Bancor Protocol

A Hierarchical Monetary System and the Foundation of a Global Decentralized Autonomous Exchange

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The phrase "double coincidence of wants" was coined in Jevons (1893). "The first difficulty in barter is to find two persons whose disposable possessions mutually suit each other's wants. There may be many people wanting, and many possessing those things wanted; but to allow of an actual act of barter there must be a double coincidence, which will rarely happen."

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The Bancor Protocol

*Abstract: Bancor is a **smart-contract-based token conversion protocol**, which enables a single party to convert any token to another, without requiring a second party to exchange with. It achieves this through the use of reserve-tokens, which provide liquidity through autonomous algorithmic price discovery, regardless of trade volume.*

Introduction

The Bancor system and method are named in honor of the Keynesian proposal[1] to introduce a supranational reserve currency called Bancor to systematize international currency conversion after World War II.

The Bancor Protocol represents the first technological solution for the classic problem in economics known as the "Double Coincidence of Wants"[2], in the domain of asset exchange. For barter, the coincidence of wants problem was solved through money. For money, exchanges still rely on labor, via bid/ask orders and trade between external agents, to make markets and supply liquidity.

Through the use of smart-contracts, Bancor-Enabled Tokens (BETs) can be created that hold one or more other tokens in their reserve. Tokens may represent existing national currencies or other types of assets. By using a reserve token model and algorithmically-calculated conversion rates, the Bancor Protocol creates a new type of ecosystem for asset exchange, with no central control. This decentralized hierarchical monetary system lays the foundation for an autonomous decentralized global exchange with numerous and substantial advantages.

Background

Bitcoin currently has a market cap of over $16B and is traded in exchanges worldwide in ~$100M daily volume as of the time of this writing[3]. Bitcoin is tradable to most national currencies and can be purchased with a credit card and exchanged with a multitude of different currencies.

Bitcoin has a dominant 85% share of the cryptocurrency market-cap. Thousands of other cryptocurrencies have been issued since Bitcoin, some of them raising millions of dollars in Initial Coin Offerings (ICOs). Currently the most popular of these is the $1B market-cap Ethereum, a blockchain that enables anyone to create a cryptocurrency (token) on top of it, which is programmable and can interact, hold and transfer other Ethereum-based tokens. The 10th most

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[1] https://en.wikipedia.org/wiki/Bancor
[2] https://en.wikipedia.org/wiki/Coincidence_of_wants
[3] Feb 13, 2017

valuable cryptocurrency, as of now, is the $48M market-cap Augur, an Ethereum-based token planned to be used in a decentralized prediction market operating on top of the Ethereum blockchain. Dozens of these new cryptocurrencies are actively traded on different online exchanges, and specialized exchanges have emerged to address the cryptocurrency market specifically.

Advantages of the Bancor Protocol

Bancor Protocol enables a smart-contract-based, decentralized-exchange, which does not require matchmaking in order to convert one token to another. This model has significant advantages:

1. **Continuous Liquidity** - For all the tokens held as reserves by Bancor-enabled tokens. The conversion rates are organically aligned to the market-value of each token, enabling liquidity for the long tail[4] of user-generated tokens (e.g. local currencies, loyalty points, etc.), as well as for tokens issued through ICOs. Previously, such assets could not have achieved liquidity and were thus disconnected from the global economy.
2. **No Counterparty Risk** - Popular exchanges such as MtGox and Bitfinex have been hacked with hundreds of millions of dollars worth of BTC stolen from their accounts. With Bancor's decentralized model, converting one token to another does not require depositing funds in an exchange. Bancor conversions are done by a predictable, open-source, immutable smart-contract.
3. **No Extra Fees** - The only fees applied with Bancor are the blockchain platform fees (starting with Ethereum, soon on Bitcoin via RSK).
4. **No Spread** - Since the price calculation is done algorithmically by the smart contract, the same conversion rate applies for purchasing and selling tokens.
5. **Decentralized ETFs -** Exchange Traded Funds[5] are the most popular class of assets traded in exchanges worldwide. The Bancor Protocol enables the creation of ETFs with no central control or counterparty risk, owned directly by their holders.
6. **Predictable Price Slippage** - The protocol allows pre-calculation of the precise price slippage, before the conversion is executed.
7. **Lower Volatility -** Obtained by maintaining reserves which provide the liquidity, rather than relying on external, independent market makers.

The Bancor Protocol Ecosystem

- **End-Users** can hold, transfer and convert any token to another at any time, as well as buy and sell decentralized ETFs.
- **Decentralized ETF Creators** deploy ETF smart-contracts which hold reserves of *multiple* other tokens. The ETFs can be purchased and sold directly vis-a-vis their smart-contracts,

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[4] http://en.wikipedia.org/wiki/Long_Tail
[5] http://www.investopedia.com/terms/e/etf.asp

in exchange for any of the tokens held in their reserves, and function as the basic building blocks of the Bancor token conversion network.

- **Bancor-Enabled Token Creators** issue new, always-liquid tokens, managed by a smart-contract which holds one or more reserves of other tokens. A Bancor-enabled token maintains a constant ratio between the value of the tokens held in the reserve and the token market cap. The initial reserve may be obtained, for example, through a token crowdsale.
- **Arbitrage Traders** are financially incentivized to constantly realign price gaps between different exchanges. With Bancor, similarly to currency exchanges, conversion of one token to another ultimately increases the value of the target token, relative to the source token. Therefore, a same financial incentive to equalize conversion rates applies.
- **Asset Tokenizers** such as Tether-USD or Digix-Gold, issue tokens which enable using Bancor to trade real-world assets. Existing crypto-exchanges are well positioned to provide such services.

How the Bancor Protocol Works

The Bancor Network smart-contract-based protocol will begin on the Ethereum blockchain and will be powered by "Bancor-Enabled Tokens" (BETs). A BET is an ERC-20 compliant smart-contract, which also holds one or more additional tokens in its reserve, at a pre-set "Constant Reserve Ratio" (CRR). The CRR can be set between 1 and 100 percent in total, such that the combined CRR of all reserve tokens cannot exceed 100%. A BET can be purchased with any of its reserve tokens, or any other token which is convertible to its reserve tokens through the network (see diagram below).

BETs are automatically issued in exchange for their specific reserve tokens using a calculated price based on the reserve's balance and its predefined CRR. BETs can also be converted back to the reserve-token(s) at any time at their current price. The converted BETs are automatically destroyed, in exchange for tokens which are withdrawn from their reserves. This process is managed by the BET's smart-contract.

The conversion rate between any BET and any of its reserve tokens is calculated in the same way:

The Reserve Balance, divided by the BET Supply, multiplied by its CRR.

$$Conversion\ Rate = \frac{ReserveBalance}{BET\ Supply \times CRR}$$

This means that every conversion-*to* the BET -- *increases* its value relative to the reserve-token, and conversion-*from* the BET -- *decreases* its value relative to the reserve-token. Intuitively, when there is more demand *to purchase* a BET, its value goes up, and when there is more demand to *sell* a BET, its value goes down.

The conversion rate takes into account the transaction size and recalculates the rate continuously using a mathematical function, described later in this paper. It is as if each unit in a transaction is "infinitely small" and executed individually, thus affecting the next unit's conversion price accordingly, until the full transaction is complete. A larger purchase, for example, would not benefit from a fixed rate, but rather an incrementally adjusted one.

BETs also enable users to convert between reserve-tokens, using two steps to calculate the conversion rate (from one reserve token - to the BET - and from the BET - to the second reserve token.) Now, therefore, the value of the converted-*from* token *decreases* relative to the BET, and the converted-*to* token value *increases*. Inter-token conversion rates which do not match external market rates, incentivizes arbitrage agents to realign them, functioning as asynchronous liquidity providers as well as external-price oracles[6] for BETs.

BETs with reserves totalling 100% CRR, function as *decentralized ETFs*[7] holding a basket of tokens in their reserve. Such ETFs are issued when purchased from their smart-contract for any of their reserve-tokens. ETFs can also be used to convert between the different reserve-tokens they hold. As the ETF's market-cap increases, the conversion rate fluctuations decrease for larger conversions between the reserve-tokens. A network of Bancor-enabled ETFs essentially function as a *decentralized exchange*, which enables anyone to convert tokens with no need to be matched by a second party wanting the opposite.

BETs with reserves totalling less than 100% CRR are designed to *create new credit,* through principles similar to fractional reserve banking, thereby expanding the money supply for the token holders. A 10% CRR BET creates 90% of new credit when purchased, and the same credit is destroyed when the BET is sold.

The coincidence-of-wants problem, in the current exchange model, creates a situation where only assets with constant market demand can be liquid. This is because the chances of finding 2nd parties to exchange with at any given time correlate to the trading volume of the asset. The Bancor Protocol solves this problem by enabling any asset to remain liquid at all times through the algorithmically-priced, tradable reserve-tokens.

Bancor solves the *double-coincidence-of-wants problem* for *asset exchange* -- through technology, rather than labor. Until now, the laborers in asset exchange have been the professional market-makers who provide liquidity and facilitate collaborative price discovery in existing exchanges. This can be likened to technologies such as *writing* and *currency* which eliminated the need for laborers which were previously required in order to exchange information and things-of-value (barter/trade).

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[6] https://blog.ethereum.org/2014/07/22/ethereum-and-oracles/
[7] https://en.wikipedia.org/wiki/Exchange-traded_fund

Bancor Token Networks

Multiple BETs which hold the same BET in their reserve, establish a network of tokens that has a *network effect.* External demand for any BET in the network would increase the value of all the BETs in the network. This happens as the backing BET has to be purchased in order to purchase the specific BET, increasing both tokens' price. A BET, which is primarily used as a reserve (a "Network BET") can be utilized by regional and industry-specific networks of tokens.

Bancor Token Initiation and Customization

New BETs can be created simply by depositing the initial reserve/s and issuing the initial token supply. More advanced usage may utilize an "Issuer" smart-contract, which pre-defines special cases for token issuance and their specific terms (e.g. a limited-time crowdsale). The contract may also define how collected funds are controlled, as well as their ultimate destinations (contractors, DAOs, foundations, etc.)

The Genesis Network BET

The Bancor Genesis Token (BGT), is the first Bancor-Enabled Network Token. It is designed to capitalize the network-effect value of the entire Ethereum Bancor Network and will maintain a significant reserve in Ether. By using BGT as a reserve token, external demand for a specific BET increases the value of *all* BETs holding a BGT reserve.

BGT will be issued in a crowdfund scheduled for Q2 2017. More details will be announced in March.

Following the crowdfund:
- A percentage of the funds raised will be used as the ETH reserve for BGT (Reserve ratio TBD), enabling continuous liquidity to any BGT holder.
- The remaining funds raised will be used to achieve a set of pre-tasked goals by different contractors and support the continuous development of the Bancor Ecosystem.
- Given BGT is Bancor-enabled, its conversion rate to ETH will be calculated by its smart-contract, which will autonomously issue and destroy BGT whenever it is purchased or sold.

The Bancor Foundation

A Swiss Nonprofit Foundation is being established, similar to projects such as the Ethereum Foundation, to coordinate the development of the key building blocks of the Bancor project. The Bancor Foundation will work with different contractors to achieve the following goals:

1. Develop, promote and maintain the Bancor Protocol, an open-source, smart-contract based token conversion protocol, and support related technologies and applications such as an open-source, user-friendly web service (desktop and mobile) to provide wallet, token-conversion, new BET creation and crowdsale solutions, leveraging the Bancor Protocol.
2. Set-up and fund the first batch of Bancor-Enabled ETF tokens - which would also function as a *decentralized exchange* with key advantages, incentivizing additional *asset tokenizer*s to represent real-world assets as Ethereum tokens. Existing crypto-currency exchanges are uniquely positioned to play this significant role in this ecosystem given their know-hows with securing deposits, processing withdrawals and complying with their jurisdictional regulations.
3. Participate in, and support of future Bancor-Enabled crowdsales using BGT as a reserve-token, both for sub-networks, end-user BETs, and new ETFs. This would be done in order to support new, regional and industry-specific BET initiatives such as local currencies, crowdfunded projects and other online token-based ecosystems.
4. Coordinate with NGOs focused on bringing financial solutions to the developing world / unbanked.

In the period before the token distribution is initiated, potential contractors will be able to offer their services and may be selected by the Bancor Foundation to assume different roles in the Bancor Protocol rollout.

Examples and Illustrations

Example #1: Bancor-Enabled Token Transactions Flow

In this example, a crowdsale for a new token (BGT) has raised 300,000 ETH.

300,000 BGTs were issued at a 1:1 ratio and transferred to the crowdsale participants. 237,000 ETH were transferred for funding the BGT project-development and 63,000 (21% CRR) were kept in the smart-contract as a reserve.

- The market opens immediately upon the crowdsale completion. The opening price is the crowdsale price, in this example 1 ETH for the first BGT.
- BGT sellers are getting ETH from the reserve of the BGT, the BGTs are destroyed, and the BGT price is decreased.
- BGT buyers are getting newly minted BGTs, their ETH is added to the reserve and the BGT price is increased.
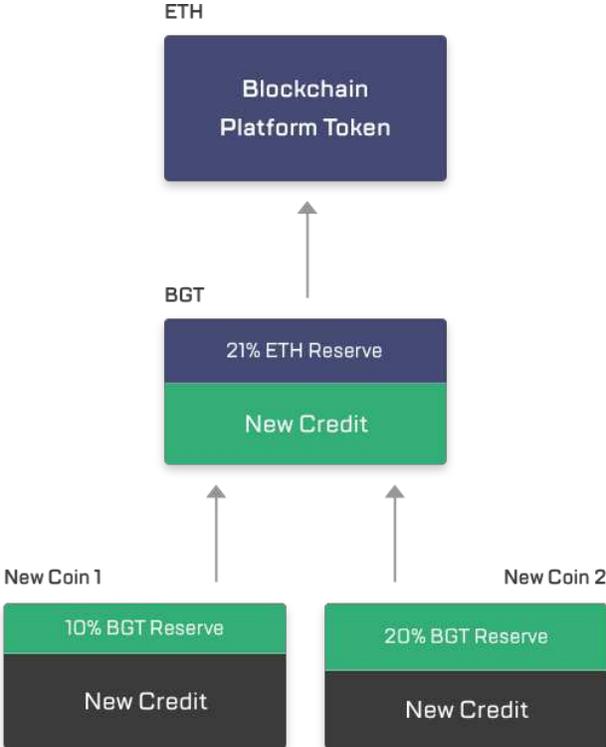
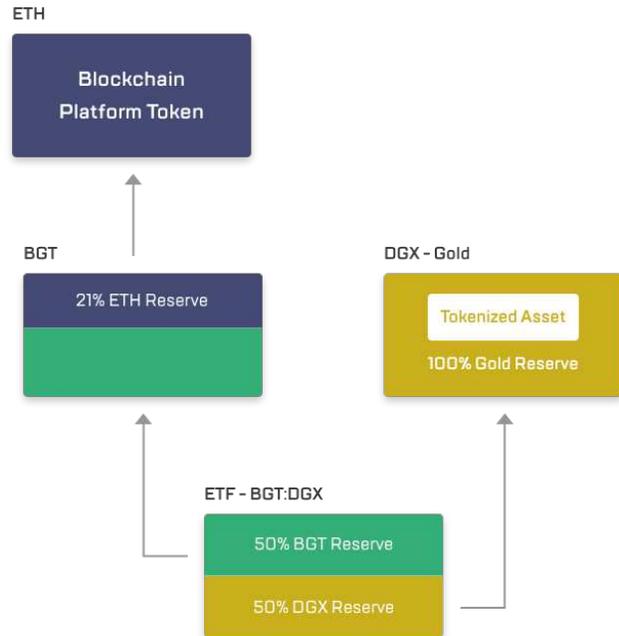The ETH reserve always stays 10% of the BGT market-cap.

Bancor-Enabled Token Symbol	BGT
Reserve Token	ETH (Ξ)
Constant Reserve Ratio	21%
Initial Token Price	Ξ1
Crowdsale Proceeds	Ξ300,000
Tokens Issued in the Crowdsale	300,000

Activity	ETH Recieved (Paid-out)	BGT Issued (Destroyed)	Conversion Rate	ETH Reserve	BGT Supply	BGT Market-cap	BGT Unit-Price	Price change
Post-crowdsale initial state				Ξ63,000	300,000	Ξ300,000	Ξ1.0000	
30 ETH converted to BGT	Ξ300	299	Ξ1.0019	Ξ63,300	300,299	Ξ301,429	Ξ1.0038	0.38%
70 ETH converted to BGT	Ξ700	694	Ξ1.0081	Ξ64,000	300,994	Ξ304,762	Ξ1.0125	0.87%
130 BT converted to ETH	Ξ(1,308)	(1,302)	Ξ1.0043	Ξ62,692	299,691	Ξ298,533	Ξ0.9961	-1.62%
700 ETH converted to the BGT	Ξ100	100	Ξ0.9968	Ξ62,792	299,792	Ξ299,010	Ξ0.9974	0.13%

Example #2: Bancor-Enabled ETF Transactions Flow

In this example an ETF is created with BGT (Bancor Genesis Token) and DGX (Tokenized Gold) as two 50% CRR reserves.

The initial market value of 1 BGT is 2 DGX so the contract defines the initial prices as 1 BGT, and 2 DGX = 1 ETF. The initial 10,000 ETF supply is issued to the depositors.

- The opening prices are 1 ETF to 1 BGT to 2 DGX as was predefined in the contract.
- The ETF is issued in exchange for BGT or DGX. The ETF price will increase in the TOKEN it was purchased with (BGT or DGX), and decreased in the uninvolved token (due to the increase in the ETF supply)
- The ETF can be converted back to BGT or DGX, decreasing the ETF price in the withdrawn token is decreased, and increased in the uninvolved token.

Bancor-Enabled ETF Symbol	ETF	
Reserve Tokens	BGT + DGX	
Constant Reserve Ratio	BGT	50%
	DGX	50%
Initial Token Price	BGT	1
	DGX	2
Deposited Reserves	BGT	5,000
	DGX	10,000

Activity		Reserve Recieved (Paid-out)	ETF Issued (Destroyed)	Conversion Rate	Reserve Balance	ETF Supply	ETF Market-cap	ETF Price per Reserve	ETF Price change	1 BGT = DGX
Initial state	BGT				5,000	10,000	10,000	1.000		0.500
	DGX				10,000		20,000	2.000		
Buying ETF for 30 BGT	BGT	30	30.0	1.0015	5,030	10,030	10,060	1.003	0.30%	0.503
	DGX				10,000		20,000	1.994	-0.30%	
Converting 70 DGX to BGT Step 1 (DGX->ETF)	BGT				5,030	10,065	10,060	1.000	-0.35%	0.500
	DGX	70	35.0	1.9975	10,070		20,140	2.001	0.35%	
Converting 70 DGX to BGT Step 2 (ETF->BGT)	BGT	(35.0)	(35.1)	1	4,995	10,030	9,990	0.996	-0.35%	0.496
	DGX				10,070		20,140	2.008	0.35%	

Illustrative Map of the Bancor Network

- ETH, DGD, DGX, REP and GNT are standard Ethereum-tokens
- NEW - New BETs created (e.g. crowdfunding campaign, a local currency, etc.)
- BGT - The Genesis Bancor-Enabled Token, backed by Ether
- Bancor-Enabled Tokens hold reserves (arrows point to tokens held in the reserve)
- ETFs are 100% backed, and hold multiple reserves
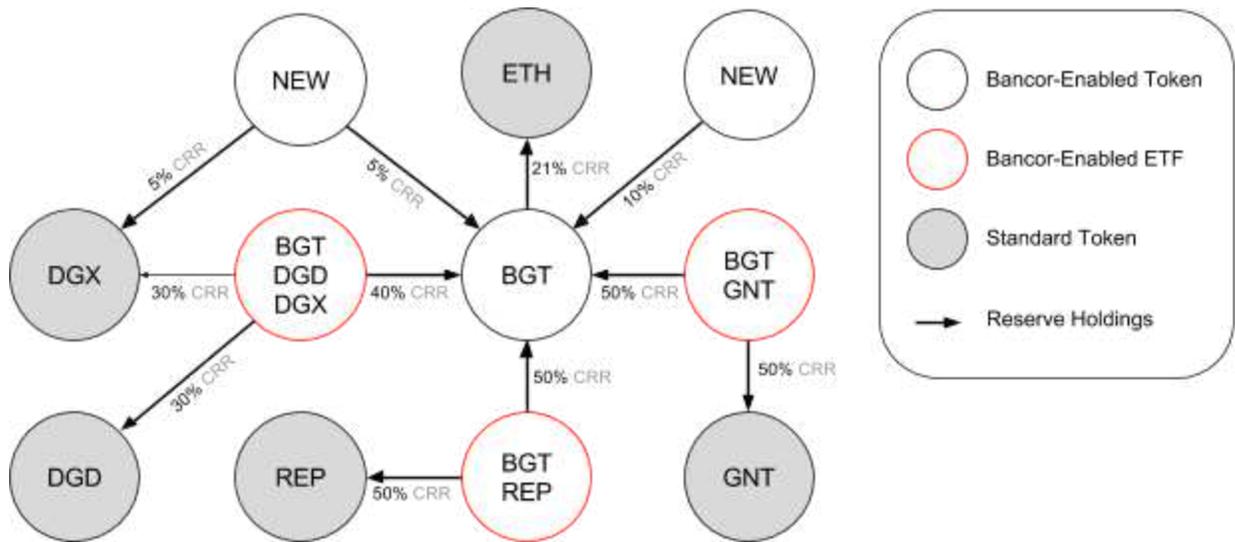
Conversion-Rate Calculation

The actual conversion rate calculation is done based on the specific conversion transaction size, which may be indicated in both, the BET or in the reserve-token.

[Mathematical proof](#) available[8]

R - Reserve-Token Balance
S - BET Supply
F - Fixed CRR

- T = BET amount received In exchange for E (reserve token paid), given R, S and F

$$T = S((1 + \tfrac{E}{R})^F - 1)$$

- E = Reserve-Token amount received in exchange for T (BET paid), given R, S and F

$$E = R(\sqrt[F]{1 + \tfrac{T}{S}} - 1)$$

Acknowledgements

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[8] Available online at https://goo.gl/HXQBUr