mining, the process of verifying the transaction record, and a fixed amount of tokens are created per unit time and added to the pool of existing Bitcoins. The placement of social trust into the Bitcoin was a gradual process that arguably had to do with the intrinsic benefits of the underlying technology in terms of privacy as well as the perfect transferability of the distribution system. The next definitions follow from this discussion as a means of clarifying the equivalence of different token representations and the scarcity of token supply.

Definition D4. *Token class. A token class is a set of economically fungible information carrying objects which have the status of being a token of a particular type. For example, paper dollars and coin dollars both belong to the dollar token class.*

Definition D5. *Vertical process. A vertical process refers to any process or rule which increases the supply of available tokens.*

Definition D6. *Token distribution channel. Any means or method by which tokens are reallocated between economic agents.*

Definition D7. *Horizontal process. A horizontal process is any process or rule which reallocates tokens from one economic agent to another using a distribution channel.*

These definitions collectively motivate and underlie the concept of a formal token system below.

Definition D8. *Formal token system. A formal token system incorporates a token*

class, a set of vertical processes, a set of horizontal processes and a token distribution channel.

Notice that fiat money, gold, bus tickets, and various digital currencies fit within this definition of a token system. Ether, the Ethereum token, represents the allocatable right to work done by the Ethereum network toward the execution of smart contracts [15]. The horizontal processes are the movement of Ether between those that execute contracts and those that require them executed, the vertical processes are the mining of Ether. The Ethereum network collectively acts as a distribution channel on which other tokens may be transferred. Moreover, an exotic cryptotoken like Civic [3] which uses blockchain for the purposes of identity verification also incorporates these systemic properties: A token which corresponds to a unique private identity as an allocatable property right, strict vertical processes which govern the creation of new tokens and an empty set of horizontal processes so that identities cannot be reallocated.

The remainder of this paper utilizes the language developed above in order to describe the specific details of the UBU as a cryptotoken, Project UBU as a formal token system, as well as several ideas around the fungibility of different token systems.

3 Universal Basic Units

Project UBU is a cryptotoken initiative that aims to use blockchain technology to deliver a universal basic income to participants: The underlying token, the Universal Basic Unit or UBU, is distributed daily to wallets of participating 'UBU citizens' as an issue from a central treasury. UBU citizens can use this daily issue to purchase UBU denominated items from participating vendors and from each other. Vendors have their own wallets which are not issued UBUs daily. At the end of each cycle, to counterbalance the fact that the UBUs are issued to citizens, every UBU wallet dissipates a percentage of their retained UBUs back to the treasury to be recycled and reissued.

The basic aim of the project is to connect vendors and citizens together by providing vendors the positive benefits of an UBU market, and by providing citizens the benefits of UBU denominated goods and services. The idea is to 'monetize' any positive externalities: moribund goods, donations, rewards and specials that vendors may be willing to allocate in order to attract customers, and to create a platform (a smartphone application) to facilitate the process of connecting citizens and vendors together.

Moreover, these types of products are often locked out of conventional economies and are usually branded as lost value; for example: unused rewards points, empty restaurant tables and incorrectly purchased stock. Thus, Project UBU aims to create a market mechanism for accessing this 'lost' economic value by allocating them as UBU denominated property rights. Alternatively, Project UBU may be viewed within the freemium model of Google and Facebook: All participants are rewarded for their collaboration and co-creation of Project UBU, and the project is rewarded by the value placed on the token. Society as a whole benefits due to a highly liquid complementary currency that unlocks lost economic value.

In terms of the language in Section 2: The UBU ecosystem is a formal token system. Blockchain technology acts as the token distribution channel which guarantees Properties P2-P4. The vertical processes in the UBU ecosystem are the issue and dissipation of tokens from the central treasury and, possibly, the charge of one UBU per transaction in order to prevent high frequency trading of UBUs from slowing down the blockchain record. The horizontal processes are the ongoing random interactions between citizens and vendors as UBUs are exchanged for allocatable property rights in an underlying economy.

However, due to the issue and dissipation process, the regulation of supply of UBUs to the UBU ecosystem is a dynamic one in which tokens are created and returned to the treasury. This is novel for a blockchain token as the supply of tokens is no longer a static mechanism, but an ongoing dynamic one. Consequently, there are various questions related to the scarcity constraint, Property P1, and the regulation of the supply of UBUs. Further, can the UBU ecosystem attain social trust and fungibility with an underlying real economy, Property P5, as well as other conventional fiat currencies and existing digital currencies?

The remainder of this paper is focussed on addressing these questions using formal arguments. In particular, the convergence of the UBU supply is discussed in Section 4. The means by which UBU can attain fungibility with conventional fiat and other digital currency is discussed in Section 5 which sets out token fungibility, and UBU to fiat fungibility arguments in 5.1 and 5.2 respectively. After these arguments are set out a discussion of the UBX, the derivative token based on the UBU, is presented in 5.3.

4 Convergence of the UBU Supply

In order for a token to hold value, a necessary requirement is that the supply of tokens is stable and does not grow too quickly relative to the property rights which imbue the token with value. The usual approach with cryptotokens is to maintain either an immutable fixed number of tokens or to issue tokens to miners for work done at a fixed rate per unit time. Project UBU is different from both these schemes as tokens are issued to wallets from a central treasury and dissipated from wallets back to the treasury on a daily basis. This makes the vertical processes which regulate the supply of UBUs to the UBU ecosystem dynamic rather than static. The question is whether the issue and dissipation mechanisms will balance each other out, and if the total supply of UBUs will reach an equilibrium position. The aim of this section is to pose this as a quantitative problem. In particular, the next result holds for the UBU system and shows the long term convergence of the UBU supply.

Theorem A. *Suppose that Ω_t is the total number of UBUs circulating in citizen and vendor wallets, ν is the daily issue rate and α the daily dissipation rate. If the number of citizens at time t, $N(t)$, follows a logistic growth curve, then for t sufficiently large and zero transaction costs $\Omega_t = \Omega$, a constant.*

The proof of Theorem A requires a convergence argument and a model for $N(t)$. How-

ever, before we turn to the proof of Theorem A, we prove several useful lemmas which support the main results in this section.

Lemma B. *In the absence of transactions, the balance X_t of a citizen wallet at time t is given by the formula*

$$X_t = \mu^t X_0 + \nu \left(\tfrac{1 \quad \mu^t}{1 \quad \mu} \right)$$

where $\mu = 1 - \alpha$ and α is the daily dissipation rate from the wallet, ν is the daily issue rate, and X_0 is the initial balance of the wallet. Further, the balance tends toward a steady state $X_t \approx \nu/\alpha$.

Proof of Lemma B. Suppose that X_t is the balance of a citizen wallet at time t. Let X_0 be the balance of the wallet at time $t = 0$. As ν UBUs are issued into the wallet per day αX_t UBUs dissipate from the wallet per day and $\mu X_t = (1 - \alpha)X_t$ UBUs remain in the wallet. In the absence of transactions the balance on day $t + 1$ is given by the difference equation

$$X_{t+1} = \mu X_t + \nu,$$

where t is measured in days. Solving this equation with X_0 as the initial condition gives the formula. Moreover, as $t \to \infty$ the balance tends to the steady state ν/α, since $0 \leq \mu \leq 1$. □

Next, we show a similar result for vendor wallets.

Lemma C. *In the absence of transactions, the balance Y_t of a vendor wallet at time t is given by the formula*

$$Y_t = \mu^t Y_0$$

where $\mu = 1 - \alpha$, α is the daily dissipation rate and Y_0 is the initial balance of the wallet.

Proof of Lemma C. Suppose that Y_t is the balance at time t of a vendor wallet. Since vendor wallets are not issued any UBUs daily and dissipate UBUs at a rate α, in the absence of transactions, μY_t UBUs remain in the wallet as the balance on day $t + 1$ is calculated from day t. This is given by the difference equation

$$Y_{t+1} = \mu Y_t.$$

Solving this equation with Y_0 as the balance when $t = 0$ gives the required result. Alternatively, the result may be deduced from Lemma B by setting $\nu = 0$. □

The growth of the supply of UBUs is directly correlated with the growth of the number of citizens $N(t)$. We write $N(t)$ instead of N_t to emphasize that the logistic model is a continuous model, while the balance models above are discrete. In the context of epidemiology [4, 10] the growth of citizens may be formulated as an S-I-S type epidemic where existing citizens (infectives) will enrol new citizens (from susceptible potentials) into the UBU ecosystem. We omit the proof of the next lemma as the result may be found in [8, 10].

Lemma D. *Suppose that the number of citizens $N(t)$ follows the infectives of an S-I-S model with gain probability β and loss probability γ. If n_0 is the initial proportion $(0 \leq n_0 \leq 1)$ of citizens participating in the project and the total population size is P, then the total citizens at time t is given by*

$$N(t) = P \times n_0 \frac{(\beta \quad \gamma)e^{(\beta \quad \gamma)t}}{\beta \quad \gamma + \beta n_0 e^{(\beta \quad \gamma)t}}.$$

Moreover, if $\beta > \gamma$, then as $t \to \infty$ the number of citizens will stabilize as $N \to P(1 - \gamma/\beta)$. Otherwise, if $\beta < \gamma$, then $N \to 0$.

Lemma D gives us a model for number of citizens $N(t)$. The model for $N(t)$ is the well known logistic curve that has been normalized and has the proportional carrying capacity $(1 - \gamma/\beta)$. This particular version of the model has been used for various projections including the spread of rumours, network economics and the growth of internet phenomena [10]. It may be formulated stochastically [11] and using difference equations [12]. As t becomes large, in the logistic model, the number of citizens stabilizes. In this model, the parameter β measures how many new citizens are recruited per existing citizen or the 'attractiveness' of the product. For example, if $\beta = 3\gamma$, then three citizens join for every who leaves the project. We now continue with the Proof of Theorem A.

Proof of Theorem A. Suppose that Ω_t is the total number of UBUs in circulation on day t, that ν is the rate at which UBUs are issued to citizens per day, and that α is the daily dissipation rate with $\mu = 1 - \alpha$. Let Φ_t be the number of billable transactions per day, and suppose that δ is the fixed transaction fee. On day $t + 1$ the total number of circulating UBUs Ω_{t+1} is given by the difference equation

$$\Omega_{t+1} = \mu\Omega_t + \nu N(t) - \delta\Phi_t.$$

(Here, we can think of measuring $N(t)$ at the precise time that UBUs are issued and deducted.)

Since every transaction is both a credit and a debit, transactions do not change the overall value of Ω_t except through the attraction of fees that are returned to the treasury. From the statement of the theorem, we may suppose that $\delta = 0$. Further, at equilibrium, $\Omega_t = \Omega_{t+1}$, and so we have

$$\Omega_t = \mu\Omega_t + \nu N(t).$$

As t gets large enough, $N(t)$ stabilizes to its carrying capacity, and so $N(t) \to \bar{N}$, a constant. This, in turn, gives

$$\Omega_t = \frac{\nu}{1 - \mu}\bar{N}.$$

The left hand side is a constant and $\Omega_t \to \Omega$, a constant. This proves the result. □

The result of Theorem A is to show that the total number of UBUs approaches a theoretical constant Ω as the total number of citizens stabilizes. If fixed transaction costs are introduced, then this will effectively increase the dissipation rate and produce a slightly different, lower, equilibrium position. The following corollary reflects this idea

under the assumption that the growth of UBU vendors is proportional to the growth of citizens.

Corollary E. *Suppose that there are $N(t)$ citizens and $V(t) = \epsilon N(t)$ vendors, where $0 \leq \epsilon \leq 1$, and that a fixed transaction fee of δ is charged per transaction. For t sufficiently large, as $N(t) \to \bar{N}$, a constant, if each wallet in the UBU system performs an average of ω transactions per day, then the total number of UBUs in circulation at equilibrium is given by*

$$\Omega = \frac{\nu \quad \delta\omega(1+\epsilon)}{1 \quad \mu}\bar{N}.$$

Proof of Corollary E. Let $V(t)$ denote the total number of vendor wallets at time t and suppose that vendor wallets grow proportionally with $N(t)$ so that $V(t) = \epsilon N(t)$, where $0 \leq \epsilon \leq 1$. Further, suppose that each wallet, on average, performs a fixed number of transactions ω per day. Let Φ_t be the total number of transactions on day t that are billable at a rate of δ per transaction by the treasury. Using the above notation and the fact that the total number of wallets at time t is $V(t) + N(t)$ gives

$$\Phi_t = \omega(V(t) + N(t)) = \omega(1 + \epsilon)N(t).$$

This allows us to modify the equation for Ω_{t+1}, the total number of circulating UBUs on day $t + 1$, in terms of Ω_t as

$$\Omega_{t+1} = \mu\Omega_t + (\nu - \delta\omega(1 + \epsilon))N(t).$$

The result follows analogously to the Proof of Theorem A, as t becomes sufficiently large. □

The next result shows that the total number of UBUs in circulation is bounded above, with the bound directly related to the daily issue and dissipation rates.

Theorem F. *The total number of UBUs in circulation is bounded above, and, moreover, $\Omega_t \leq N(t) \times \frac{\nu}{\alpha}$ where ν is the daily issue rate and α is the daily dissipation rate.*

Proof of Theorem F. By Lemma B the formula for the balance, X_t, of an UBU wallet under the no transaction assumption is

$$X_t = \mu^t X_0 + \nu\left(\frac{1 - \mu^t}{1 - \mu}\right).$$

Since $t \geq 0$, $\mu^t = (1 - \alpha)^t$ and $0 \leq \alpha \leq 1$, it follows that $(1 - \alpha)^t \leq 1$ and

$$X_t \leq X_0 + \frac{\nu}{\alpha}.$$

When the UBU system is initiated all balances apart from the treasury will be zero so $X_0 = 0$. Thus, the balance in any wallet that does not transact is bounded above as

$$X_t \leq \frac{\nu}{\alpha}.$$

If no transactions occur, then this is the worst case for the UBU treasury in terms of recovering UBUs. Further, by Lemma C, the vendor wallet balances will remain zero. At any given time there are $N(t)$ citizen wallets. Thus, we have the upper bound

$$\Omega_t \leq N(t)\frac{\nu}{\alpha}.$$

This completes the Proof of Theorem F. □

Theorem F indicates that the convergence and stability of the UBU is closely related to the value of $N(t)$. Further, one can argue that if $N(t)$ is stable in some localized geopolitical region, for example, in a metropolitan city where UBU has been established for a while, then prices of UBU denominated goods and services will also be locally stable.

5 Fiat Value and Derivatives

A derivative is a financial instrument which obtains its value from an underlying asset. Monetary tokens are, in a sense, a type of derivative since they derive their value from an underlying real economy. The goal of Project UBU is place value onto the UBU token by monetizing lost or moribund fiat value as well as the willingness of agents to donate positive externalities to UBU citizens in exchange for other, intangible, market benefits. However, since UBU is an allocated token and UBU wallets rapidly dissipate UBU tokens, the fungibility between UBU, conventional fiat money, and other digital currencies and tokens is questionable. On the other hand, Bitcoin and other digital currencies have over the past few years obtained an exchange value and a fungibility with conventional money. The question of how an UBU can obtain a fiat value on an exchange is a serious one for potential investors, vendors and citizens. The purpose of this section is to address this question and to illustrate that the UBU token, in the long term, can gain a fiat or 'dollar' value on an exchange. Furthermore, we present a model of the UBX, an UBU derivative product, and argue that an investor can make a speculative return on a fiat investment into the UBX token.

5.1 Token Exchanges

When conventional fiat currency is exchanged the fiat tokens of one geopolitical region are sold at a price denominated in the fiat tokens of another geopolitical region: currency exchanges are markets for tokens priced in terms of other tokens. Why do economic agents exchange tokens? If one considers tokens as metagoods that store value, then there are two components which drive agents to swap tokens: Access to an allocatable property right that may be exclusively priced in a given token and speculative beliefs about the arbitrage potential of the token. The next example is constructed to illustrate these different aspects.

Example E1. At the airport Simone exchanges fiat money for airplane tickets and buys a flight to Frankfurt that leaves in two hours. The airline ticket 'token' gives her access

to a property right, namely the claim specified on the ticket which the flight operator is required to fulfil. As a speculator, she buys a transferable ticket which allows her transfer this claim to someone else. In the airport lounge she over hears complaints from someone who has missed his flight to Frankfurt and cannot get another one that evening. She sells him her ticket for fiat currency at a premium on the fiat price that she paid originally.

Now, airports do not necessarily sell transferable plane tickets, but the point of the example is that there are two aspects to the value of the ticket. There is the underlying property right, for example, the right to buy things with fiat currency in the geopolitical region where that fiat represents goods and exchange, and there is the speculative value that locally there will be a future spike in demand for a particular token or the property rights it gives access to, which will make it worth 'more' to the token holder.

In order to phrase this formally, let S and R represent sets of property rights and suppose that $S = \{S_1, S_2, S_3 \ldots\}$ and $R = \{R_1, R_2, R_3 \ldots\}$. Further, suppose the property rights reside in different 'vending machines' one which accepts S-tokens and another that accepts R-tokens. The price of the property right with index i is denoted, in terms of its native token, $s(S_i)$ or $r(R_i)$. Economic agents are either S-token holders that hold S-tokens or R-token holders that hold R-tokens. The idea of exchange between different token types is formalized in the next definitions and the results below clarify the conversion between tokens under a variety of conditions on the sets S and R.

Definition D9. *Property right fungibility. Let P be an allocatable property right and let X and Y be token classes. The token classes X and Y are property right fungible with respect to P if P has a price in terms of X tokens and Y tokens. The fungibility chains $X \to P \to Y$, and $Y \to P \to X$ then defines an exchange between the token systems.*

Definition D10. *Token fungible. Let X and Y be token classes with property right sets P and Q respectively. Let $X(j)$, $Y(j)$ denote the right to j tokens of type X, type Y respectively. The token classes X and Y are token fungible if $Y(j) \in P$ and $X(j) \in Q$.*

Theorem G. *Suppose that $S = R$ and, moreover, $S_i = R_i$. For every pair of indices i, j suppose that there are no price arbitrage opportunities between $R_i, R_j \in R$ and $S_i, S_j \in S$ that may be obtained via currency exchange. Then, the pricing of individual rights $s(S_i)$ and $r(R_i)$ determines the exchange rate between S-tokens and R-tokens.*

Proof of Theorem G. Suppose that R_i and S_i are identical property rights. Let $r(R_i) = r_i$ and let $s(S_i) = s_i$. Since there are no price arbitrage opportunities between pairs of items in R and S, the ratios of prices r_i/s_i and r_j/s_j are identical for different choices of indices i and j. Then $r_i = r(R_i) \equiv r(S_i)$ and $s_i = s(S_i) = s(R_i)$. Thus, r_i R-tokens $\equiv s_i$ S-tokens. This gives the rate of exchange between the token systems. □

Theorem G formalizes the idea that if the allocatable property rights in different token economies are identical, then the tokens are fungible due to the fungibility of the underlying property rights. The next example is based directly on Theorem G.

Example E2. As a frequent flyer Justin has earned 400,000 reward tokens which he may redeem for holiday packages and nothing else. He finds a holiday package priced in

fiat currency at 10000 fiat units and, equivalently, in reward tokens at 100,000 tokens. He decides to redeem his tokens. Thus, one unit of fiat is equivalent to ten reward tokens.

In Example E2, a property right is priced both in fiat and in reward tokens. Further, the right is the only property right allocated to the reward tokens, so this meets the arbitrage condition of the theorem. In this case, the property right acts as a common element between these systems and dictates the exchange rate. However, the tacit assumption is that the protagonist can resell the holiday within a fiat denominated market without incurring any transfer or transaction costs, or losses due to expiry. If these types of costs do occur, then the exchange ratio must necessarily reflect this fact. Similarly, if the fiat price of the holiday package goes up while the rewards token price remains the same, then this must also be reflected.

Now, suppose that we consider the opposite extreme of disjoint sets S and R of property rights. The following result holds.

Theorem H. *Suppose S and R are sets of allocatable property rights and $S \cap R = \emptyset$. Then, a direct exchange is only possible if R-tokens $\in S$ and S-tokens $\in R$ as allocatable rights to the respective token holders. Moreover, the pricing mechanisms for these rights in their native tokens fully determine the exchange rate between the token types.*

Proof of Theorem H. Let S and R be sets of allocatable property rights and suppose that $S \cap R = \emptyset$. If S-tokens are not an allocatable right in R, then R-tokens holders are unable to buy S-tokens at any price. On the other hand, if R-tokens are not an allocatable right in S, then S-token holders are unable to buy R-tokens at any price. Thus, for an exchange to occur, S-tokens necessarily must be an allocatable right in R, and visa versa. Let $S_j^* = S^*(j) \in R$ denote the right to j S-tokens and let $R_j^* = R^*(j) \in S$ denote the right to j R-tokens; for an R and S wallet holder respectively. Let $r(S_j^*) = r_j^*$ and $s(R_j^*) = s_j^*$ denote the prices for the tokens with respect to each set. Now, from an R-wallet holders perspective r_j^* is the wallet holders willingness to pay r_j^* R-tokens in exchange for j S-tokens. Ranging over possible j's gives a demand curve from the R-wallet holders perspective for S-tokens, and a supply curve from an S-wallets holders perspective for R-tokens. Similarly, using the function s_j^* gives a demand curve for R-tokens from an S-wallet holders perspective, and a supply curve for S-tokens from an R-wallet holders perspective. The intersection of these curves gives a market determined exchange rate. □

Next, we consider the case where the sets S and R have a non-empty intersection, but $S \neq R$, and the property rights in the intersection of S and R are perfectly transferable between S-token holders and R-token holders. By perfectly transferable, it is meant that an S-token holder may buy an S-token denominated right and resell it as an R-token denominated right without incurring any sticky effects such as transfer costs and transaction costs for moving the right between the differently denominated markets.

Theorem I. *Suppose that S and R are sets of allocatable property rights with $S \cap R \neq \emptyset$ and, further, $S \nsubseteq R$ and $R \nsubseteq S$. If S-token denominated rights and R-token denominated*

rights are perfectly transferable, and a direct exchange of R and S tokens is possible, then the exchange rates set by property right fungibility, and by token fungibility are either equal or arbitrage opportunities are available to agents.

Proof of Theorem I. Let S and R be sets of allocatable property rights with $S \cap R \neq \emptyset$, and further $S \nsubseteq R$ and $R \nsubseteq S$. Thus, there are objects in S which are not in R and visa versa. Further, suppose that R-tokens are an allocatable right in the set S, and S-tokens are an allocatable right in the set R. An agent has two possibilities for exchanging R-tokens for S-tokens: (1) property right fungibility, in the sense of Theorem G, and (2) token fungibility in the sense of Theorem H. We proceed case by case.

Case 1. Suppose that an S-token holder wishes to obtain R-tokens. Since $S \cap R \neq \emptyset$. The token holder may buy a right in S tokens and re-denominate that right into R-tokens. Suppose $R_j = S_i \in S \cap R$ and, $r(R_j) = \bar{r}$ with $s(S_i) = \bar{s}$. Then, the exchange rate between R-tokens and S-tokens is given by $\bar{r} \equiv \bar{s}$. This implies that an R-token is equivalent to $\bar{s}/\bar{r}$ S-tokens. Similarly, an S-token is equivalent to $\bar{r}/\bar{s}$ R-tokens.

Case 2. Suppose that S-tokens are an R-token denominated right and that R-tokens are an S-token denominated right. Let $S_j^* \in S$ and $R_j^* \in R$ label the right to j tokens in their respective denominations. Proceeding analogously to the proof of Theorem H, a market determined exchange rate exists that makes these tokens fungible. Let r^* R-tokens be equivalent to s^* S-tokens under this exchange (at a theoretical equilibrium where the different curves intersect). In this case an R-token is equivalent to s^*/r^* S-tokens and an S-token is equivalent to r^*/s^* R-tokens.

We now continue with the proof of Theorem I. In the event that $r^* \neq \bar{r}$ and $s^* \neq \bar{s}$ and agent may exploit the differences in exchange rates between the two types of fungibility to increase his R-tokens or his S-tokens at no risk. Consider an R-token holder: The R-token holder may buy S-tokens at a price of r^*/s^* on an exchange, use his S-tokens to buy a right from $S \cap R$ and resell that item for R-tokens. In the event that the exchange rate requires him to pay less for the item in R-tokens than he may have in the R-market, this agent obtains an arbitrage opportunity. Similarly, the holder of a a property right in $S \cap R$ may obtain an arbitrage opportunity by changing property right denomination and then exchanging currencies. □

Theorems G, H and I formalize several ideas which are reflected when fiat tokens are exchanged for other fiat tokens in the usual economic sense. Arguably, such language is not necessary to describe the process for physical goods and services where the assumptions of no 'stickiness' and perfect exchange are unrealistic, however, in a digital economy with digital rights and contracts that are perfectly transferable between agents, these descriptions become pertinent. These theorems are used in the next section to argue that the UBU can obtain a fiat value. Finally, we close this section with a final definition that formalizes the idea of a sequence of interchangeable tokens.

Definition D11. *Token fungibility chain. A set of token classes $\mathcal{C} = \{A_1, A_2, \ldots, A_n\}$ forms a token fungibility chain if for each sequential pair (A_i, A_{i+1}) the tokens in the pair are token fungible.*

Further, by Definition D11, a given token need not attain fungibility with every other token in order for exchange between them to be be possible. All that would be required is that it become equivalent to one of the member token classes in the set $\mathcal{C}$. Once this has occurred it will be equivalent, using the fungibility chain, to all of them.

5.2 Fiat and UBU

An important question for investors, potential UBU citizens, and vendors is the value proposition embedded into Project UBU and how, in the long term, this can translate into a fiat value on an exchange. To this end, recall the notions of the *intrinsic* and *extrinsic* value of a token from Section 2.

Definition D1. *Intrinsic value. The intrinsic value of a token is the consumption value of a token independent of the society which ascribes value to it.*

Definition D2. *Extrinsic value. The value of a token which is ascribed to it by a society; the token represents an equivalence class of property rights allocated to the token by social consensus.*

In these terms, one can argue for the intrinsic value of the UBU as an economic system that acts as an *information product* which connects market participants on a willing basis, and an extrinsic value that market participants will ascribe to the UBU based on its usefulness as an information product. The UBU macroeconomy is designed around connection and choice: UBU connects citizens to vendors through a smartphone application, and citizens, by choice, can allow vendors to engage with them through the UBU application. Moreover, since citizens are issued UBUs directly and vendors place value into the UBU by pricing property rights in UBUs, citizens are rewarded for engaging with vendors via the market place. As the project gathers momentum in terms of citizens and vendors the UBU then obtains a value backed by a set of property rights. In fact, UBU as a digital currency system, is designed to facilitate this type of engagement, by favouring egalitarian liquidity and transactions over savings. The next examples illustrate several aspects of the functionality of UBU in a real world context.

Example E3. Lily and Hannah who live in South Africa want to take a holiday in Norway. As coffee shop owners, they accumulate 30,000UBUs by inviting customers to buy an UBU priced coffee for every cupcake bought in fiat currency. A hotel in Oslo offers an UBU special, 70,000UBU, for a 10 day long stay. The regular price for a room in the hotel is 70$ per night. In order to make the most of their UBUs, they go to an exchange to bid for the remaining 40,000UBU using fiat currency. The exchange price is 0.01$ per UBU so they buy the remaining UBUs they need for 400$.

Example E4. Atle and Owe, Norwegian hoteliers, wish to make a donation to a local community in central Johannesburg. They offer a 10 day accommodation special at their Oslo hotel to any South Africans visiting Norway. They raise around 1,000,000UBU. An international maize cooperative has just had an excessive surplus and wants to get rid of surplus maize before they crash the regional maize prices. They sell a 100 tons of maize to the Norwegians at 10,000UBUs per ton including transport. The Norwegians agree

to 'donate' this maize to the Johannesburg community by pricing it at 100UBUs per kilo. The community has a number of UBU citizens so the maize sells out in UBUs, the Norwegians have not lost any UBUs, but a positive economic benefit has been created. The mechanism by which the maize was donated lies in the fact that UBUs are pre-issued to citizens.

Example E5. Dudley enjoys fixing vintage cars. Unfortunately, the required parts are not always available and they are rather expensive to import. He also has a lot of UBUs through his business interests. A local machine shop owner is willing to let him use their equipment after hours to make the parts in exchange for a combination of UBUs and fiat to cover the electricity costs; the owner is trying to raise UBUs for an UBU discounted Norwegian holiday.

Each of these examples illustrates a slightly different aspect of the UBU value proposition: For Lily and Hannah, their investment in coffees was offset by the increased traffic to the coffee shop, and the UBUs they earned monetize benefits of their 'free' coffees. The 10 day stay at regular prices would cost 700$ so, in this case, their benefit is a pure fiat value of 300$. In the maize example, each participant in this chain receives a positive benefit for reallocating a fiat denominated good as an UBU denominated good. In usual circumstances the maize may have been destroyed, or fiat prices may have crashed. Further, there is no net loss to the Norwegian donors in terms of UBUs. It is true that the UBUs may dissipate back to the treasury over time, but in the same vein, stored maize also can lose its value simply due to the imputed storage expenses. The machine shop owner 'donates' moribund time value of his equipment to the UBU economy. These agents receive an economic benefit and Project UBU is collectively this positive externality macroeconomy.

The unique and noteworthy point with UBU is that instead of a 'donation' barter economy where participants donate value in one direction only, the UBU creates a monetized 'donation' economy where participants have a pool of positive externality goods and services that they can chose in a marketplace, and donors also receive a direct benefit: The token acts a a complementary currency that holds the value of positive externality property rights and continually reallocates them to participants.

Before, we proceed with arguing for the fiat fungibility of the UBU in terms of Theorems G, H, and I, it is worth pointing out that the ideas behind the UBU are not necessarily novel, and have historical precedents: The assignment of property rights to negative externalities and the creation of carbon credit markets is well established, so UBU is a system for assigning more generic positive property rights to a token. A second point is that while fiat currency usually works on principles of inflation and positive interest rates for balance holders, several countries have experienced deflationary economies and negative interest rates [6].

Let U be the set of property rights allocated to the UBU token. At the onset of Project UBU this set of property rights is empty and $U = \emptyset$. The goal of the project is bootstrap the UBU token by enrolling vendors to contribute to the set U, by offering them UBU as a platform for doing business. (Bitcoin went through as similar bootstrapping progress more or less organically from 2008-2012.) As the set of

allocatable property rights U grows, so too will the value of the UBU to citizens, and as the number of citizens grows the value of the UBU marketplace will grow from the vendor perspective. This positive cycle can then lead to a fungibility of UBU and fiat money in the context of Theorems G, H, and I. There are two possibilities, which are not mutually exclusive: If the set of fiat property rights and UBU property rights overlaps, then the UBU obtains property rights fungibility with conventional currency, or if the UBU attains direct token fungibility with any one fiat currency, and, in turn, forms a fungibility chain within a collection of token classes.

5.3 Derivatives

The final question to address is the behaviour of a derivative based on the UBU. In the context of Project UBU and its aims, conventional fiat money is required to spark the process which begins the positive UBU bootstrap cycle. This would be raised from investors who expect a return. The result is a derivative product : The UBX token which derives its value from the UBU as an underlying asset. Further, in order to avoid a circularity problem, there is a clear distinction between the UBU which begins as an accounting instrument and takes on a real economic value as vendors and citizens join the project; and the UBX which is a speculative investment instrument that increases its fiat and UBU value as Project UBU gains momentum.

The UBX is an Ethereum based contract that promises to pay to the bearer an amount of UBUs dependent on the total number of UBU citizens at a series of fixed time intervals. To model the UBX suppose that the instrument pays an amount of x UBUs per time period, per m citizens and let $N(t)$ be the prescribed population curve that is embedded into the UBX contract. If the UBX is initiated at time $t = 0$ and has a maturity date at time T, then at the periodic time intervals $t_1, t_2, \ldots, t_\ell$, where $t_\ell = T$ the contract holder receives a payment in UBUs. Moreover, for an UBX contract that pays the holder UBUs at fixed times in perpetuity we simply let $T \to \infty$. Using this notation, the capital flows from the UBX will be the sequence

$$\frac{x}{m}N(t_1),\ \frac{x}{m}N(t_2),\ \ldots,\ \frac{x}{m}N(t_\ell).$$

The next two results provide a long term means for valuing the UBX in terms of UBUs and in terms of conventional fiat money.

Theorem J. *Suppose Z_t is the balance of a digital wallet that is entitled to the cash flows from a single UBX contract. Let $N(t)$ be the logistic function (Lemma D) used to model the UBU citizen factor in the UBX cash flow, and let α be the daily dissipation rate. Further, suppose the contract initiated at $t = 0$ pays x UBUs per m citizens every d days at the time intervals t_1, t_2, $\ldots t_\ell = T$. In the absence of transactions, the balance of the wallet at time T is given by*

$$Z_T = \textstyle\sum_{i=1}^{\ell}(1-\alpha)^{d(\ell\ \ i)}N(t_i)\frac{x}{m}.$$

Proof of Theorem J. Let $N(t)$ be the logistic function (Lemma D) used to model the UBU citizen factor in the UBX contract, and let α be the daily dissipation rate.

Let t_1, t_2,$\ldots t_\ell = T$ be a series of fixed time intervals at which a payment is made, and let $t_{i+1} - t_i = d$ days, be the period between payments. At time t_i the contract pays $\frac{x}{m}N(t_i)$, however by the time of the next payment at t_{i+1} this has decayed by a factor of $(1-\alpha)^d$. Thus, if the contract starts at time $t = 0$ and the first payment is made time t_1 the first payment will have decayed by a factor of $(1-\alpha)^{d(\ell\ \ 1)}$ at time t_ℓ. Generally, the ith payment in the flow will have decayed by a factor of $(1-\alpha)^{d(\ell\ \ i)}$. Using these decay factors to adjust the payments at t_i of $N(t_i) \times \frac{x}{m}$ UBUs and summing the capital flows from $t = 0$, to $t = T$ gives the formula for Z_T. □

In the event that the UBX pays out in perpetuity the next result follows from Theorem J.

Corollary K. *Suppose that the conditions in the statement of Theorem J hold and the UBX pays out, in perpetuity, a citizen dependent amount of UBUs as a periodic capital flow. Further, for t large enough, if $N(t)$ follows the logistic function defined in Lemma D, then $N(t) \to \bar{N}$, a constant. Let $\phi = \frac{x}{m}\bar{N}$. Then, in the absence of transactions, the balance of an UBX account has the theoretical limit*

$$Z_\infty \approx \frac{\phi}{1\ \ (1\ \ \alpha)^d}.$$

Proof of Corollary K. Suppose that the conditions in the statement of Theorem K hold. For t large enough, if $N(t)$ follows the logistic function defined in Lemma D, then $N(t) \to \bar{N}$, a constant. Set $\phi = \frac{x}{m}\bar{N}$ and consider the sum defined in the statement of Theorem J. If the order of the sum is reversed, then

$$Z_T \approx \phi + \phi(1-\alpha)^d + \phi(1-\alpha)^{2d} \ldots + \phi(1-\alpha)^{\ell d}$$

where the approximation sign reflects the fact that ϕ may be lower as $N(t) < \bar{N}$ in the earlier stages of the UBU system. As $T \to \infty$ this may be rewritten using the geometric series, since $0 < (1-\alpha)^d < 1$. The result follows. □

The result from Corollary K is analogous to the long term steady state of ν/α that is implied by Lemma B for citizen wallets. Essentially, it implies that an UBX holder may accumulate a balance of UBUs up to Z_∞ regardless of dissipation, and that the regular issue of UBUs by the contract will drive the balance toward this figure.

As a final result for this section, the question of how an UBX will reflect as a fiat capital flow is considered.

Theorem L. *Suppose that Z_T is the balance of a digital wallet that is entitled to the cash flows from a single UBX contract. Let $N(t)$ be the logistic function (Lemma D) used to model the UBU citizen fact in the UBX cash flow, and let α be the daily dissipation rate. Further, suppose the contract initiated at $t = 0$ pays x UBUs per m citizens every d days at the time intervals $t_1, t_2, \ldots, t_\ell = T$. If the UBU capital flows are converted to a fiat currency at a rate of y per UBU, and held in a fiat account that pays an interest rate of r (with r and y assumed to be constant) at time t_i, then the total present fiat value, F_T, of the UBX capital flows are given by*

$$F_T \equiv \textstyle\sum_{i=1}^{l}(1+r)^{\ \ t_i}\frac{xy}{m}N(t_i).$$

Proof of Theorem L. Suppose that the conditions and definitions in the statement of the theorem hold and that Z_T is the balance of the wallet that receives the given UBX capital flows. In the event that an investor moves each UBX payment immediately via an exchange at a rate of y units of fiat per UBU, and hold the balance in a fiat account that pays an interest rate of r, the present fiat value of an UBX capital flow at t_i, denoted $p(t_i)$, is given by the formula

$$p(t_i) = (1+r)^{\ t_i} \frac{xy}{m} N(t_i)$$

Summing these flows over the time intervals t_i gives the required result. □

The results of Theorems J, K and L give computational tools for the valuation of the UBX in terms of the number of UBUs that can accumulate to an UBX holder, as well as in terms of the fiat value that can accumulate if the holder of the contract converts his UBUs using an exchange. The contract guarantees a regular UBU windfall that is paid over and above the daily issue of UBUs. Despite the sources of volatility in y, r and $N(t)$, if the fiat interest rate r is positive, then the fiat value of an UBX that pays in perpetuity is technically infinite.

As a numerical example consider an UBX that pays 1 UBU per million citizens per month. Suppose $N(t) = 500 \times 10^6$ or 500 million citizens, $r = 0.0001$ units of fiat per day (around 3.75% per year) and $y = 0.01$ fiat units to the UBU. The contract holder is is paid 500UBUs per month. Suppose that these are sold on an exchange and the return of 5 units of fiat is kept in an interest paying account. By Theorem L, the forward value of this as a one year contract is 53.92 units of fiat. Even discounting by 90% for volatility, an UBX token priced at around 5 units of fiat and held until the project can gather momentum has a strong value proposition: The key is waiting for the UBU marketplace of vendors and citizens to develop.

6 Summary

This paper introduces several ideas about abstract token systems and applies them to the UBU token of Project UBU [16]. The results of the paper indicate that the supply of UBUs converge, and that through the assignment of value and property rights by vendors the UBU may attain long run fungibility with conventional fiat currency. Finally, methods for valuing the UBX token which pays a fixed amount of UBUs per participating citizen per month are developed.

References

[1] Chiang, A.-C., and Wainwright K., *Fundamental Methods of Mathematical Economics, Fourth Edition.* McGraw Hill, 2005.

[2] Chugh, S.-K., *Modern Macroeconomics*, MIT Press, 2015.

[3] Civic token sale white paper, *Civic Technologies*, 2017. `tokensale.civic.com/CivicTokenSaleWhitePaper.pdf`

[4] Kermack, W.-O., McKendrick, A.-G, A contribution to the mathematical theory of of epidemics. *Proceedings of the Royal Society A.* 115(772):700-721, 1927.

[5] Elaydi, S., *An introduction to difference equations*, Springer, 2005.

[6] Jobst, A. and Lin, H., Negative interest rate policy: Implications for monetary transmission and bank profitability in the Euro area. *IMF working paper: 16172*, 2016.

[7] Mazières, D., The Stellar Consensus Protocol: A Federated Model for Internet-level Consensus, *Stellar Development Foundation*, 2016.

[8] Murray, J.-D., *Mathematical Biology: An Introduction, Third Edition*, Springer, 2002.

[9] Nakamoto, S., Bitcoin: A peer to peer electronic cash system. *Consulted*, 1:2012, 2008.

[10] Newman, M., *Networks: An Introduction*. Oxford University Press, 2010.

[11] Schurz H., Modeling analysis and discretization of stochastic logistic equations, *International Journal of Numerical Analysis and Modeling* 4(2) 178-197, 2007.

[12] T. Tassier, The Economics of Epidemiology, *Springer Briefs in Public Health*, 2013.

[13] Tapscott D., and Tapscott A. Realizing the potential of blockchain: A multi-stakeholder approach to the stewardship of blockchain and other cryptocurrencies. *World Economic Forum*, 2017.

[14] Tschorsch, F., and Scheuermann B., Bitcoin and beyond, a technical survey on decentralized digital currencies. *IEEE Communications Surveys & Tutorials* 18 (3), 2016.

[15] Wood, G., Ethereum, A secure decentralized transaction ledger, EIP-150 revision. *Ethereum and Ethcore*, 2014.

[16] `www.projectubu.com`

UBX Yellow Paper

The UBX Value Proposition

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Abstract

This paper quantifies the value proposition of the UBX cryptotoken in terms of Metcalfe's law for networks. Assuming that the vendor-citizen interaction network is bipartite gives a formulation for the 'network value' of the UBX token as a Metcalfe type rule. The rule separates the value drivers of the UBX token into three core factors: real vendor growth, real citizen growth and participation levels from vendors and citizens. Moreover, a quadratic relationship between the UBX token and the number of participating citizens is derived.

1 Introduction

The main drivers of cryptocurrency and cryptotoken growth are, arguably, the powerful network effects which occur as more users join the cryptomarketplace. In empirical analysis of the development of Bitcoin and Ethereum as currencies [1, 3] a commonly observed relationship is Metcalfe's law for networks which states that the value of a network is proportional to the square of the number of users [4]. That is, for a network with n nodes one can claim that the value V of the network is proportional to n^2:

$$V \propto n^2 \Leftrightarrow V = kn^2,$$

where k is a proportionality constant and the V is a typical metric such as transaction volume in fiat currency [1, 3].

In terms of graph theory [5], a plausible explanation for Metcalfe's law is that in a network of n users where loops and multiple exchanges are not allowed $n(n-1)$ is the maximum number of possible directed edges. This is roughly a function of n^2 and so any metric that is related to network activity value would be expected to be quadratic in complexity. Transaction volume, for example, is likely to be some fraction of the total number of possible links in the network, multiplied by the average transaction value. As the network evolves in time and more nodes are created this value relationship given by Metcalfe's law seems to persist empirically [3].

The goal of this paper is to illustrate a Metcalfe's law type result for the UBX token, the cryptotoken offered by Project UBU. The idea behind Project UBU is that of a cryptocurrency, the Universal Basic Unit or UBU, which is issued to citizens, on a daily basis, in exchange for their participation as the 'nodes' in the UBU network. Citizens may then engage with vendors within Project UBU and exchange their UBUs for items that are usually deemed lost economic value or promotional items that are 'donated' for marketing purposes. (The details of may be found in [2] or at `www.projectubu.com`.)

This system of interactions derives its value from the strength of the underlying network which tracks the real exchanges of UBUs for vendor supplied goods and services. In turn, the UBX token is a derivative that obtains its economic value from the UBU and the UBU marketplace. Each UBX token pays out exactly one UBU per million citizens per month where the number of citizens at time t, $N(t)$, is calculated from a prescribed logistic curve [2]. The key result of the present paper is to show that the value of the UBX token has the proportional relationship

$$1\text{UBX} \propto v \cdot n \cdot N$$

where v is the number of vendors in the network, n is the number of actual citizens in the network, and N is the postulated number of citizens in the network. And, further, that this relationship can be reduced approximately to

$$1\text{UBX} \propto v.n^2$$

which is a Metcalfe type result dependent on the square of the number of participating citizens. This supports the argument that as Project UBU enrols more citizens and vendors and the UBU network grows, the value of an UBX token will increase non-linearly.

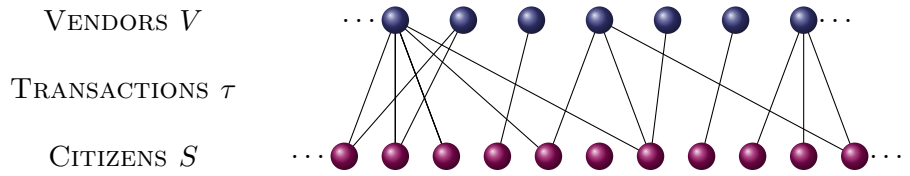

Figure 1: A section of a bipartite vendor-citizen network.

2 UBX Network Value

The UBX token of project UBU is a derivative product that promises to pay the bearer an amount of 1 UBU per million citizens per month from a prescribed logistic curve. On the surface, the token derives its value from two sources: the value of a single UBU and the number of citizens on a projected logistic curve that has a carrying capacity of 500×10^6 users. Both these topics have been covered extensively in the UBU yellow paper [2] so the technical details are omitted. We focus in this section, however, on the development of the UBU network, and how this drives the value of the UBX.

2.1 The UBU Network

In order to understand the value of the UBX, one first needs to develop a network model for the UBU market. The Project UBU network comprises two core sets. The set of vendors V and the set of citizens S. Let $|V| = v$ and $|S| = n$ denote the respective cardinalities of these sets. The nodes of the network are the participants; citizens and vendors that engage with each other and transact using UBUs. Each transaction corresponds to an 'edge' or a link in the network. The network evolves in time: new users are added, users may leave, and transaction patterns may change, but on a given day, for example, one can construct a snapshot of the network and the participant interactions for that particular day.

In the UBU network there are three possible types of interactions: Vendor-vendor, citizen-citizen, and vendor-citizen. Given the nature of UBU, a fair assumption is that the interactions will be mostly of the vendor-citizen type. Imposing this restriction gives the network a bipartite structure [5] with partitions V and S.[1] In this event, the number of edges in the network is going to be proportional to $v \cdot n$ the maximum possible number of edges. Further, the number of transactions τ in a given static 'snapshot' of the network will behave according to $\tau \propto v \cdot n$ or

$$\tau = \kappa \cdot v \cdot n$$

where κ is a constant of proportionality. Putting together a series of these network 'snapshots' and letting $\langle f(t) \rangle$ denote the average fiat value per transaction gives the following network transaction volume 'value' for the UBU network

$$\tau(t) = \langle f(t) \rangle \times \kappa(t) \cdot v(t) \cdot n(t). \tag{1}$$

[1] A sample of a typical bipartite network structure is given in Figure 1. Notice that nodes in the same set do not transact. Further, such a network picture would be constructed by taking a snapshot of the vendor-citizen transactions over some fixed time period, for example, one day. The evolution of this network in time models the evolution of the UBU marketplace.

This can be interpreted as average fiat 'value' per exchange multiplied by the total exchanges in the network at a given time t. So, if on the 22nd May 2018, all you could buy from participating vendors with UBUs are 1$ coffees and a million of these are exchanged between vendors and citizens, then it could be argued that the UBU transaction volume in dollars on that day is one million dollars. And, this gives a quantitative value to Project UBU as an exchange network.

2.2 The UBX Token

Now, recall that the UBX token derives its value from the UBU network, and it pays the holder 1 UBU per million citizens per month where the number of citizens $N(t)$ is drawn from a logistic curve [2]

$$N(t) = \frac{500 \times 10^6}{1 + e^{-\theta(t-t_0)}} \cdot \tag{2}$$

The curve has a carrying capacity of 500×10^6 and θ and t_0 are parameters related to the steepness and the midpoint of the curve respectively. In effect, the UBX has a monthly payout of

$$1 \text{ UBX} \equiv N(t) \times 10^{-6} \text{ UBU}, \tag{3}$$

where t depends on the age of the UBU system. At carrying capacity, this will pay per month

$$1 \text{ UBX} \equiv 500 \text{ UBU}. \tag{4}$$

Combining Eqs. (1) and (3), it could be argued that the proportional network value of an UBX is

$$1\text{UBX} \propto N(t) \times 10^{-6} \times \langle f(t) \rangle \times \kappa(t) \cdot v(t) \cdot n(t) \tag{5}$$

where the right hand side has, for example, some homogenised fiat value at time t. Further, at carrying capacity the contract has a maximum value given as

$$1\text{UBX} \propto 500 \times \langle f(t) \rangle \times \kappa(t) \cdot v(t) \cdot n(t). \tag{6}$$

Eqs. (5) and (6) give a breakdown of the different components that add value to the UBX. Moreover, Eq. (5) can be taken a step further if one assumes that the actual number of citizens $n(t)$ follows its own sigmoidal curve which is a scaled and shifted version of $N(t)$ the UBX projection curve. If we suppose that

$$N(t) = \alpha n(\rho t) + \mu, \tag{7}$$

where α, ρ and μ are constant parameters that relate the actual curve to the projected curve, then we have from Eq. (5)

$$1\text{UBX} \propto \langle f(t) \rangle \times \kappa(t) \cdot v(t) \cdot n(t) \times (\alpha(n(\rho t) + \mu)) \times 10^{-6}. \tag{8}$$

It is impossible to find the parameters α, ρ and μ *a priori* and these will only be determined from empirical work once Project UBU goes live, but, however, note that the above equation is essentially

$$1\text{UBX} \propto \langle f(t) \rangle \times \kappa(t) \cdot v(t) \cdot [O(n^2(t)) + O(n(t))] \times 10^{-6} \tag{9}$$

where we have used the big-oh notation from complexity theory. Neglecting terms linear in n, the Metcalfe type rule

$$1\text{UBX} \approx C \times \langle f(t) \rangle \times \kappa(t) \cdot v(t) \cdot n^2(t) \tag{10}$$

emerges for the UBX token, where C is a proportionality constant. In the longer run, the terms $\langle f(t) \rangle$ and $\kappa(t)$ will most likely stabilize so that

$$1\text{UBX} \propto v(t) n^2(t). \tag{11}$$

Thus, within our assumptions, the value of an UBX token scales linearly with the number of vendors $v(t)$ and quadratically with the number of citizens $n(t)$

2.3 UBX Value Drivers

Using Eq. (10), the value of the UBX token can be constructed part by part: As vendors ascribe an increasing dollar value to the UBU the value of $\langle f(t) \rangle$ will increase; as users find more vendors with whom to engage the fraction of total transactions $\kappa(t)$ will increase; and $v(t)$ and $n(t)$ will go up as more participants join the project. The interplay of these different variables creates a positive citizen–vendor feedback loop and as the project evolves this loop creates value within the UBX token.

3 Summary

In this paper, we argue that the UBX token has an underlying value driven by a Metcalfe type rule that relies on the strength of participation in the UBU marketplace. Over the long term, as the UBU marketplace grows, value is placed into the UBX token from the underlying networked interactions of citizens and vendors. Under certain assumptions this 'network value' in the UBX token scales linearly with the number of vendors and quadratically with the number of citizens in the project. It also scales linearly with the 'willingness' to participate in the project from vendors and citizens. These results quantify the relationship between the UBU and UBX and clarifies the value drivers of the UBX token.

References

[1] Alabi, K., 2017. Digital block chain networks appear to be following Metcalfe's Law. *Electronic Commerce and Applications,* **24** 23-29.

[2] Naicker, V., 2017. Tokens and Universal Basic Units, https://ito.projectubu.com/pdf/ProjectUBU_Whitepaper.pdf

[3] http://nakamotoinstitute.org/mempool/how-we-know-bitcoin-is-not-a-bubble/

[4] Metcalfe, B., 2013. Metcalfes Law after 40 years of ethernet. IEEE Comput. 46 (12), 2631.

[5] West, D., *Introduction to Graph Theory*, Prentice Hall, 2nd ed., 2002.