A Methodology for the Generation of Bitcoin and Ethereum Daily Spot Fixing Price Indices

('XBTFixing' and 'ETHFixing')

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Abstract

Cryptocurrencies have developed from a theoretical extension of the distributed ledger concept to a set of more than 1,000 de facto currencies valued in the hundreds of billions of dollars in less than ten years. As with any new industry or market which experiences explosive growth, it will take significant time for the infrastructure and services supporting cryptocurrencies to reach levels necessary for the long term viability and continued growth of the market. Indeed, most large buy-side and sell-side financial institutions have been unwilling or extremely reluctant to participate in the crypto market due to the lack of mature and robust infrastructure and supporting services, as well as concerns over how the regulatory landscape will develop. Significant institutional participation is critical to the future growth of this industry.

One of the most frequently cited weaknesses of the crypto markets is the lack of dependable and robust daily price data. Prices are readily observable across a broad array of spot cryptocurrency exchanges, but inconsistency across these exchanges in execution costs, liquidity, leverage and funding availability, execution and security technology, and many other factors have led to a fragmented market in which non-trivial arbitrage between various spot cryptocurrency exchanges and market makers can persist for periods of time far longer than in markets for more traditional asset classes. This in turns leads to uncertainty in daily pricing data and a lack of confidence in marking large positions to market, which is unacceptable for institutions.

Various attempts have been made to generate fixing prices that address these issues with varying degrees of success; none have been widely adopted as a standard for valuing cryptocurrency positions. Furthermore, the lack of widely accepted benchmark pricing for spot cryptocurrencies has severely limited the development of markets for derivatives on these currencies.

In this paper, trueDIGITAL describes its methodology for the calculation of daily price fixings for spot Bitcoin and Ethereum which addresses all of these challenges and which will be readily adaptable as market conditions change.

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1. Introduction

This paper details the methodologies used by trueDIGITAL for calculating daily fixing prices for spot Bitcoin ("XBTFixing") and Ethereum ("ETHFixing"), the two most widely held and traded cryptocurrencies.

Calculating fixing prices for cryptocurrencies presents challenges unique to the financial markets. In typical markets for any financial or physical asset, growth of the market is driven by institutional participants. While many of these markets later draw large numbers of retail participants, it is the initial institutionally driven development of the market and its associated large trade sizes which provide a basis for traditional pricing index calculation methodologies.

These traditional methodologies tend to look at snapshots of the market just before Fixing Time and / or trading activity over a very short period (i.e., less than 15 minutes) prior to Fixing Time.

Conversely, the recent explosive growth of both the number of cryptocurrencies and the trading volume in them has been fueled mostly by a large community of retail participants ranging from those who buy them in order to use them for internet based transactions to day traders and speculators. The ease of divisibility of cryptocurrencies into very small fractional units and the very low transactional costs (typically 0% – 1% of the notional amount) means that anyone with even a casual interest can trade them in extremely small notional sizes (for example, 0.01 Ether is equivalent to about 10 US dollars).

Further, this trading activity is spread across a large number of retail spot cryptocurrency exchanges and institutional OTC market makers with a variety of execution fees, funding sources and costs, leverage restrictions, and jurisdictions.

The distributed nature of the cryptocurrency markets means that trading is very atypical for financial markets: huge numbers of extremely small notional value trades on retail exchanges with much larger institutional size trades being privately negotiated with Over the Counter ("OTC") market makers. This engenders challenges in the creation of fixing prices which are unique:

- Extremely high minute to minute volatility of prices
- Arbitrage across different execution venues which can persist for minutes or sometimes hours
- Manipulation of markets to a much higher degree than traditional financial markets

trueDIGITAL has developed a fixing price methodology specifically designed to overcome these challenges. Further, these indices are designed to be representative of the OTC institutional

spot cryptocurrency markets rather than the retail exchange markets. The trueDIGITAL family of cryptocurrency fixing price indices (XBTFixing and ETHFixing) are calculated continuously and published once daily at 4:30pm New York time. The trueDIGITAL fixing price methodology is fully compliant with the IOSCO Principles for Financial Benchmarks (July 2013).

2. Methodology Overview

The methodology used by trueDIGITAL for calculating cryptocurrency fixing prices has three primary objectives:

- Use pricing data that accurately reflects the *institutional* market for spot cryptocurrencies.
- Calculate a price which is representative of activity across the market, and independent of venue specific execution costs and rules
- Minimize the opportunity for malicious actors to manipulate the fixing price

This section is a general discussion of certain high level characteristics of the methodology within the context of the stated objectives. Section 3 will detail the full methodology.

2.1 Data Sources

Given that the market is distributed across multiple trading venues, trueDIGITAL uses pricing information from a number of the largest cryptocurrency market makers; it will also potentially incorporate *institutional* spot cryptocurrency exchanges which meet a strict set of selection criteria as detailed in section 3.2.2.

Using a broad set of pricing data sources decouples the fixing price calculation from specific characteristics of any given trading venue. It also dampens the effect of market anomalies and attempted market manipulation within any one trading venue.

Specifically, executable bid/offer prices from institutional market makers and order book data from spot institutional cryptocurrency exchanges are used. The exact number of sources as well as their specific identity may vary over time as the Index Administrator responds to changes in market conditions, regulations, liquidity, etc. There will be a minimum of 8 sources used, with a target of maintaining 8 to 12.

The Index Administrator will follow a detailed data sourcing and fall-back policy when making decisions regarding the inclusion, exclusion, or changing of contributing sources, and the process will be subject to an independent Oversight Committee. The fall-back policy also

details the waterfall of backup pricing sources and methodologies should index calculation fail for any reason. Full details can be found in Section 3 below.

2.2 Calculation Window

Traditional futures exchange daily settlement price calculation methodologies use a very short settlement window (the amount of time preceding the stated settlement time from which pricing data is used), typically ranging from 1 or 2 minutes up to 15 minutes. This is appropriate for markets which have fairly consistent volume through time, as the short window will usually have enough prices to determine true market levels.

However, trading volumes in OTC spot cryptocurrency markets are often inconsistent throughout the day. Further, these market are open for trading 24/7. This means that there is no short time window at any point during the day which will dependably represent true market sentiment.

For the above reasons, trueDIGITAL uses market maker bid/offer prices and institutional exchange order book data from a Fixing Window which will initially be four hours measured back from the stated Fixing Time. As these market continue to grow and mature, future market behavior may justify shortening this window. Any decisions regarding the length of the calculation window will be made by the Index Administrator subject to Oversight Committee approval, and will be published with adequate advance notice to all market participants.

3. Methodology

3.1 Data

trueDIGITAL will receive data feeds from a number of the top spot cryptocurrency market makers ("Contributors"). These data feeds will be comprised of streaming executable bid/offer prices over the entire Fixing Window.

Before inclusion in the indices, Contributors sign an Index Contribution Agreement. In addition to defining the legal relationship between the Contributor and the Index Administrator, the Index Contribution Agreement specifies the following:

- Prices streamed to trueDIGITAL must be *executable* bid / offer prices for a size of 100 bitcoin or 1,000 ethereum.

- trueDIGITAL has the right to periodically verify that prices streamed to the index contribution API are the same as prices they are actively making to their institutional clients

trueDIGITAL will also include order book snapshots from its own spot institutional cryptocurrency exchange once the average daily total notional value of trades is greater than USD 5 million for a given cryptocurrency.

Other spot institutional cryptocurrency exchanges may be included in the future if they agree to the information sharing requirements of the CFTC or other relevant regulatory authorities, and meet the selection criteria detailed in Section 5.2.2 below. Such inclusion would be subject to Oversight Committee approval.

3.2 Data Source Selection Criteria

3.2.1 Contributors

All Contributors for trueDIGITAL fixing price index determinations will sign Index Contribution Agreements with trueDIGITAL. Key aspects of this agreement include:

- The Contributor will continuously stream real executable bid / offer markets for spot Bitcoin and spot Ethereum.
  - If the Contributor is actively making spot markets on trueDIGITAL spot exchange, the bid / offer markets used in the index determination will be equal to the inside market which is streamed to the spot exchange.
  - If the Contributor is not actively making spot markets on trueDIGITAL, then the Contributor will stream bid / offer prices that are identical to the markets they are making to their customers for 100 Bitcoin and 1,000 Ether respectively.
- trueDIGITAL will have full audit capability to ensure that the prices used in XBTFixing and ETHFixing determination are the actual markets being made
- An information sharing agreement between the Contributor and trueDIGITAL which enables either to report suspected malicious activity in the underlying spot cryptocurrency markets or in the cryptocurrency derivative markets, along with the identity of the actor, to each other and to the relevant regulatory agencies.
- A requirement for the Contributor to be a designated market maker in non-deliverable forward "(NDF)" contracts listed on trueEX LLC ("trueEX"). As a DMM on trueEX, the Contributor is required to be a Participant of trueEX and is therefore bound to the trueEX Rulebook, which requires (among other things), compliance with CFTC Regulation 37.404

3.2.2 Spot Institutional Cryptocurrency Exchanges

trueDIGITAL has a strong set of qualification criteria which must be met in order to be considered for inclusion in the XBTFixing and ETHFixing determination process. To be considered for inclusion the spot institutional cryptocurrency exchange must:

- be designated for and provide access for institutional participation only
- be domiciled in the US or UK.
- be a party to an information sharing agreement with trueDIGITAL and trueEX.
- have minimum daily volume of $5mm in XBT/USD for XBTFixing
- have minimum daily volume of $5mm in ETH/USD for ETHFixing
- provide full visibility into trading activity on a live basis
- have not been ruled out for qualitative reasons (discussed below)

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The following are qualitative measures which the Index Administrator will consider, such as whether or not the spot cryptocurrency exchange:

1. is regulated by a major banking or financial markets regulator in the jurisdiction in which they operate.
2. has customer identification and vetting procedures designed to prevent inappropriate, potentially harmful customers from transacting on the exchange.
3. has a Chief Compliance Officer who is responsible both for ensuring compliance with all applicable laws and regulations and for monitoring exchange activity.
4. has robust market surveillance technologies and procedures designed to prevent malicious activity such as spoofing or market manipulation.
5. has an operating history which is free of any legal or regulatory sanctioning for disruptive market practices or unethical behavior.

3.3 General Policies Regarding Data Sourcing

- trueDIGITAL will maintain fully tested and operational data interfaces for all spot cryptocurrency Contributors.
- trueDIGITAL will maintain data interfaces with the spot cryptocurrency exchange operations of trueDIGITAL and with any spot institutional cryptocurrency exchanges which may be included as Contributors.

- trueDIGITAL will build and fully test data interfaces for any new Contributors which sign such market making agreements prior to the time they begin making markets for either trueDIGITAL or trueEX.
- trueDIGITAL will maintain a minimum of eight (with a general target of eight to twelve) contributing data sources for each cryptocurrency in which it publishes fixing prices
- Each Contributor and / or spot cryptocurrency exchange will be subject to information sharing agreements as described in Sections 3.2.1 and 3.2.2 above.
- The Index Administrator will periodically re-evaluate Contributors and spot cryptocurrency exchanges from whom it is receiving data.
- The Index Administrator will monitor the establishment of new Contributors in spot cryptocurrencies and new spot cryptocurrency exchanges for possible inclusion as data sources.
- Any data source removal or replacement is subject to Oversight Committee ratification.
- The Index Administrator will document all data source related actions and retain such documentation for at least 7 years.

3.4 Pre-Calculation Filtering of Raw Data

There are several cases in which a Contributor's price should be excluded from the calculation. However, if the problem is resolved, the methodology should be able to re-include that Contributor as soon as their data is of value to the calculation. For this reason, the four hour fixing window is divided into 30-second data filtering and index calculation intervals. In each interval, filtering of raw data is performed as described in sections 3.4.1 through 3.4.3. Then the index level is calculated for the interval as described in detail in section 3.5.1.

3.4.1 Removing Stale Data

While it is expected that market maker streamed bid/offer prices will update very frequently (often multiple times per second), it is possible that a technology problem or a problem with the Contributor's internal pricing model could lead to bids and/or offers not being updated for an extended period of time. However, it is desirable to continue reflecting a Contributor's unchanged price if they continue to stream that price, and to allow some "buffer" time over which the receipt of no updates should be assumed to mean that the Contributor's price has not changed.

For these reasons, a Contributor will be excluded from an interval calculation if trueDIGITAL has not received both a bid price and an offer price within the last 15 minutes. This 15-minute

period is a model calibration variable and may be tuned by the index administrator from time to time depending on market volatility levels.

3.4.2 Removing Data Errors

A Contributor will be excluded from an interval calculation if any of the following errors is present in the streamed bid/offer data:

- The most bid price is greater than the offer price
- Either the bid or the offer is zero
- Either the bid or the offer is negative or non-numeric.
- Either the bid or the offer differs from the prior interval's price by more than 25%.

If a Contributor is excluded for any of these reasons described in sections 3.4.1 and 3.4.2, it will be excluded from the outlier check described in section 3.4.3 in addition to being excluded from the actual interval calculation.

3.4.3 Removing Outlier Data

The methodology for removing outlier price points must address the following situations while preserving all information regarding real market movement:

- Individual bad prices due to errors in the Contributor or exchange data
- Contributors or spot cryptocurrency exchanges which, for a period of time, trade and / or stream prices which are unreasonably far in price from the other Contributors or spot cryptocurrency exchanges contributing to the fixing price, whether due to technological problems or attempted manipulation.

This outlier check is only performed on those Contributors which have not been excluded from the interval for any of the reasons in sections 3.4.1 and 3.4.2, and any institutional spot exchanges which have been added as contributors.

For each data point in the interval, the price is compared to the average price for the interval across all contributing sources *excluding the source of the data point being analysed.* If the price is more than 3% different from the average of the other sources that price point is discarded. If there are only two sources from which prices have been obtained for the 30

second interval, data points will be discarded if they are more than 3% different from the price of the preceding 30 second interval. Data points which are disqualified according to this provision will remain disqualified as the partition gradually moves back through the calculation window.

Using these very frequent intervals while looking for outlier prices ensures:

- That a Contributor or spot cryptocurrency exchange which has been excluded due to divergence from the other sources will quickly be included once it is no longer an outlier.
- That quick, sharp moves which are consistent across the market are *not* ruled out as outliers

3.5 Calculation Methodology

Calculation of the indices is split into two phases.

In the first phase, the index level is calculated for each 30 second interval throughout the Fixing Window. In the second phase, all of the 30 second intervals throughout the Fixing Window are aggregated to determine the final index level to be published.

Interval calculations are done on a live basis, allowing trueDIGITAL to detect problems with incoming data streams and respond appropriately as they occur. The use of intervals also allows decisions regarding usage of data to be made independently of all other intervals within the Fixing Window. This ensures that the optimum and freshest market data is always being used within the index calculation.

The following two subsections describe the detailed methodology and the fall-back procedures used for each phase of the index determination.

3.5.1 Interval Calculation Phase

An index level for each 30 second interval within the Fixing Window is calculated using the following waterfall. At each level of the waterfall, if there is sufficient data (defined below) to calculate the interval index level, it will be calculated using the methodology for that waterfall level; if not, the algorithm will move on to the next waterfall level.

1. <u>Weighted Order Book and Bid / Offer Based Method</u>. This calculation method,

described in detail in Section 3.5.1.1, below, requires at least two sources providing either streamed bid/ offer markets or spot cryptocurrency exchange order books within the Fixing Window.

2. <u>Cost of Carry Method</u>. This calculation method, described in detail in Section 3.5.1.2, below, will use the live Non-Deliverable Forward market for the Front Contract on the trueEX exchange.

3. <u>Most Recent Interval Index.</u> If none of the above methodologies can determine an index level for the interval, that interval's index level will be the prior interval's index level.

Anytime the interval index levels are based on methods 2 or 3 for more than 5% of the total number of intervals within the Fixing Window, the Index Administrator will notify the Oversight Committee; the Oversight Committee will determine whether stakeholder notification is appropriate.

In the event of wide spread, systemic deterioration or cessation of trading in spot Bitcoin or spot Ethereum, the Index Administrator will consult with market participants and the Oversight Committee to determine if the cessation of calculation and publication of the Fixing price index is appropriate. Should the decision be made to cease publication of Fixing price indices, the trueDIGITAL Index Cessation Policy will be followed.

3.5.1.1 Calculating the Order Book and Bid / Offer Based Price

The interval price will be based on the streaming bid / offer markets received from the Contributors, and the order books of any included exchanges. The Contributor bid/offer prices are either the inside market which they stream to the trueDIGITAL spot trading platform or are identical to the real markets they are making to their customers; this limits the possibility of manipulation as any intentionally shifted prices will be at risk of being traded.

At the end of the 30 second interval, a snapshot of each Contributor's streamed bid price and offer price, and each exchange's order book, is taken.

For the Contributor bid / offer prices, the mid of these prices is calculated as follows:

$$MP = \frac{(P_b + P_a)}{2}$$

Where:

MP = the mid-market price for this snapshot of this Contributor

P_b = the Contributor's bid price

P_a = the Contributor's offer price

To prepare the order book data from each exchange snapshot, imbalance in the order book must also be eliminated to prevent attempted manipulation by the placement of large buy or sell orders behind the inside market. Imbalance is removed by the following:

We define a size X which is the total cumulative size of bids and offers which will be taken into account, regardless of how many levels of bids or offers this encompasses. For example, if X requires the 15 best offers and the 10 best bids, the 15 best offers and the 10 best bids will participate in the calculation, while the rest of this order book snapshot is discarded. Further, the size of the widest participating bid and the widest participating offer will be reduced to the amount required to bring the cumulative size to exactly X. This will prevent attempted manipulation through the placement of very large orders from significantly influencing the calculation. An example of trimming an exchange order book is shown in Appendix 2.

We then perform a size weighted average across the entire range of participating bids and offers.

Specifically, the calculation is as follows:

$$MP = \frac{\sum_{i=1}^{n-1} S_i * P_i + P_n * \left(X - \sum_{i=1}^{n-1} S_i\right) + \sum_{j=1}^{m-1} S_j * P_j + P_m * \left(X - \sum_{j=1}^{m-1} S_j\right)}{2X}$$

Where:

MP = the calculated mid-market price for this snapshot of this exchange's order book

S_x = the size of the bid or offer at point x in the order book

P_x = the price of the bid or offer at point x in the order book

n = the number of bids, ordered from the highest bid to the lowest bid

m = the number of offers, ordered from the lowest offer to the highest offer

X will initially be set at 100 coins for XBTFixing and 1000 coins for ETHFixing; this could be increased in the future if volume growth justifies it.

This calculation is performed across all participating exchanges.

Outliers are removed from each interval if they are more than 3% away from the average of the remaining Contributors and exchanges or from the price of the preceding 30 second interval.

Next, the average of the snapshots from all Contributors and all exchanges for this interval is calculated as follows:

$$Interval\ Price\ = \frac{\sum_{i=1}^{m} P_i + \sum_{j=1}^{n} P_j}{m + n}$$

Where:

P_i = the interval price for Contributor i

P_j = the interval price for exchange j

m = the number of Contributors participating in this interval

n = the number of exchanges participating in this interval

3.5.1.3 Calculating the Cost of Carry Based Price

The cost of carry method is used to calculate the index level for an interval as follows:

$$Interval\ Price = \frac{NDF_{front}}{(1 + r * t)}$$

Where:

NDF_{front} = the live average of the highest bid price and the lowest offer price in the trueEX order book for the front Non-Deliverable Forward contract

r = the USD OIS swap rate as of the index determination date for swaps maturing on the expiration date of the front NDF

3.5.2 Final Index Determination Phase

At the Index determination time (4:30pm Eastern US Time), the final index level for publication is determined using the following waterfall:

1. The average of the interval index levels for all 30 second intervals within the Fixing Window.
2. If the Index Administrator is unable to determine a final index level using the above methodology for any reason, the index level will be calculated using cost of carry methodology exactly as described above, but using the trueEX Daily Settlement Price for the front non-deliverable forward contract.
3. If the Index Administrator is unable to use the cost of carry method, the index level will be equal to the most recently published index level.

4. Bitcoin or Ethereum Forks

The precise characteristics of a fork and the resulting post fork derivative markets directly impact which fixing prices will need to be calculated going forward. trueEX (a DCM / SEF) lists derivative products on Bitcoin and Ethereum which use the XBTFixing and ETHFixing indices as reference prices for final settlement. For this reason, trueDIGITAL and trueEX have a unified fork policy and will make decisions jointly regarding hard forks. This section details the joint policy as it applies both to the determination of trueDIGITAL fixing prices for spot Bitcoin and Ethereum as well as to the settlement and trading of derivative products on trueEX.

In a cryptocurrency hard fork, the lack of backward compatibility raises the possibility that a new cryptocurrency could be created if only part of the network decides to implement and abide by the new protocol. This process is analogous to a publicly traded company spinning off a portion of its business; a portion of the company's assets remain with the original company (and stock) and a portion goes with the new company. In the case of cryptocurrency forks, it is the hashing power that is split between the old cryptocurrency and the new cryptocurrency; the precise split depends on the level of community support for each branch of the fork. However, an important limitation of this analogy is that unlike new stocks, which any custodial service or brokerage accounts can handle, new cryptocurrencies may not be supported by digital wallets.

For more than 20 years, the OTC equity derivatives market has treated spinoffs by altering the underlying for derivative positions referencing the stock of the original company which were open prior to the spinoff to be a basket of the original stock and the new stock. New positions entered into after the spinoff which reference the original stock would have only the original stock as their underlying.

The trueDIGITAL and trueEX joint fork policy allows for a similar treatment of cryptocurrency forks. However, because the asset class is very young, there is not enough history to make unilateral assumptions about the behavior of future forks, spot cryptocurrency exchanges can be inconsistent in their treatment of forks, and digital wallets may not necessarily support a

given forked currency, the companies will need to evaluate the specific characteristics and market treatment of any future fork to decide whether or not the basket approach is feasible. Section 4.2 discusses this in more detail.

4.1 Fork Categories

In general, cryptocurrency forks are categorized as "soft", meaning that the new protocol is backward compatible, or "hard", meaning that it is not. While it is certainly possible that a soft fork could create a political divide in the cryptocurrency's community which would result in a network split, this is thought to be unlikely. In the case of hard forks, the ideal result would be either unanimous network acceptance of the upgrade or unanimous rejection; either of these would result in no new cryptocurrency being created, and therefore would require no special actions by trueDIGITAL or trueEX in their Fixing price index and derivatives product lines.

The reality is that many hard forks will fall somewhere in between these two ideals, with some of the network implementing and supporting the new protocol and some of the network rejecting it. Further, while it is expected that the original cryptocurrency's name and symbol would be retained by the branch with the majority of the post-fork hashing power, this is not a certainty.

The fork policy will be effective in all of the following contingencies:

- Forks where the upgraded branch has so little network acceptance that it dies out and the resulting new cryptocurrency never trades.
- Forks where a significant minority of the network accepts the upgrade, and the resulting new cryptocurrency begins trading under a new name and symbol
- Forks where a majority of the network accepts the upgrade, and the original name and symbol follow this branch. In this case, the original cryptocurrency would begin trading under a new name and symbol.
- Forks where the minority branch retains the original name and symbol regardless of whether the new branch or the old branch is the majority.

The following sections detail the joint fork policy organized by business flow context. As mentioned above, these policies only apply to forks which result in the creation of a new cryptocurrency and in which both networks and their associated cryptocurrencies trade post-fork.

4.2 Fork Policy

For any hard fork of Bitcoin or Ethereum, the following policy will be followed by both trueDIGITAL and trueEX:

1. If the fork occurs (i.e., the stated fork block height is reached) between 4:30pm NY time of the fourth business day immediately preceding the Maturity Date of a trueEX forward contract and 4:30pm NY time of the business day immediately preceding the Maturity Date of a trueEX forward contract (the reference price Fixing Time), no further action will be taken. Open derivative positions will continue to have only the branch of the fork retaining the original cryptocurrency name and symbol as their underlying, and trueDIGITAL will continue calculating and publishing the Fixing price index for the branch retaining the original name and symbol.

2. If the fork occurs prior to 4:30pm NY time of the fourth business day immediately preceding the Maturity Date of a trueEX forward contract, trueDIGITAL and trueEX will observe post fork market conditions and consult with each other to determine if the new cryptocurrency will be included in the underlying of open derivative positions and whether fixing prices will be calculated for the new cryptocurrency. The following criteria will be considered in making the decision of whether or not to include the new cryptocurrency:

    a. Which spot cryptocurrency exchanges and Contributors, if any, are supporting trading in the new cryptocurrency. In particular, forked cryptocurrencies which are not trading on at least one major US domiciled spot cryptocurrency exchange (as defined in section 5.2.2; however, the information sharing requirement is not applicable) and supported by at least one of the spot cryptocurrency market makers which is acting as a data source for trueDIGITAL will automatically be excluded.

    b. Whether new blocks are being successfully mined on the branch of the fork representing the new cryptocurrency.

    c. The percentage of total pre-fork hashing / network power which is being used to mine blocks and confirm transactions in the new cryptocurrency.

    d. Whether the digital wallets used for physical settlement of derivative products can handle the new cryptocurrency.

    e. Whether trueDIGITAL believes it can calculate a fair and robust Fixing price index for the new cryptocurrency.

3. If trueDIGITAL and trueEX jointly decide that the new cryptocurrency should be included in a basket underlying for open derivative positions, trueEX will seek final confirmation from the digital asset custodian that they are prepared to support physical settlement of a basket consisting of the original cryptocurrency and the new cryptocurrency. *The*

basket treatment for cryptocurrency hard forks will only be applied if settlement can be supported for both deliverable and non-deliverable derivative contracts, and only if trueDIGITAL, trueEX, and the digital asset custodian all agree. However, if only cash settled forward contracts are offered, inclusion of the forked currency does not require physical settlement support.

4. The final decision will be made as quickly as feasible, and must be made before 4:30pm NY time on the second business day immediately preceding the first trueEX forward contract Maturity Date after the fork occurs.

4.3 Treatment of Fixing Price Indices and Derivative Products Resulting from the Fork Policy Decision

As soon as practicable after reaching a final decision regarding treatment of a particular fork, both trueDIGITAL and trueEX will publish on their respective websites and will inform all market participants of the time at which their decision will be made public. The period between this notification and the actual publication of the decision will not be less than 2 hours.

Trading in all derivatives contracts which reference the cryptocurrency which is undergoing the fork will be suspended for the 10 minute period beginning 5 minutes before the decision is published and ending 5 minutes after the decision is published. This is to ensure that all market participants have the opportunity to fully understand the decision and to provide a clear cutoff time beyond which new trades will not be eligible for basket treatment if it occurs.

If the decision is to exclude the new cryptocurrency from participation in the underlying, no further action will be taken.

If the decision is to include the new cryptocurrency in a basket underlying for open derivative positions, the following steps will be taken:

1. Any open derivative positions which were traded prior to the halt of trading will have their underlying converted from the original cryptocurrency to a basket consisting of the two post fork cryptocurrencies.
2. trueDIGITAL will begin calculating and publishing a daily fixing price index for the new cryptocurrency and will continue doing so until the maturity of the longest open derivative position which was traded prior to the halt of trading.
3. In the case of physically settled derivatives traded on trueEX, the number of original cryptocurrency units in the basket will be equal to the underlying number of units of the original contract; the number of new cryptocurrency units in the basket will be equal to the underlying number of units of the original contract multiplied by the ratio of new

cryptocurrency units issued per original cryptocurrency unit. For example, in the Bitcoin Diamond fork of November 24, 2017 a holder of 1 Bitcoin was entitled to 10 Bitcoin Diamond. If a hypothetical pre-fork open deliverable forward contract on 10 Bitcoins were converted to a Bitcoin + Bitcoin Diamond basket, the basket would consist of 10 Bitcoins and 100 Bitcoin Diamond.   The basket of both digital assets would be delivered into final settlement.

4. In the case of cash settled derivatives, the final cash settlement amount would be calculated based on the value of a portfolio containing both cryptocurrencies. Specifically, the reference price for settlement would be equal to the sum of the trueDIGITAL Fixing price for the original cryptocurrency as of the stated derivative contract's fixing date / time *plus the* trueDIGITAL *fixing price for the new cryptocurrency as of the stated derivative contract's fixing date / time multiplied by the ratio of new cryptocurrency units issued per original cryptocurrency units.* The number of contracts used for calculation of final settlement amount will remain unchanged.

5. Any derivatives traded once trading reopens 5 minutes after publication of the fork decision will have only the original cryptocurrency as their underlying.

6. After the final maturity of the longest expiration position which was open prior to the halt of trading, trueDIGITAL may, at its discretion, cease publication of daily fixing prices for the new cryptocurrency.

5. Governance

A proper administration and governance framework is crucial to the long term viability of the trueDIGITAL fixing price indices. While this is true for any price, fixing, index level, etc. which is used as a benchmark of market performance or a reference price for other financial contracts (e.g., futures and options), it is even more critical in an asset class which is immature, highly decentralized, and lightly regulated.

The trueDIGITAL governance framework is a set of technologies, guidelines, and formal protocols administered by trueDIGITAL and overseen by the Oversight Committee, which will be used to determine if/when particular market makers or spot cryptocurrency exchanges should be removed from or added to the data sources used for calculation of the fixing prices. This section is a very high level description of the governance framework.

Central to the framework is a set of automated market monitors which will alert the Index Administrator if any of a number of predefined market conditions indicative of potential problems with one or more pricing data sources used in the calculation of XBTFixing or ETHFixing occurs. Among the key alerts will be:

- Sustained drop in the market depth of a given spot cryptocurrency exchange

- Sustained drop in the average size of the streaming market received from a given market maker.
- Sustained unexplained widening of a particular market maker's streaming bid / offer spread

In addition to the automated monitors, the Index Administrator will monitor qualitative measures such as regulatory changes, structural changes within spot cryptocurrency exchanges, and general industry news. Should this information cause the Index Administrator to feel that a market maker or spot cryptocurrency exchange should be dropped, they will act according to the following protocol.

- Should there be a need to remove a data source, the Index Administrator will temporarily remove the source from the calculation and will submit that data source, along with his/her recommendation and any supporting statistics and/or news, to the Oversight Committee. The Administrator will also prepare a statement to market participants which will be posted on the trueDIGITAL website explaining that the specific data source has been temporarily removed from the calculation pending Oversight Committee review.
- The Committee will review the data source, the supporting statistics or news, and the Index Administrator's recommendation and return with one of the following conclusions:
  o Permanently drop the data source
  o Keep the data source but monitor it very closely in the near term
  o Keep the data source

Further, the Index Administrator will require approval from the Oversight Committee before:
- Adding a new market maker or spot cryptocurrency exchange into the calculation. The Index Administrator will provide the Committee its reasoning and supporting data for such a change.
- Making any material change to the methodology of calculation. Material change refers to any change in methodology that is not a simple calibration of the model.

5.1 Review of Methodology and Consultation with Market Participants

Pursuant to Principles 10, 11f, and 12 of the IOSCO Principles for Financial Benchmarks, the Index Administrator will conduct a quarterly review of the methodology. It will report in a timely manner the results of this review to the Oversight Committee. Any proposed material

changes to the methodology resulting from this review process will be promptly disseminated to market participants; comments from the market participants will be provided to the Oversight Committee so that it may consider them in making its final decision.

In this context, "material changes to the methodology" does not refer to changes to constituents, but rather to alterations in the mathematical algorithm used for calculation of the fixing price.

Changes to constituents and/or methodology will be reported to all market participants and the general public via the trueDIGITAL website, and will be retained for at least 7 years and made available to any market participants in the future. This reporting will also be done for changes to the methodology resulting from causes other than the quarterly review process.

5.2 Documentation of Index Administrator Activity

In addition to the notifications to the Oversight Committee and to market participants detailed in Sections 3 and 5, the Index Administrator will document in detail all of the following and retain such documentation for a minimum of 7 years:

- Material changes to the methodology
- Changes to contributing data sources other than short term changes which fall under the short term data fall-back policy
- Interactions with the Oversight Committee regarding methodology and / or data sourcing including Oversight Committee guidelines and decisions.

5.3 Limitations of the Fixing Price Indices

Pursuant to principle 11h of the IOSCO Principles for Financial Benchmarks, the methodology has been specifically designed to work in illiquid, fragmented markets with potential for concentration of inputs. As such, there are no specific limitations of applicability of the fixing prices.

Appendix 1: Glossary of Terms

ETH: the trading symbol for Ether, which is the digital asset associated with the Ethereum blockchain

ETHFixing Price Index (ETHFixing): the price index for Ethereum which is calculated and published daily by trueDIGITAL

Fixing Time: The end of the Fixing Window.

Fixing Window: the period of time prior to the calculation of a fixing price index from which spot cryptocurrency trades and orders are taken.

Index Administrator: an employee of trueDIGITAL with the primary responsibility for managing one or more Fixing price indices.

Maturity Date: the maturity date of a trueEX cryptocurrency derivative contract as specified in the trueEX rulebook

Oversight Committee: the committee charged with overseeing the activities of the Index Administrator. It is composed of two trueDIGITAL employee and threee industry experts who are not trueDIGITAL employees. The Oversight Committee charter and membership criteria are provided in separate documentation in the governance section of the trueDIGITAL website.

trueEX: trueEX LLC. More specifically, the trueDIGITAL division of trueEX, LLC

trueDIGITAL: trueDIGITAL, LLC

XBT: The trading symbol for Bitcoin, which is the digital asset associated with the Bitcoin Core blockchain

XBTFixing Price Index (XBTFixing): The price index for Bitcoin which is calculated and published daily by Virtuoso

Appendix 2: Trimming the Order Book

This appendix provides an example of the order book trimming process described in section 7. Assume that we have X = 100 units, and we have the following structure of one venue's order book:

		Bid Size	Offer Size		
(Highest Bid)	Bid 1	10.000	5.000	Offer 1	(Lowest Offer)
	Bid 2	12.300	33.000	Offer 2	
	Bid 3	4.000	2.000	Offer 3	
	Bid 4	27.000	7.600	Offer 4	
	Bid 5	13.000	6.000	Offer 5	
	Bid 6	6.230	49.000	Offer 6	
	Bid 7	14.000	10.000	Offer 7	
	Bid 8	20.000	3.000	Offer 8	
	Bid 9	25.000	12.000	Offer 9	
	Bid 10	10.000	22.000	Offer 10	
			8.000	Offer 11	
			44.000	Offer 12	

We first identify how many bids and how many offers are required for a total size of 100 units on each side of the market. In this example, it requires 8 bids and 6 offers to total at least 100 units.

		Bid Size	Offer Size		
(Highest Bid)	**Bid 1**	**10.000**	**5.000**	**Offer 1**	(Lowest Offer)
	Bid 2	**12.300**	**33.000**	**Offer 2**	
	Bid 3	**4.000**	**2.000**	**Offer 3**	
	Bid 4	**27.000**	**7.600**	**Offer 4**	
	Bid 5	**13.000**	**6.000**	**Offer 5**	
	Bid 6	**6.230**	**49.000**	**Offer 6**	
	Bid 7	**14.000**	10.000	Offer 7	
	Bid 8	**20.000**	3.000	Offer 8	
	Bid 9	25.000	12.000	Offer 9	
	Bid 10	10.000	22.000	Offer 10	
			8.000	Offer 11	
			44.000	Offer 12	
Cumulative Size Bids 1 to 8			106.530		
Cumulative Size Offers 1 to 6			102.600		

Next, the bids and offer beyond those needed are trimmed from the order book:

		Bid Size	Offer Size		
(Highest Bid)	Bid 1	10.000	5.000	Offer 1	(Lowest Offer)
	Bid 2	12.300	33.000	Offer 2	
	Bid 3	4.000	2.000	Offer 3	
	Bid 4	27.000	7.600	Offer 4	
	Bid 5	13.000	6.000	Offer 5	
	Bid 6	6.230	49.000	Offer 6	
	Bid 7	14.000			
	Bid 8	20.000			

Finally, we trim the size of Bid 8 from 20 units to 13.47 units to reduce the cumulative bid size to exactly 100 (i.e., since the cumulative size of bids 1 to 7 is 86.53, only 13.47 of the 8th bid is required to bring the total to 100), and we trim the size of Offer 6 from 49 units to 46.4 units to reduce the cumulative offer size to exactly 100 (i.e., since the cumulative size of offers 1 to 5 is 53.6, only 46.4 of the 6th offer is required to bring the total to 100). This results in the trimmed and balanced order book snapshot

		Bid Size	Offer Size		
(Highest Bid)	Bid 1	10.000	5.000	Offer 1	(Lowest Offer)
	Bid 2	12.300	33.000	Offer 2	
	Bid 3	4.000	2.000	Offer 3	
	Bid 4	27.000	7.600	Offer 4	
	Bid 5	13.000	6.000	Offer 5	
	Bid 6	6.230	46.400	Offer 6	
	Bid 7	14.000			
	Bid 8	13.470			
Cumulative size Bids 1 to 8			100		
Cumulative Size Offers 1 to 6			100		