



## CF SETTLEMENT PRICES

Methodology Guide

Version: 9.3

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# 1 Version History

Version	Version Date	Changes to Previous
1	20 <sup>th</sup> June 2018	N/A
2	15 <sup>th</sup> August 2018	Addition of Parameters and Specifications for Bitcoin Cash
3	5 <sup>th</sup> June 2019	Amendment to Methodology Parameters for CF Ripple-Bitcoin Settlement Price
3.1	2 <sup>nd</sup> July 2019	Removal of Bitfinex from CF Ripple-Bitcoin Settlement Price
3.2	16 <sup>th</sup> July 2019	Move constituent list to separate document
4	16 <sup>th</sup> July 2019	Rebrand for CF Benchmarks
5	11 <sup>th</sup> September 2019	Update legal text with BMR registration
6	10 <sup>th</sup> February 2020	Change potentially erroneous data parameter
7	13 <sup>th</sup> May 2020	Addition of: <ul style="list-style-type: none"> <li>• CF EOS-Dollar Settlement Price</li> <li>• CF Stellar Lumens-Dollar Settlement Price</li> <li>• CF Tezos-Dollar Settlement Price</li> </ul> Update ticker symbols
8	31 <sup>st</sup> July 2020	Addition of sections concerning: <ul style="list-style-type: none"> <li>• Underlying Economic Reality</li> <li>• Expert Judgement</li> <li>• Methodology review and Changes</li> </ul>
9	25 <sup>th</sup> August 2020	Addition of: <ul style="list-style-type: none"> <li>• CF PAX Gold-Dollar Settlement Price</li> <li>• CF Bitcoin-Euro Settlement Price</li> <li>• CF Ether-Euro Settlement Price</li> </ul>
9.1	13 <sup>th</sup> October 2020	Addition of: <ul style="list-style-type: none"> <li>• CF Chainlink-Dollar Settlement Price</li> </ul>
9.2	28 <sup>th</sup> January 2021	Addition of: <ul style="list-style-type: none"> <li>• CF OMG Network – Dollar Settlement Price</li> <li>• CF Orchid – Dollar Settlement Price</li> </ul>
9.3	9 <sup>th</sup> February 2021	Addition of: <ul style="list-style-type: none"> <li>• CF Bitcoin – Dollar U.S. Settlement Price</li> </ul>

## 2 Overview

The CF Settlement Prices have been created to facilitate settlement of regulated financial products. The methodology has been specifically designed to ensure that it is fit for this purpose. No further applications of the CF Settlement Prices have been taken into consideration in its design.

Each Settlement Price represents a transparent indicator of the price of an underlying cryptocurrency pair at the point in time stated in the specifications in section 7.

### **Underlying Economic Reality**

The CF Settlement Prices are intended to measure the underlying economic reality of the exchange of the base asset for the quote asset and vice versa. This is accomplished by the use of order input data from Constituent Exchanges, the criteria for eligibility for which are available in the CF Constituent Exchange Criteria.

## 3 Definitions

**API:** Application programming interface.

**Calculation Day:** Any day for which a CF Settlement Price is published.

**Constituent Exchange:** A cryptocurrency trading venue approved by CF Benchmarks Management to serve as pricing source for the calculation of a CF Settlement Price

**Relevant Pair:** The cryptocurrency versus cryptocurrency or legal tender pair referenced by a CF Settlement Price, as defined in Section 6.

**Relevant Transaction:** Any cryptocurrency versus cryptocurrency or legal tender spot trade that occurs during the TWAP Period on a Constituent Exchange in the Relevant Pair that is reported through its API to the Calculation Agent.

**Retrieval Time:** One minute after the end of the TWAP Period on a given Calculation Day, as given by the server clock of the Calculation Agent.

**TWAP Period:** A period of time equal to the TWAP Period Length leading up to the Effective Time, as defined in Section 6.

## 4 Methodology and Ground Rules

### 4.1 Methodology

#### 4.1.1 Qualitative Description

The CF Settlement Prices are calculated based on the Relevant Transactions of all Constituent Exchanges. Calculation steps on any given Calculation Day are as follows:

1. All Relevant Transactions are added to a joint list, recording the trade price and size for each transaction.
2. The list is partitioned into a number of equally-sized time intervals, as specified in Section 6.
3. For each partition separately, the volume-weighted median trade price is calculated from the trade prices and sizes of all Relevant Transactions, i.e. across all Constituent Exchanges. A volume-weighted median differs from a standard median in that a weighting factor, in this case trade size, is factored into the calculation.
4. The CF Settlement Price is then given by the equally-weighted average of the volume-weighted medians of all partitions.

### 4.1.2 Mathematical Representation

The following table shows the symbols used in the mathematical representation of CF Settlement Price.

Symbol	Name	Description	Type
$T$	Effective time	The time as of which a CF Settlement Price is calculated	Parameter, see Section 6
$\tau$	TWAP period length	The length of the time-period prior to the effective time during which transaction data is collected	Parameter, see Section 6
$\hat{\tau}$ with $\hat{\tau} \leq \tau$ and $\hat{\tau}   \tau$	Partition length	The length of the time periods into which the TWAP period length is partitioned	Parameter, see Section 6
$K$	Number of partitions	The number of partitions, given by $K = \tau / \hat{\tau}$	Output
$k$ with $k \in (1, \dots, K)$	Partition	The $k$ th partition	Output
$X_k$ for $k \in (1, \dots, K)$	TWAP period trades	The price-ordered collection of price / size trade pairs observed in the Relevant Pair on all Constituent Exchanges in the $k$ th partition, i.e. between times $T - \tau + (k - 1)$ and $T - \tau + k$	Input
$I_k$	TWAP period trades count	The number of trades in the $k$ th partition	Output
$x_{k,i}$ with $x_{k,i} = (p_{k,i}, s_{k,i})$ and $x_{k,i} \in X_k$	TWAP period trade	The $i$ th price / size trade pair of the $k$ th partition	Input
$p_{k,i}$	TWAP period trade price	The price of the $i$ th price/size trade pair of the $k$ th partition	Input
$s_{k,i}$	TWAP period trade size	The size of the $i$ th price/size trade pair of the $k$ th partition	Input
$WM_k$	Weighted median	The weighted median trade price of the $k$ th partition	Output
$CCRR_T$	CCRR	The CF Settlement Price at time $T$	Output

For each partition  $k$ , the volume-weighted median trade prices  $WM_k$  across all Relevant Transactions is calculated as:

$WM_k = p_{k,j} \text{ where } j \text{ satisfies } \sum_{i=1}^{j-1} s_{k,i} < \frac{1}{2} \sum_{i=1}^{I_k} s_{k,i} \text{ and } \sum_{i=j+1}^{I_k} s_{k,i} \leq \frac{1}{2} \sum_{i=1}^{I_k} s_{k,i}$ $\text{If } s_{k,1} \geq \frac{1}{2} \sum_{i=1}^{I_k} s_{k,i} \text{ then } WM_k = p_{k,1}$ $\text{If } \sum_{i=j+1}^{I_k} s_{k,i} = \frac{1}{2} \sum_{i=1}^{I_k} s_{k,i}, \text{ then } WM_k = \frac{p_{k,j} + p_{k,j+1}}{2}$	<b>Eq. 1</b>
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The CF Settlement Price of the effective time  $T$ ,  $CCRR_T$ , is then given by:

$CCRR_T = \frac{1}{K} \sum_{k=1}^K WM_k$	<b>Eq. 2</b>
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## 4.2 A Note on Properties

The calculation methodology immunizes CF Settlement Price to a high degree against price anomalies, while being replicable though spot trading on Constituent Exchanges. This is achieved through the following design choices:

### Partitions

The CF Settlement Price is calculated as the equally-weighted average of the intermediate calculation steps for the  $K$  partitions. A single large trade or cluster of trades occurring in any one partition will therefore only have a limited effect on the CF Settlement Price.

### Weighting of Partitions

Partitions are equally-weighted (as opposed to volume-weighted) to facilitate replication of CF Settlement Price through trading on Constituent Exchanges.

### Medians

Spot prices have historically varied considerably across trading venues, in particular during times of high volatility. The use of medians to calculate the weighted median trade price for each partition (as opposed to averages) greatly reduces the CF Settlement Prices' susceptibility to price extremes on one or more Constituent Exchanges.

### Volume-Weighting of Medians

Trading is driven to some extent by automated algorithms that may execute a high number of small trades. The use of volume-weighted medians to calculate the weighted



median trade price for each partition (as opposed to simple medians) assures that the CF Settlement Price appropriately reflects large trades and that whether an order is executed in parts or in full has no effect on calculation results.

# 5 Contingency Calculation Rules

## 5.1 Delayed Data and Missing Data

Delayed data and missing data are treated according to the following rules:

1. Any Relevant Transaction for a given Calculation Day that for any reason cannot be retrieved by the Calculation Agent from a Constituent Exchange's API by the Retrieval Time is disregarded in the calculation of the CF Settlement Price for that Calculation Day.
2. If no Relevant Transaction occurs on a Constituent Exchange on a given Calculation Day or one or more Relevant Transactions occur but for any reason cannot be retrieved by the Calculation Agent, the Constituent Exchange is disregarded in the calculation of the CF Settlement Price for that Calculation Day.
3. If, for any of the  $K$  partitions of the TWAP Period, no Relevant Transaction occurs on any Constituent Exchange or one or more Relevant Transactions occur but for any reason cannot be retrieved by the Calculation Agent, the partition remains empty and will be disregarded in the calculation of the CF Settlement Price for that Calculation Day. The denominator in Eq. 2 will then be decremented by the number of empty partitions.
4. If no Relevant Transaction occurs on any Constituent Exchange on a given Calculation Day or one or more Relevant Transactions occur but for any reason no Relevant Transaction can be retrieved from any Constituent Exchange by the Calculation Agent, a CF Settlement Price calculation failure occurs for that Calculation Day (see Section 5.5).

## 5.2 Erroneous Data

All Relevant Transactions retrieved by the Calculation Agent for a given Calculation Day are subject to an automated screening for erroneous data according to the following rules:

1. If a Relevant Transaction shows a non-numeric or non-positive trade price or trade size, it is flagged as erroneous.
2. If a Relevant Transaction is reported in a format that deviates from the expected format such that it cannot be parsed, it is flagged as erroneous.

Relevant Transactions flagged as erroneous for a given Calculation Day are disregarded in the calculation of the CF Settlement Price for that Calculation Day.

If all Relevant Transactions of all Constituent Exchanges are flagged as erroneous for a given Calculation Day, a CF Settlement Price calculation failure occurs for that Calculation Day (see Section 5.5).

### 5.3 Potentially Erroneous Data

All Relevant Transactions retrieved by the Calculation Agent for a given Calculation Day are subject to an automated screening for potentially erroneous data according to the following rules:

1. For each Constituent Exchange individually, the volume-weighted median trade price across all Relevant Transactions of that Constituent Exchange is calculated.
2. For each Constituent Exchange, the absolute percentage deviation of the volume-weighted median trade price, as calculated in the previous step, from the median of the volume-weighted median trade prices of all Constituent Exchanges is calculated.
3. If for any Constituent Exchange the absolute percentage deviation, as calculated in the previous step, exceeds the potentially erroneous data parameter for the respective CF Settlement Price, all Relevant Transactions of that Constituent Exchange are flagged as potentially erroneous.

Relevant Transactions flagged as potentially erroneous for a given Calculation Day are disregarded in the calculation of the CF Settlement Price for that Calculation Day.

If all Relevant Transactions of all Constituent Exchanges are flagged as potentially erroneous for a given Calculation Day, a CF Settlement Price calculation failure occurs for that Calculation Day (see Section 5.5).

### 5.4 Expert Judgement

The Administrator does not utilise expert judgment in the day to day calculation of the Settlement Prices. In extraordinary circumstances Expert Judgement may be exercised by the Administrator in accordance with its codified policies and processes which are available upon request.

### 5.5 Calculation Failure

If a CF Settlement Price cannot be calculated for a given Calculation Day, for instance because:

- no Relevant Transaction occurs on any Constituent Exchange on that Calculation Day, or

- one or more Relevant Transactions occur but for any reason cannot be retrieved by the Calculation Agent, or
- all Relevant Transactions retrieved by the Calculation Agent are flagged as erroneous or potentially erroneous (see Section 5.2); or
- any other reason or circumstance that prevents the orderly calculation of a CF Settlement Price,

Then the CF Settlement Price for that Calculation Day is given by the CF Spot Rate for the particular pair published at 4pm London time that day (see CF Spot Rate Methodology Guide for further details).

Should there be no CF Settlement Price published at 4pm London time that day then the CF Settlement Price for that calculation day is given by the last published CF Spot Rate for the particular pair published before 4pm London time on that day.

## 6 Settlement Price Parameters

The following table summarizes the parameters for the currently supported CF Settlement Prices:

	CF Litecoin-Dollar Settlement Price	CF Ripple-Dollar Settlement Price	CF Bitcoin Cash-Dollar Settlement Price	CF Ripple-Bitcoin Settlement Price
<b>Effective Time (<math>T</math>)</b>	4:00 p.m. London time every day			
<b>TWAP Period Length (<math>\tau</math>)</b>	60 minutes	60 minutes	60 minutes	90 minutes
<b>Partition Length (<math>\hat{\tau}</math>)</b>	5 minutes	5 minutes	5 minutes	10 minutes
<b>Number of Partitions (<math>K</math>)</b>	12	12	12	9
<b>Potentially Erroneous Data</b>	10%	10%	10%	10%

	CF EOS-Dollar Settlement Price	CF Stellar Lumens-Dollar Settlement Price	CF Tezos-Dollar Settlement Price	CF PAX Gold-Dollar Settlement Price
<b>Effective Time (<math>T</math>)</b>	4:00 p.m. London time every day			
<b>TWAP Period Length (<math>\tau</math>)</b>	90 minutes			
<b>Partition Length (<math>\hat{\tau}</math>)</b>	10 minutes			
<b>Number of Partitions (<math>K</math>)</b>	9			
<b>Potentially Erroneous Data</b>	25%			10%

	CF Chainlink- Dollar Settlement Price	CF Bitcoin-Euro Settlement Price	CF Ether-Euro Settlement Price	CF Bitcoin- Dollar US Settlement Price
<b>Effective Time (<math>T</math>)</b>	4:00 p.m. London time every day			4.00pm New York time every day
<b>TWAP Period Length (<math>\tau</math>)</b>	90 minutes	60 minutes		
<b>Partition Length (<math>\hat{\tau}</math>)</b>	10 minutes	5 minutes		
<b>Number of Partitions (<math>K</math>)</b>	9	12		
<b>Potentially Erroneous Data</b>	10%			

	CF OmiseGo – Dollar Settlement Price	CF Orchid-Dollar Settlement Price
<b>Effective Time (<math>T</math>)</b>	4:00 p.m. London time every day	
<b>TWAP Period Length (<math>\tau</math>)</b>	60 minutes	60 minutes
<b>Partition Length (<math>\hat{\tau}</math>)</b>	5 minutes	5 minutes
<b>Number of Partitions (<math>K</math>)</b>	12	12
<b>Potentially Erroneous Data</b>	10%	10%

## 7 Settlement Price Specifications

	<b>CF Litecoin-Dollar Settlement Price</b>	<b>CF Ripple-Dollar Settlement Price</b>	<b>CF Bitcoin Cash-Dollar Settlement Price</b>	<b>CF Ripple-Bitcoin Settlement Price</b>
<b>Ticker Symbol</b>	LTCUSD_RR	XRPUSD_RR	BCHUSD_RR	XRPXBT_RR
<b>Relevant Pair</b>	Litecoin vs. U.S. Dollars	XRP vs. U.S. Dollars	Bitcoin Cash vs. U.S. Dollars	XRP vs Bitcoin
<b>Administrator</b>	CF Benchmarks Ltd			
<b>Calculation Agent</b>	CF Benchmarks Ltd			
<b>Description</b>	U.S. Dollar price of one Litecoin as of 4:00 p.m. London time every day	U.S. Dollar price of one XRP as of 4:00 p.m. London time every day	U.S. Dollar price of one Bitcoin Cash as of 4:00 p.m. London time every day	Bitcoin price of one XRP as of 4:00 p.m. London time every day
<b>Calculation Methodology</b>	Aggregation of trade executions occurring on Constituent Exchanges during the Observation Window for the relevant calculation day			
<b>Observation Window Timing</b>	3:00pm to 4:00pm London Time			2:30pm to 4:00pm London Time
<b>Dissemination Time</b>	Once per day, every day of the year including weekends and holidays, between 4:00 p.m. and 4:30 p.m. London time			
<b>Dissemination Precision</b>	0.01 U.S. Dollars	0.00001 U.S. Dollars	0.01 U.S. Dollars	0.00000001 Bitcoin

	<b>CF EOS-Dollar Settlement Price</b>	<b>CF Stellar Lumens-Dollar Settlement Price</b>	<b>CF Tezos-Dollar Settlement Price</b>	<b>CF PAX Gold-Dollar Settlement Price</b>
<b>Ticker Symbol</b>	EOSUSD_RR	XLMUSD_RR	XTZUSD_RR	PAXGUSD_RR
<b>Relevant Pair</b>	EOS vs. U.S. Dollars	Stellar Lumens vs. U.S. Dollars	Tezos vs. U.S. Dollars	PAX Gold vs U.S. Dollars
<b>Administrator</b>	CF Benchmarks Ltd			
<b>Calculation Agent</b>	CF Benchmarks Ltd			
<b>Description</b>	U.S. Dollar price of one EOS as of 4:00 p.m. London time every day	U.S. Dollar price of one Stellar Lumens as of 4:00 p.m. London time every day	U.S. Dollar price of one Tezos as of 4:00 p.m. London time every day	U.S. Dollar price of one PAX Gold token as of 4:00pm London time every day
<b>Calculation Methodology</b>	Aggregation of trade executions occurring on Constituent Exchanges during the Observation Window for the relevant calculation day			
<b>Observation Window Timing</b>	2:30pm to 4:00pm London Time			
<b>Dissemination Time</b>	Once per day, every day of the year including weekends and holidays, between 4:00 p.m. and 4:30 p.m. London time			
<b>Dissemination Precision</b>	0.001 U.S. Dollars	0.00001 U.S. Dollars	0.0001 U.S. Dollars	0.01 U.S. Dollars



	<b>CF Chainlink-Dollar Settlement Price</b>	<b>CF Bitcoin-Euro Settlement Price</b>	<b>CF Ether-Euro Settlement Price</b>	<b>CF Bitcoin- Dollar US Settlement Price</b>
<b>Ticker Symbol</b>	LINKUSD_RR	XBTEUR_RR	ETHEUR_RR	XBTUSD_US_RR
<b>Relevant Pair</b>	Chainlink vs. U.S. Dollar	Bitcoin vs. Euro	Ether vs. Euro	Bitcoin vs. U.S. Dollars
<b>Administrator</b>	CF Benchmarks Ltd			
<b>Calculation Agent</b>	CF Benchmarks Ltd			
<b>Description</b>	U.S. Dollar price of one Link token as of 4:00 p.m. London time every day	Euro price of one Bitcoin as of 4:00 p.m. London time every day	Euro price of one Ether as of 4:00 p.m. London time every day	US Dollar price of one Bitcoin as of 4:00pm New York Time Every Day
<b>Calculation Methodology</b>	Aggregation of trade executions occurring on Constituent Exchanges during the Observation Window for the relevant calculation day			
<b>Observation Window Timing</b>	2:30pm to 4:00pm London Time	3.00 to 4.00 pm London Time		3:00 to 4:00 pm New York Time
<b>Dissemination Time</b>	Once per day, every day of the year including weekends and holidays, between 4:00 p.m. and 4:30 p.m. London time			Once per day, every day of the year including weekends and holidays, between 4:00 p.m. and 4:30 p.m. New York time
<b>Dissemination Precision</b>	0.001 U.S. Dollars	0.01 Euros	0.01 Euros	0.01 U.S. Dollars

	<b>CF OmiseGo-Dollar Settlement Price</b>	<b>CF Orchid-Dollar Settlement Price</b>
<b>Ticker Symbol</b>	OMGUSD_RR	OXTUSD_RR
<b>Relevant Pair</b>	OmiseGo vs. U.S. Dollars	Orchid vs. U.S. Dollars
<b>Administrator</b>	CF Benchmarks Ltd	
<b>Calculation Agent</b>	CF Benchmarks Ltd	
<b>Description</b>	U.S. Dollar price of one OmiseGo as of 4:00 p.m. London time every day	U.S. Dollar price of one Orchid as of 4:00 p.m. London time every day
<b>Calculation Methodology</b>	Aggregation of trade executions occurring on Constituent Exchanges during the Observation Window for the relevant calculation day	
<b>Observation Window Timing</b>	3:00pm to 4:00pm London Time	
<b>Dissemination Time</b>	Once per day, every day of the year including weekends and holidays, between 4:00 p.m. and 4:30 p.m. London time	
<b>Dissemination Precision</b>	0.0001 U.S. Dollars	0.00001 U.S. Dollars

## 8 Methodology Review and Changes

This methodology is subject to internal review by the Administrator and the CF Oversight Function at least annually.

Any changes to this methodology are overseen by the CF Oversight Function, and In accordance with EU BMR Article 13.

All *material* changes to the methodology shall only be implemented after a consultation process with users and relevant stakeholders that shall be conducted according to the Administrator's policies and overseen by the CF Oversight Function.

Should the Administrator deem it necessary to cease providing any of the Settlement Prices it shall only do so after a consultation process with users and relevant stakeholders that shall be conducted according to the Administrator's policies and overseen by the CF Oversight Function

# Contact Information

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