Quobands: A Funding Mechanism For Crowd Construction

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Abstract

A quoband is a smart contract that represents ownership of physical property and allows multiple stakeholders to own, fund, manage and invest in it. Unlike REITs, quobands can interface directly with the property title represented as a non-fungible token on the blockchain. The scale of the property can be as small as a house or as large as a city-state or special economic zone (SEZ). A quoband can be used as an open, equity-based mechanism to securitize and crowdfund property development projects in the place of more traditional approaches such as a mortgage. Ownership of the title is divided using tokens, allowing the holder to receive dividends from revenues produced by the property. Quobands can be structured as an equity or a debt, or a hybrid (similar to Mezzanine debt). In a fixed (debt-based) quoband, the issuer would be able to do a "quote recall"- buying back the tokens at an agreed schedule at a set price plus an additional coupon rate until full ownership is regained. For larger commercial or industrial developments such as an SEZ, government land lease or city-state, a floating (equity-based) quoband would be implemented. In this model the issuer would maintain a partial stake and continue paying dividends to investors indefinitely. The token price would float freely on the quote market to reflect the perceived value of the property. This paper lays out a general specification of the quoband model and its application to some real estate development use cases.

1 Definitions

Quotes: A standard unit of property, representing ownership of an underlying physical asset secured by the quoband contract. For example: Bob mints a quoband for a construction project containing a total of 1000 quotes [1] at $5000 each. The goal is to raise $5,000,000. He retains 200 (20%) himself. Alice buys 50 quotes in the quoband ICO, which gives her a 5% stake.

Quoband: A smart contract that tokenizes a property and can be used to fund, manage and invest in development projects. Splits the ownership into 1000 basis points (bps), or quotes, and contains functionality related to governance of the property. Quotes can be subdivided into two or three decimal places for larger valuations.

NFT: Non-Fungible Token. Originally defined in the ERC721 standard interface[2], a Non-Fungible Token is an indivisible token that represents an external object in the universe.

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[1]We use a different term from *shares* so as not to confuse quobands with companies or REITs, as well as to denote direct ownership of the property itself. The word "quote" used here is short for *quotient*- in arithmetic the result of the division of two numbers. Not *quotation*.

[2] ERC: Non-fungible token standard. `https://github.com/ethereum/eips/issues/721`

Every NFT contains a link to an immutable metadata document which sets out a description of the object. Used in quobands to define the property owned by the contract, containing attributes such as GPS coordinates, occupants and a hyperlink to the canonical land record where applicable (for example HM Land Registry in the UK or SLA in Singapore).

Coupon: In a fixed quoband where the issuer buys back quotes to regain ownership, there is a small premium called a coupon. The quote recall price is the original offering price (which can be adjusted via oracle to account for price volatility) plus the coupon. To take one example, in Bob's construction quoband, the coupon is 5%. The original offering price was $5000 per quote. So the quote recall price would be $5250.

Possession: Whoever has the use-rights to the property and act with the contractual permissions of the issuer as well as responsibilities and decision-making ability. The possessor is set automatically by the smart contract as the blockchain address which owns the largest number of quotes.

Limit: The maximum number of quotes that it is possible for any single investor to hold, as a proportion of the total. In a limited quoband this is set below the number of quotes held by the issuer, which gives them an automatic right of occupancy. No investor is able to hold more quotes than the issuer. In an unlimited quoband, anyone can acquire as many quotes as they like without permission and even change the occupancy- the equivalent of a hostile takeover. This would be an undesirable feature in the majority of real estate development use cases, however may have some utility in quobands implemented for public property or commons if combined with additional mechanisms.
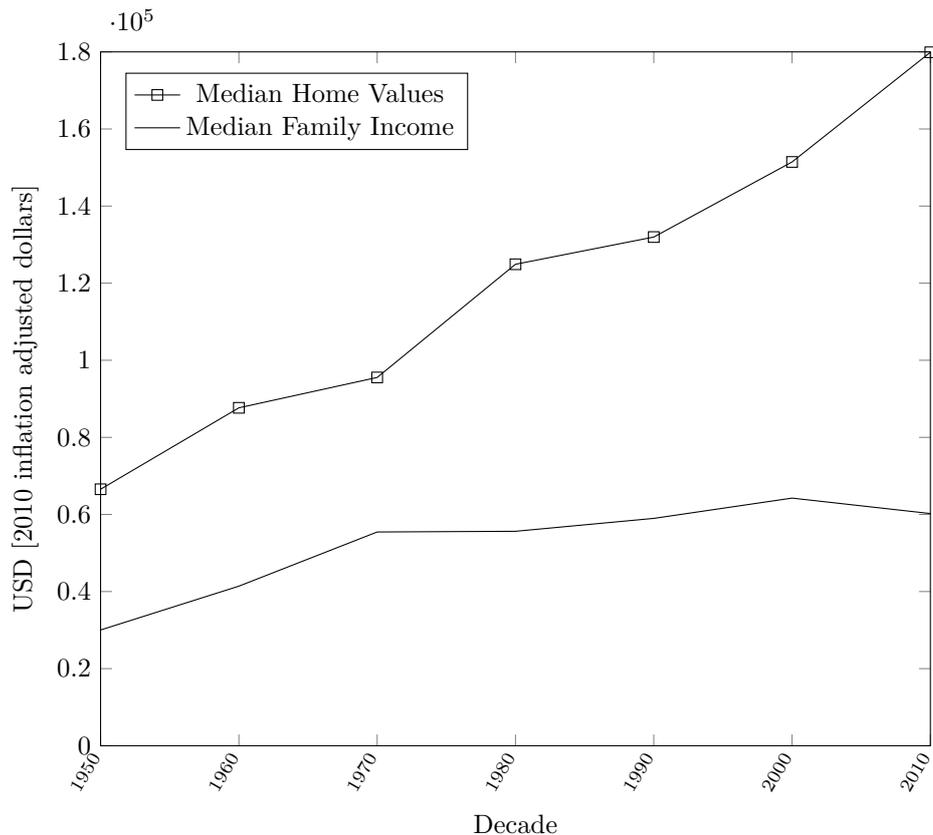
Veto: The ability of the owners acting in tandem to circumvent the issuer/occupant of a quoband. Exercised in distress scenarios under pre-agreed conditions.

2   Background

Millennials have a problem. Each generation since the boomers has had to wait longer and longer to achieve one of the basic hallmarks of economic and physical security: the ability to own a home. The following table (which has been adjusted for inflation) reveals the stark rise in median house prices in comparison to median household income in the United States since 1950 [1]:

Year	Median Family Income	Median Home Values
1950	$30,030	$66,539
1960	$41,401	$87,664
1970	$55,452	$95,540
1980	$55,633	$124,905
1990	$58,981	$131,968
2000	$64,241	$151,448
2010	$60,236	$179,900

To contrast these numbers more clearly, let's take a look at them on a graph.

$\cdot 10^5$

Median Home Values
Median Family Income

USD [2010 inflation adjusted dollars]

1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0

1950 1960 1970 1980 1990 2000 2010

Decade

A more granular look at the relationship between home values and income is available in Appendix A. Home values can certainly rise for "innocent" reasons such as increased quality, square footage, or a move from rural to urban living. Even controlling for such factors these broad averages still shows an undeniable trend: a widening affordability gap in the western world which has already changed how Millennials live compared to previous generations. During this timespan the gap between median income and median house prices has risen 228% according to 2010 inflation-adjusted figures.

Even if these higher costs can be framed in innocent terms, this is not the standard that we have come to expect in other areas of the economy. Markets operating freely under normal circumstances generally lead to an increase in quality combined with a reduction in price. This is well understood in technology. A laptop in 1996 that cost $4699 would get you a 75MHz processor and 8MB of RAM. In 2017 a smartphone that cost less than $100 has a 1.5GHz processor and 2GB of RAM. What if this could happen in real estate development? The possibilities of new technology for fast, inexpensive and high-quality construction enabled by 3D-printing and robotics have yet to be realized at a large scale. Yet very often words like *stagnating* are used to describe a fall in house prices. To paraphrase Peter Thiel, the astonishing advances of the world of bits have failed to encompass the world of atoms. The beneficial processes of economization celebrated in other areas of the economy are relatively absent in the world of real estate, indicating that more often than not the interests of speculators are prioritized above the interests of would-be homebuyers.

The human cost of this failure is tragic. In 1981 the typical homebuyer was 25-34. In 2017 the typical homebuyer is 44. Considering the cost of owning a home, it's easy to see why. Many millennials are in a state of permanent serfdom, living at home or renting, with shorter time horizons rendering them unable to plan for the long term or build the necessary economic foundations to start a family. These shorter time horizons are an adaptation to the surrounding incentives. As the ladder of true ownership have been lifted, so too has the psychology of ownership, or what Nassim Taleb calls *skin in the game*. The tendency to

value one's surroundings, to invest and build a foundation out of a belief that doing so will lead to a better future.

Technology has tried to work around the affordability crisis in real estate by helping us make more out of less. One example of this, the sharing economy, allows people to rent their spare spaces and widgets to maximize efficiency while providing consumers with cheaper alternatives. This is not bad on the face of it. There is nothing wrong with being more efficient and making better use of resources. Yet the sharing economy has become a commoditization of ever-encroaching poverty [3] in much of the developed world. Instead of doing the necessary work of building and expanding to keep track of increasing demand, real estate has become almost purely a speculative asset, with many layers of intermediaries taking a larger and larger cut in order to finance deals.

Interest rates and quantitative easing in particular have had a profound effect on house prices. By keeping interest rates low, more buyers are encouraged to take out mortgages enter the market for real estate. Since rates have been kept near zero for many years, sometimes even dipping below, house prices have unsurprisingly increased.

The difference between house prices in London versus Berlin is a striking contrast. The *Baugruppe* (Building Groups) of Berlin, which can be traced back to the 1960's and 1970's are instructive [2]. In Germany there is a general recognition that real estate is an essential public good first and a speculative asset second. Baugruppe are formed by locals in order to plan and build developments along certain themes, for example elderly or young families. This peer-to-peer approach cuts out many layers of middlemen thus keeping house prices much lower. Whereas in London a combination of all the aforementioned pressures, including macroeconomic, regulatory, environmental and speculative factors have conspired to drive up prices and make it extremely difficult for supply to keep up with demand in the city.

2.1 The Ownership Economy

The essential innovation of blockchain and smart contract technology is the use of cryptography to enable true digital ownership. As long as you have control of the private key, you have complete sovereignty over the contents assigned by the record to the corresponding public key, be it units of cryptocurrency, tokens or more complex abilities and permissions enabled by smart contracts. Smart contracts are pieces of executable code which can operate on the blockchain's record in more complex ways- one that enables a much richer degree of flexibility beyond straightforward transactions. "Private Property" isn't just a wet-coded legal definition in a statute book, but an objective, executable attribute of the network which is true regardless of physical location. Since public blockchains are generally decentralized, no single agency is able to amend the shared record without the overwhelming consensus of other participants. From one simple axiom- a public key over which a private key is sovereign- an emergent ownership economy can be built.

2.2 Real Estate Investment Trusts

A Real Estate Investment Trust (REIT) is a kind of corporation whose purpose is primarily to buy and hold income-producing real estate. Owning shares in a REIT entitles you to the income produced by the underlying assets. REITs were first introduced in the 1950's under the Eisenhower administration, and have been a fairly reliable investment. Quobands and REITs have many similarities, but the chief difference is that a quoband involves the direct ownership of the property title itself (represented as an NFT), and also implements quite a lot of necessary real estate functionality in a highly integrated and transparent manner- including optioning, crowdfunding, securitization, transfer, and dividends. Existing REITs

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[3]In terms of fundamentals. Some will optimistically point out that living standards have increased due to industrial efficiencies, trade and technology, however this does not take into account that America is $20 trillion in debt. The surface increase in wealth is built on a foundation of sand.

could fairly easily adopt the quoband model to improve their processes and governance. Unlike REITs however, quobands can be used for many other purposes, such as a "crowdfunded mortgage" on the blockchain which opens up new possibilities and markets.

3 Objectives

Quobands will be developed by Nuhanse Network Inc., under *quobands.com* primarily. The project will initially focus on creating a number of experimental quobands around startup society projects in special economic zones (SEZ). The next stage will aim to transform the real estate market more broadly by targeting the housing market. The project will encompass ecosystem initiatives to facilitate emerging quote markets across multiple platforms and stakeholders.

The Nuhanse Network itself is modelled as a kind of 21st century Hanseatic League. The Hanseatic League was a commercial confederation of self-governing guilds and towns that existed in Europe around the Baltic during the late Middle Ages. Nuhanse will launch a number of initiatives around the theme of decentralization and institutional innovation, including software development, consultation for businesses, governments, startup societies and SEZ's.

Quobands will boldly address the affordability crisis in real estate in the following ways:

1. By implementing blockchain-based systems to move real estate in the direction of equity-based financing for projects large and small, we route around the influence of centralized mortgage interest rates on the housing market.

2. By using cryptocurrencies such as Bitcoin and Ether as a primary medium of exchange, we route around the influence of quantitative easing on the housing market.

3. By supporting Special Economic Zones we can fix some of the regulatory factors that cause shortages in supply, such as zoning restrictions.

To get millennials onto the property ladder, we must build, and fast. And we must do so in a way that rewards investors and structures incentives so that investors can profit from participating in quote markets despite falling house prices.

Our mission is to reduce median house prices by 80%, adjusted for inflation, in the next 20 years across the developed world.

We believe it is possible for the average person to fully own a decent home for the price of one year of income or less.

4 Specification

In essence, a quoband contains two elements: a subject (or multiple subjects) and an object (or multiple objects). The purpose of the contract is to bind them and govern their relationship and permissions. The subject is defined by tokens, which are owned by keypairs, and a Non-Fungible Token (NFT) which identifies some physical or digital property external to the blockchain. The NFT is the "object" which is owned by the subjects. The contract defines rules about who has the right of possession and administrative authority over the object in question. In addition to this there are a number of modules which allow for components such as initial crowdfunding, voting, dividend payments, auditing and so on.

Quoband sub-ownership is useful in several scenarios, including land leases where the quoband represents overall ownership of a large area of land, but where parcels of the property can be leased out according to a certain conditions. Hong Kong is an example of this system in practice, where land is essentially owned by the government but leased out to private entities for 75 years at a time.
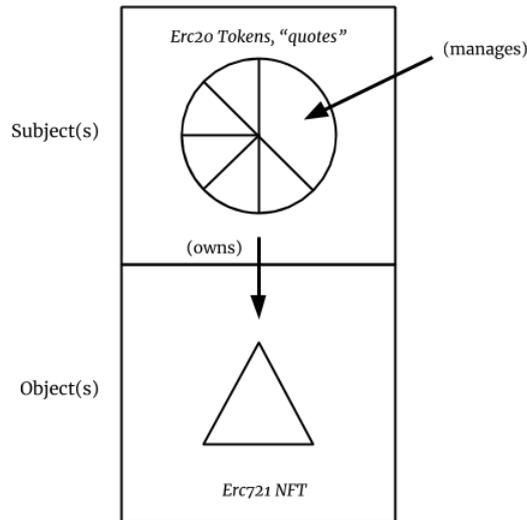
4.1 NFT

Non-Fungible Tokens (ERC721) are a standard interface for smart contracts which can define ownership of scarce real world assets. The most well known application on Ethereum so far is the "CryptoKitties" game, where NFT's are used to track ownership of digital cartoon cats with their own unique set of genetic characteristics. NFT's have also been envisioned for usage in real estate where there is need to clearly identify and assign the bundle of rights securely and transparently. NFT's are used in quobands as a kind of "tokenized title"- an ownable blockchain token containing an immutable link to a document (or set of documents) detailing the property. This could potentially be used as a secure record for deeds. However most jurisdictions in developed countries have established land registrars required by law, so in this case the NFT metadata can contain a hyperlink to a canonical land registry. Alternatively, where this proves difficult, an NFT could contain a link to a title insurance policy, which is often just as good or better than the official record (often kept offline in local counties in the US).
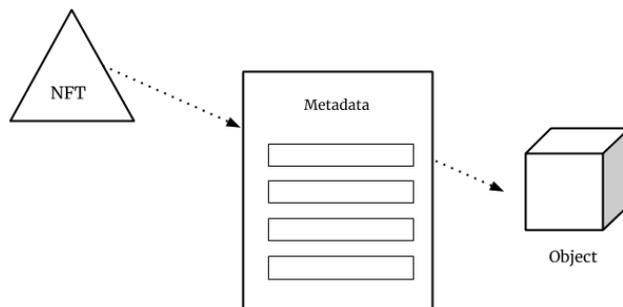
A quoband can keep track of multiple NFT's in the same contract, giving each one a unique 256-bit unsigned integer as an ID. This allows a single quoband to keep track of several properties; for example a residential or office property development with individually sub-letted units. The quoband would apply to the overall development but the arrangements would be privately managed by the issuer. Another area this could apply is to government land leases such as what is practiced in Hong Kong or Singapore. The government has "base ownership" of all the territory, but leases the land to private developers on long term contracts under fairly stable and predictable conditions and terms.

4.2 The Bundle of Rights

The concept of property rights have traditionally been broken into five separate rights, called the "bundle of rights". These are:

Rights	Description
Possession	*The property is owned by whoever holds the title.*
Control	*The ability to regulate how the property is used.*
Exclusion	*Others can be excluded from using or entering the property.*
Enjoyment	*The owner can enjoy the use of the property within the law.*
Disposition	*The ability to sell, rent or transfer ownership of the property.*

4.3 Metadata

The "metadata" component of an NFT is a string variable in the contract which can represent a permanent link to any external piece of content. This document contains the various parameters of the property including the bundle of rights and physical dimensions. For the purpose of quobands we use IPFS (Interplanetary File System) where content links are permanent and immutable. The metadata document for a single property is linked in the following format: */ipfs/abc…xyz.*

Alternatively for quobands that govern multiple properties, a domain name approach can be used, with multiple alternatives available. An IPNS (Interplanetary Name Space) link can be used with its identifier: */ipns/abc…xyz.* With IPNS an owner controls the key, but can change the content linked to it. This can be used elsewhere to look up the content linked to that public key. ENS (Ethereum Name Service) can also be used in this instance, by providing the ENS url as the metadata parameter: *mybuildingproject.quoband.eth.* This can then be used to look up the ENS resolver with content links to the information about the property.

Metadata will have Standard Parameters in JSON format as well as other identifying features such as a KML file [4].

4.4 Phases

- **Identification.** The property title is identified and specified. If a Non-Fungible Token does not already exist for the property, it is created. If the NFT already exists and is owned, then the optioning process will be followed for transferring it to a newly issued quoband. If the quoband doesn't involve some kind of initial property transaction then the optioning step is unnecessary.

- **Optioning.** In traditional real estate projects it is customary to place an "option" on a property before raising the finance to execute the actual transaction and owner-ship transfer. An option is an agreement which commits a transfer of an underlying

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[4]Keyhole Markup Language: a file format used to physically pinpoint locations, add image overlays, and expose rich data in Google Maps.

asset to take place at a certain price (known as the "strike price") within a specified timeframe. A quoband can integrate this optioning process from the beginning, using cryptocurrency as a medium of exchange. The advantage of an end-to-end approach is that there is less risk of the option failing due to currency fluctuations, which might happen if the option was defined in terms of fiat while finance was raised using crypto. If the seller wishes to eventually exchange back to fiat, they may do so once the whole transfer process is completed on-chain.
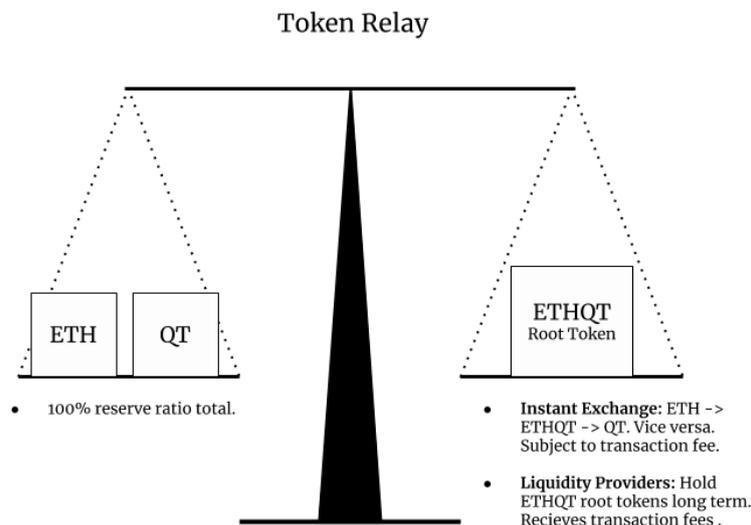
The NFT that securitizes the property is either created (for the first time) or transferred from an existing quoband into an new option smart contract, where the Ether strike price is set along with the blockchain address of the new quoband, the seller, and a timeout. If the issuer successfully executes the crowdfund within the timeframe, the money is sent to the option contract and triggers a transfer of the NFT to the new quoband. The option then passes the funds to the seller, completing the transaction.

- **Crowdfunding.** Once the target valuation is set, a quoband contract is created containing 1,000 quotes (as ERC20 tokens). The address with the largest number of quotes has the right of possession over the NFT and legally has the use-right of the property. The limit factor (if set) also prevents any single other address from acquiring more quotes than the occupancy limit- i.e. engaging in a hostile takeover. This means that transfers must be by the consent of the current occupant, unless in exceptional circumstances such as a veto from the other owners.

- **Rooting.** To allow investors to freely buy in and out of the contract, it is necessary to have liquidity. For this every quoband will have its own token relay to facilitate automatic exchanges between the quote token and Ether. The relay contract acts as a market maker for ETH → QT and vice versa. Once the crowdfunding phase is over, a certain amount of the raised funds (say 5%) can be deposited into the relay contract along with a stock of quotes. The more initial liquidity provided the better, since very large transactions may move the Bancor price too much in either direction before it can be balanced through arbitrage. To solve this problem the relay can have an optional "window"- such that trades that cause the buy/sell price to move more than a certain percentage (say 10%) are refused. This means that larger transactions will have to use an OTC (Over The Counter) provider or trade on a secondary market.

- **Possession.** The person with right of possession of a quobanded property is whichever owner holds the most quote tokens. Whoever has the largest share of quotes has ownership of the NFT (Non-Fungible Token) representing the property. In a limited model this is always the issuer. However the possessor has the prerogative of transferring possession rights to the second largest holder by selling their quotes, in which case the second largest older becomes the possessor. In the "real world" this is enforced by the legal agreements set out in advance when the quoband is initially minted.

- **Transfer.** To transfer possession (NFT ownership) in a limited quoband, one must attain the majority of quotes by consent of the existing occupant. This can be done in a number of ways: the interested party could purchase the quoband outright (subject to consent of the current possessor). In reality this would mean buying back every other owner's tokens plus the recall coupon, or the current occupant could sell just enough quotes to the next largest holder so they become the majority. Theoretically in a quoband where the occupant has 20% of the quotes and the next largest quoter has 19%, the occupant could sell 1% of theirs to the next one so that they become the new possessor, while still maintaining a fairly large stake in the property. Any quoband provider/facilitator will have to handle the legal aspects of such a transfer according to the laws of the jurisdiction. The United Kingdom limits the number of owners on the title, so in this case only the occupant would be named on the official registrar. If the occupant changes this will be updated on the canonical record also.

- **Quote Recall.** Quote recalls allows the issuer to buy back the quotes from other quoteholders. This can be done by depositing Ether into the contract. Then any quoteholder can sell their quotes back to the contract in exchange for Ether for the initial price plus an additional coupon rate. The recall price can be adjusted via an external oracle to account for price volatility. The goal of a fixed limited quoband is for the issuer to eventually regain full ownership (i.e. 100% stake), but other floating models can also engage in quote recalls.

- **Distress.** Distress situations include cases where an issuer is unable to continue buying back tokens at the agreed schedule, or fails to move in the case of occupancy transfer. In this case a group representing the facilitator and the investors can "veto" the quoband. This can be done by a vote of quoteholders which must exceed a very high quorum. Privately-enforced eviction may be possible in some circumstances.

- **Completion.** When a quotes have been completely bought back by the issuer (in the case of a fixed-limited contract), the quoband is considered "complete"- the issuer has full ownership of the property- i.e. the NFT is owned by a single blockchain address.

5 Liquidity

In some implementations it would be possible to do without the automated liquidity mechanism and simply use a traditional exchange orderbook method for trading quotes. However for our planned implemented we will use Bancor to provide liquidity automatically. Bancor is a smart contract that acts as an automated market-maker, holding one token in reserve and issuing a new token in its place [3] at a specified reserve ratio. This means that instead of having to use a third party exchange to buy and sell quotes, users can exchange directly with the smart contract- by selling the contract reserve tokens one can receive the issued currency, and vice versa. The price offered by the contract can adjust according to the ratio of reserves to issued tokens.

Token Relay

ETH   QT

ETHQT
Root Token

- 100% reserve ratio total.

- **Instant Exchange:** ETH -> ETHQT -> QT. Vice versa. Subject to transaction fee.

- **Liquidity Providers:** Hold ETHQT root tokens long term. Recieves transaction fees .

To show how this works we will use the analogy of the weighing scale with two plates- the reserve plate and the issue plate [4]. If you want to receive tokens, you must deposit a certain amount of the reserve currency onto the reserve plate. The contract then automatically mints a certain amount of the token on the issue plate. And vice versa: if you hold a number of issued tokens and want to exchange it back for the reserve, the computer calculates a price

then takes those issued tokens out of circulation and sends the reserve currency back to you, taking it off the reserve plate. In this way the "scale" remains in balance always.

The two most common use cases of Bancor are Smart Tokens and Token Relays.

- **Smart Token:** A token that can hold one or multiple other tokens as "reserves"- or connectors- and adjusts its minted supply based on the configured reserve ratio to keep in balance as users trade with it.

- **Token Relay:** A kind of smart token who purpose is to facilitate exchange between two reserve currencies. The "issued" token (root token) acts as a temporary intermediary to facilitate exchange from one reserve to another. Alternatively the root token can be held to receive transaction fees.

The following is the Bancor pricing formula which calculates the offering price for exchanges between reserves and issued supply tokens. The variables:

R Reserve Balance

M Minted Supply

W Weight

D Deposits

Root Tokens (ETHQT) recieved in exchange for reserve:

$$Price = M((1 + \frac{D}{R})W - 1) \tag{1}$$

Reserve paid back in exchange for ETHQT:

$$Price = R(1 - \sqrt[w]{1 - \frac{D}{M}}) \tag{2}$$

6   Types

There are four basic types of quoband that correspond to various real estate development use cases. In terms of financial structure they correspond to debt-based, equity-based or a hybrid of both.

Fixed-Limited: This is the classic "mortgage" style quoband- hybrid of an equity and a bond (debt). This is used by private issuers interested in buying or building relatively small scale properties. Fixed-limited quobands have two essential features: during the minting phase, the issuer is given the majority of quotes. This share is what sets the "limit"- no other investor can buy more than the amount of quotes held by the issuer, thus ensuring that the issuer retains the right of possession. And it is "fixed" in the sense that recalls or buybacks occur at a fixed rate plus a small markup so that investors are rewarded for their risk. The advantage of taking a quoband over a mortgage to the issuer is that as long as they are credit-worthy, there is no need to put up a deposit. This is one of the most difficult barriers to homeownership currently.

Floating-Limited: A floating-limited quoband will be most useful for large scale private real estate developments such as private cities and special economic zones. This is also useful for commercial or industrial property development. In a floating model the price of quotes can fluctuate freely. Investors in a floating-limited quoband are entitled to receive dividends from revenues generated by the property. Initially our project will develop prototypes following this model for implementation in an SEZ context. As before, the issuer

	Fixed	*Floating*
Limited	Small private property	Large real estate development, private city, SEZ
Unlimited	small public property development, commons	City-state, settlement project, republic

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has possession- which gives them the right to use the property and transfer it if they see fit. The occupant of a quoband can also unilaterally transfer occupancy by selling their quotes below the limit to another investor. In that case the next largest quoteholder automatically becomes the new possessor.

Fixed-Unlimited: This model may have occasional usefulness for public utilities or commons, where the right of possession has no particular significance and other governance mechanisms are embedded for management of the funds, and where all stakeholders have voting rights on the disbursement and repayment of the funds. In particular Elinor Ostrom has done some very interesting work on the management of common pool resources where such a model might be applicable [5].

Floating-Unlimited: A quoband of this type could be used by a nation-states and cities to raise capital and to give investors a stake in very large scale investment projects. Governance rules are once again would be customized to the required situation, but the same principles apply: quotes are openly tradeable in marketplaces and owning a majority stake does not confer special rights above and beyond what is allowed to other stakeholders. It is conceivable that a special kind of quoband on the blockchain could even represent the whole property within the borders of a state, where possession changes according to elections (hence why it is unlimited). Secondary or tertiary NFT's below the primary one would represent property owned by citizens and companies. This is a speculative but interesting use case to consider.

7 Medium of Exchange

Many Ethereum-based platforms have opted to use a purposely-designed utility tokens, issued via crowdsale, which is structured simultaneously as a medium of exchange and a kind of software access key. Notable examples include the Melon protocol (MLN) and Basic Attention Token (BAT). In the case of BAT, a variety of services are offered related attention and advertising, priced in the token, while rewards are paid to publishers at the other end, also denominated in BAT's. This model is essentially a closed mini-economy devoted to supporting one or other service loop provided by the platform in question.

There have been several technical criticisms of this model. One of the best was provided

by none other than Vitalik Buterin himself in his article, *"On Medium Of Exchange Token Valuations"* [6]. A reductio ad absurdum of this model is one where every platform runs its own token- AMZ to make purchases on Amazon, MAC tokens to buy a Big Mac, and so on. Even accounting for a future where seamless decentralized exchanges on the blockchain are possible, this would still impose a great cognitive load on the average user and several complications in pricing products to keep adjusting prices to keep track of price changes.

The main argument against utility tokens as a medium of exchange is that the overall stability of a token and economic viability depends very much on a users ability and willingness to hold it. According to Vitalik Buterin:

> "If someone creates a very efficient exchange, which allows users to purchase an appcoin in real time and then immediately use it in the application, then allowing sellers to immediately cash out, then the market cap would drop precipitously. If a currency is stable or prospects are looking optimistic, then this may not matter because users actually see no disadvantage from holding the token instead of holding something else (ie. zero "de-facto fee"), but if prospects start to turn sour then such a well-functioning exchange can accelerate its demise."

It is best to use a high liquidity cryptocurrency with a fairly stable monetary policy rather than with a utility token. Our implementation of this project will use Ether (ETH) as a medium of exchange, although other options will be available, including fiat. We advocate a complete separation of concerns between tokens implemented as securities and the medium of exchange used to purchase them and pay dividends within a particular system.

Most utility token implementations fail the Howey Test, and already regulators are moving to seal up any gaps that might have once been exploited by token creators to avoid being classed as securities. On the upside, France has recently approved trading of unlisted securities [7]. This is an indication of the direction of travel: proper security tokens on the blockchain in a legal environment that permits them to exist. In this context the case for utility tokens is diminished.

8   Participants

Quote markets have three basic roles, or categories of participant. These can obviously overlapping categories.

Investors. Due to the macroeconomic conditions operating over the past few decades, real estate investment has mostly been a matter of asset appreciation. Changing the underlying incentives of real estate to reverse this trend for the emerging generation creates a problem with incentivizing investment. In the case of fixed limited quobands for the residential and commercial market, the solution is focus on cashflow from coupons or dividend payments instead of asset appreciation. This is a similar category of investor to the bond market. However floating quobands in large scale property developments will attract investors interested in quotes as a form of equity which increases in value as the development becomes more valuable. The goal is to make investment profitable while getting the balance between cashflow and asset appreciation correct for the particular use case.

Issuers. We envision that quoband issuers initially will mostly take the form of real estate development firms, and for most projects that adopt the quoband model to be slightly larger scale developments. Part of this is because early pioneers will be faced with a certain amount of legal risk as well as other costs like global securities registration. We feel that the SEZ/startup society market is the most likely to have the most immediate application, since economic zones provide a level of legal freedom to implement such models, and many players in this industry are involved in blockchain. But as the legal framework becomes standardized however this can be extended to the residential market and more traditional

industry, commercial or government applications.

Facilitators. Facilitators are parties, platforms or protocols that provide identity, credit rating, evaluation, legal, auditing or other advisory services around the launch and marketing of quoband projects. Facilitators can also provide liquidity, insurance and secondary quote markets. Quobands.com will provide many of these services, and will aim to be integrated with many decentralized blockchain-based alternatives. Nuhanse Network will work on other civic tech products to integrate with quobands. Another role of facilitators is to act as a proxy of owners instead of direct voting or interaction with the possessor.

9   Quote Markets

When launching a quoband ICO, the offering price of each quote is found by the following formula:

$$Price = \frac{Valuation}{1000} \tag{3}$$

This is the total valuation (or target raise of the ICO) divided by 1000 in the chosen medium of exchange. This means that one quote will always represent a Basis Point (bps) of ownership of the property. Basis points are a unit commonly used for quoting stock which equals 1/100th of 1%. However to make quoband crowdsales more accessible to the broader public, especially for projects with a larger valuation, fractional quotes to 2 or more decimal places are possible, e.g. 1.25 quotes.

Voting: In any situation such as a veto where a vote from owners is required, each full quote will have 1 vote. That means only owners of full quotes will be able to vote in these (hopefully rare) situations.

Delegation: In most circumstances it may be preferable for a facilitator to act as a delegate on behalf of all the other non-possessing owners and the person with possession rights. In this case there would be no voting in the case of a distress or other scenarios- the delegate would have full authority to act in the interests of the other owners.

Quote tokens will be registered securities rather than utility tokens. A majority quote position can entitle the holder to ownership of the NFT and minority positions entitle the holder to a share of cashflow or asset appreciation. We will aim to list quotes on secondary marketplaces dedicated to facilitating the market for real estate ownership.

Facilitators that provide quoband issuance are responsible for doing things like writing the prospectus, credit rating and other factors that will help to sell the token on quote markets.

Quotes listed on secondary marketplaces will have a credit rating similar to bond ratings, which are rated from AAA to D. This records the estimated ability of the issuer/current occupant of the quoband to meet the agreed obligations. Quobands.com will develop a decentralized protocol for credit ratings and so that a multiplayer quote market will be able to agree to the same basic standards of valuation.

10   Applications

The following are some example applications of the quoband model in real estate development use cases at differing scales.

10.1　The Farmhouse

Ben and Olivia are in their early thirties and are seeking to buy a home. Previously they had lived and worked in London but wanted to move to a smaller city nearer to the countryside in England. Olivia had seen an advertisement about an old stone farmhouse located on the outskirts of the charming city of Bath. There were no windows, almost no roof and only the stone walls remained of the farmhouse. Structurally it was very large and would accommodate an inn as well as a permanent home for them both. So they have the idea of buying and restoring it.

There were a lot of other people in the community who were also interested in helping to restore the farmhouse, since it was considered to be a historical artefact. So Olivia has the idea of financing the restoration with a quoband. Instead of going for a mortgage, they decide to create a fixed, limited quoband through smart contracts through a facilitator. They get in touch with the current owner, who is an old farmer, and negotiate to buy it for the equivalent of $800,000 in pounds sterling. They also estimate that restoration work with cost $150,000. So the facilitator helps to prepare the quoband contracts, which includes the creation of an NFT representing the Farmhouse in an option contract, which will be programmed to transfer the NFT to the new quoband on receipt of the agreed funds within 30 days.

They do some online marketing around Bath to announce their plans for the Farmhouse-to turn it into an inn. They will distribute quotes in the property via a crowdfund to give the community a stake, and then regain ownership over the next few years from the revenues of the inn.

A fixed, limited quoband is the most suitable for the financing of small scale residential property. It would also be structured as a debt, meaning that a certain coupon would have to be paid along with mandatory quote recall (token buybacks) at an agreed schedule- a term of 11 years with a 1 year grace period at the beginning. This has the advantage over a mortgage that they don't need to put up a large initial deposit.

The Farmhouse ICO	Amount
Raise Target	$1,000,000
Valuation	$1,250,000
Quote Price	$1,250
Minimum Investment	$12.50
Limit	20%
Credit Rating	A
Type	Fixed, Limited
Cap Table	*Amount (in quotes)*
The Farmhouse	200
Public	800

Grace Period: The legal contract for the quoband specified a 1 year grace period so that Ben and Olivia can do the necessary construction work on the Farmhouse. During this time, only the interest (coupons) would have to be paid.

10.2　Las Orillas

A development company has spent the last few years negotiating with the Puerto Rican government to get permission to create a special economic zone on the island. Their goal is to create a new startup city called "Las Orillas"- which would be the Dubai of the Caribbean. Las Orillas would use economic freedom as a tactic to kickstart the economy after a series of recent natural disasters that has befallen the island. The government has agreed to allow them to use the land for the development, and they negotiate agreement where Las Orillas

remains under the partial sovereignty of the Puerto Rico with various exceptions. Future citizens and residents of the city would be exempt from nearly all taxes and regulations, however the company would have to make a single annual payment to the Puerto Rican government for a variety of services. This is taken from taxes and revenue generated by the company from land leases and real estate sales as well as residency permits.

| Las Orillas ICO	Amount
Target Raise	$100,000,000
Valuation	$125,000,000
Quote Price	$100,000
Minimum Investment	$1000 (100 sub-units)
Limit	20%
Credit Rating	A
Type	Floating, Limited
Cap Table	Amount (in quotes)
Las Orillas	200
Puerto Rican Gov.	100
Public	650
Other	50

The company developing Las Orillas decides to implement a floating-limited quoband to raise the necessary capital. The reason for this choice is that the token needs to float freely in secondary markets to represent the perceived value of the development. It also provides a very easy to implement way of giving the parent government a stake in the project.

Federated NFTs. An SEZ-based private city can give the parent government a stake in the quoband, entitling them to a share of payments from revenue, rents and taxes. The quoband for Las Orillas contains a tokenized primary NFT as normal, but also has "secondary" and "tertiary" NFT's for lower levels, according to the following scheme.

1. **Primary:** An NFT representing the total value of the city. Holders are entitled to revenues from taxes, revenues, leases, rents and other sources. Metadata contains the dimensions of the SEZ as negotiated with the Puerto Rican government.

2. **Secondary:** An NFT representing a land lease. Usually held by development companies within Las Orillas. Payments can be made annually to the City. The NFT metadata contains the dimensions of the agreed lease as well as the contract with the relevant terms and conditions.

3. **Tertiary:** An NFT which can be distributed by holders of the land lease NFT with privately agreed terms to individual residential, commercial or industrial units. Metadata contains all the title and deed of the individual property.

The quoband governing the city property gives the right to create non-conflicting quobands at the subsequent level, however NFTs at a lower level are not directly controlled by the quoband- only the right to create and distribute the NFT. It is possible for a tertiary NFT representing a piece of residential property, for example, to be used to implement a residential quoband that has no direct relationship to the overall Las Orillas quoband besides or land lease besides the NFT itself.

Capturing land value increases. One of the most lucrative sources of revenue for cities is ground rents. This allows the government to capture increases in land value that come about as a result of development by other companies operating within the territory. In his
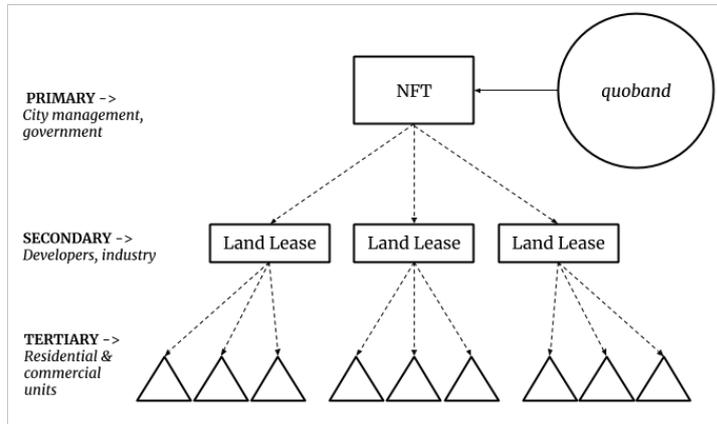
paper, "A New Hanseatic League", Mark Frazier shows how this is done in Hong Kong and Singapore [8].

> Singapore and Hong Kong, as Asia's leading special economic zones since the mid-1800s, are also world leaders in land value capture. More than 99 percent of all land in Hong Kong, and more than 80 percent in Singapore, is now owned by government or parastatal bodies. Their governments generate revenue by offering long term leases to high bidders through open auctions and tenders, and rely on upon revenues from land value capture to cover as much as a third of their annual operating budgets. Singapore and Hong Kong are rewarded for actions that ensure offering world-class conditions for investors and entrepreneurs, because investors bid more for leases when they have confidence in the quality and stability of the business climate.

This could be done by automatically the city company a stake in the secondary NFT's. Ground rents will be an indispensable source of revenue for the city as it grows larger.

10.3   Fort Valley

Gabriel is a 29 year old Canadian real estate developer living in Valdivia, Chile. A few years ago he and a group of friends created a startup village called Fort Valley from scratch, with the goal of growing it into a thriving community for entrepreneurs. After cashing in some Bitcoin from a small investment he had made two years ago, he was able to build a wooden outhouse in a remote spot in the countryside from Valdivia.

Gabriel wants to build ten new permanent homes next to the outhouse in Fort Valley. In addition he wants to build an academy for programming and cryptocurrency skills. He envisions the academy being used to hold educational talks and events. After several months of speaking at conferences and building an online following for his startup society project, Gabriel finally found three prospective buyers willing to put up a deposit, but not enough to be able to fund construction.

So Gabriel decides to launch a quoband with the following specification for his extended village:

Since he has prospective buyers already lined up, he feels fairly confident that he can make up the revenue of the building cost once it's complete by selling or leasing out the real estate. So Gabriel decides to implement a fixed, limited quoband for the Fort Valley project, with a

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Fort Valley ICO	Amount
Raise Target	$4,000,000
Valuation	$5,000,000
Quote Price	$4,000
Minimum Investment	$40
Limit	20%
Credit Rating	BB
Type	Fixed, Limited
Cap Table	*Amount (in quotes)*
Fort Valley, Inc.	200
Public	800

10% coupon. Any revenues produced in the meantime will be paid as ongoing dividends to the quoteholders until he can buy them back. The process of preparation involves writing a prospectus and working with a quoband facilitator for a deal involving the registration of his offering as a security on the blockchain.

11   Etymology

The word "quoband" is a combination of the Latin *quo* (where/place) and *band* which comes from the Old English word for bind. In other words, a specific place, land or property to which multiple owners are bound. We wanted a word for an equity-based property crowdfunding to contrast with "mortgage", which is a combination of the Old French words mort (dead/death) and gage (pledge).

In choosing this term we are getting at one of the most exciting value propositions that blockchain technology makes possible- a move from debt-based financing to equity-based financing. Since the issuer has a share in the property themselves, there is an incentive to increase the value of the asset over time. If a 2008-style crash ever occurred again, equity-based financing would mean that while the value of the property may go down, they would still retain the same stake in the property. Coincidentally quobands are also compliant with certain Islamic and Buddhist traditions which forbid debt-based financing models.

12   Conclusion

We have provided a specification of the quoband model and its application to various property development use cases. The goal is to move to in the direction of an equity-based financing system for real estate and describe some tools for getting there. This is partly as a strategy for routing around some existing malincentives that have driven up house prices. Some details of are necessarily left out of scope as business problems to be solved elsewhere. There are also many other dependencies such as legal or political constraints in various jurisdictions, and the challenge of competing against established incumbents. This is true for any potentially transformational system. We believe in the potential of quobands to be the foundation on which the societies of the future will be built.

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A Previous Work

This paper builds upon certain ideas, terminology and content developed by Philip Saunders and Abhimanyu Dayal in the paper entitled "Estatechain: Building the Peer-to-Peer Ownership Economy", and is hereby relinquished into the public domain.

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