



CM Real-Time Reference Rates Methodology

Version 0.1 (Beta 2)

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0 Change Log	3
1 Introduction	3
2 Description	3
3 Coverage Universe	3
4 Data and Calculation Methodology	7
4.1 Data Sources	7
4.2 Market Selection Framework	7
4.3 Data Inputs	8
4.3.1 Bitcoin (BTC) and Ethereum (ETH)	8
4.3.2 Other Cryptocurrencies Excluding Stablecoins	9
4.3.3 Stablecoins	9
4.4 Calculation Algorithm	10
4.5 Data Contingency Rules	10
4.6 Data Exclusion Rules	10
5 Reference Rate Revisions	11
6 Administration	11
7 Internal Oversight	11
8 Conflicts of Interest	11
9 Material Changes or Termination	12
10 Internal Controls	12
11 Complaints	12
12 Internal Audit	13
13 Record Retention	13
14 Compliance	13

0 Change Log

Release	Date	Changes
Version 0.1 (Beta 2)	December 9, 2019	Modified Calculation Algorithm to include inverse variance weighting to lessen the occurrence of outlier rates. Expanded Coverage Universe: Added the following assets: algo, beam.
Version 0 (Beta)	August 30, 2019	Finalized Real-Time Reference Rate Methodology v0 for Beta release.

1 Introduction

Coin Metrics produces the CM Real-Time Reference Rates (the “Real-Time Reference Rates”), a real-time price quoted in U.S. dollars for a set of cryptocurrencies. The Real-Time Reference Rates is designed to serve as a transparent and independent pricing source that promotes the functioning of efficient markets, reduces information asymmetries among market participants, facilitates trading in standardized contracts, and accelerates the adoption of cryptocurrencies as an asset class with the highest standards. The Real-Time Reference Rates is calculated using a robust and resilient methodology that is resistant to manipulation and adheres to international best practices for financial benchmarks, including the International Organization of Securities Commissions’ (IOSCO) Principles for Financial Benchmarks. The Coin Metrics Oversight Committee (the “Oversight Committee”) and an independent governance structure protect the integrity of the Real-Time Reference Rates and ensure the Real-Time Reference Rates serves as a source of transparent and independent pricing.

2 Description

The Real-Time Reference Rates are calculated once every second and represents the real-time price of one unit of the cryptocurrency quoted in U.S. dollars.

3 Coverage Universe

Cryptocurrencies included in the CM Real-Time Reference Rate coverage universe are listed in Appendix A.

4 Data and Calculation Methodology

4.1 Data Sources

The input data source for the Real-Time Reference Rates are markets traded on cryptocurrency exchanges that are approved to serve as pricing sources by the Oversight Committee. The Oversight

Committee evaluates markets using a Market Selection Framework that assesses markets along a wide set of criteria to determine if the data source reflects trading activity in a transparent and representative manner. The Oversight Committee evaluates new markets for inclusion as a selected data source and evaluates already selected markets using the Market Selection Framework on a quarterly basis or as market conditions warrant. Markets that are approved by the Oversight Committee are added to a list of selected markets (the “Selected Markets”). A separate list of Selected Markets is maintained for each Real-Time Reference Rates in the coverage universe.

A candidate market can be nominated for inclusion and an already selected market can be nominated for exclusion by any member of the public or member of the Oversight Committee. Public nominations for inclusion or exclusion of a market can be submitted in writing to support@coinmetrics.io. The Oversight Committee may convene to apply the Market Selection Framework to evaluate the inclusion or exclusion of a market between regularly-scheduled quarterly meetings if market conditions or circumstances warrant. Coin Metrics publishes a current list of Selected Markets for each of the Reference Rates, updates on inclusions or exclusions of exchanges, and the rationale for making any change.

4.2 Market Selection Framework

The Market Selection Framework consists of a fully-systematized process for evaluating markets to serve as input pricing sources for the calculation of the Reference Rates. It produces a unique set of candidate selected markets for each asset in the coverage universe that are then subsequently reviewed by the Oversight Committee. The market selection framework evaluates markets based on the following criteria:

1. **Technology:** An assessment of whether the technology infrastructure of the market’s exchange provides sufficient availability and reliability for input data collection. Evaluates whether the exchange offers a REST API, Websocket feed, or FIX API suitable for data collection. Evaluates the performance of the API in terms of reliability and latency.
2. **Legal and Compliance:** An assessment of whether the market’s exchange complies with laws and regulations. Evaluates the exchange’s legal risk exposure, and whether it adheres to regulatory best practices. Evaluates whether the exchange has publicly-disclosed trading policies, uses market surveillance technology, and complies with national regulatory organizations, and enforces KYC and AML requirements. Evaluates whether the exchange has functioning fiat and cryptocurrency withdrawals processed within a normal timeframe. Evaluates whether a data sharing license can be executed with the exchange.
3. **Business Model:** An assessment of the market’s exchange with respect to its business model, including its fee structure and asset listing standards.
4. **Data Availability:** An assessment of the available data the market’s exchange offers for the given cryptocurrency, including the number of markets where the given cryptocurrency is the base currency, whether the markets are quoted in fiat currencies or other cryptocurrencies, and the type of markets offered.
5. **Price:** An assessment of the quality of the market’s price data, including testing for the occurrence of price outliers and impactful price deviations from other markets, and implementing tests that determine whether the exchange’s markets function as active markets in the underlying

cryptocurrency and are anchored by observable transactions entered into at arm's length between buyers and sellers.

6. Volume: An assessment of the quality of the market's volume data, including testing for manipulated volume figures, and implementing tests that determine whether the exchange's markets function as active markets in the underlying cryptocurrency and are anchored by observable transactions entered into at arm's length between buyers and sellers. The size of the exchange's markets are also considered.
7. Order Book: An assessment of the quality of the market's order book data, including tests for manipulated orders, and implementing tests that determine whether the market function as active markets in the underlying cryptocurrency and are anchored by observable transactions entered into at arm's length between buyers and sellers. The liquidity of the market is also considered.

4.3 Data Inputs

The data inputs for the calculation of the Real-Time Reference Rates are observable transactions in an active market where the given cryptocurrency is traded. The pool of candidate markets that are evaluated by the Market Selection Framework are determined by a hierarchy of data inputs that varies depending on the given cryptocurrency. Coin Metrics publishes a list of current data inputs for each of the Real-Time Reference Rates, changes to the data inputs, and the rationale for making any change.

4.3.1 Bitcoin (BTC) and Ethereum (ETH)

The pool of candidate markets that are evaluated for the calculation of the Real-Time Reference Rates for Bitcoin (BTC) and Ethereum (ETH) are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given cryptocurrency is the base currency and the quote currency is U.S. dollars.
2. Markets where the given cryptocurrency is the base currency and the quote currency is not U.S. dollars are not considered, including markets quoted in other fiat currencies or markets quoted in stablecoins.

4.3.2 Other Cryptocurrencies Excluding Stablecoins

The pool of candidate markets that are evaluated for the calculation of the Real-Time Reference Rates for other cryptocurrencies, excluding Bitcoin (BTC), Ethereum (ETH), and stablecoins are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given cryptocurrency is the base currency and the quote currency is U.S. dollars.
2. If the above data inputs do not exist or the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, the universe of data inputs will expand to include observable transactions in an active market where the given cryptocurrency is

the base currency and quote currency is BTC.

3. If the above data inputs do not exist or the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, the universe of data inputs will expand to include observable transactions in an active market where the given cryptocurrency is the base currency and quote currency is ETH.

4.3.3 Stablecoins

The pool of candidate markets that are evaluated for the calculation of the Real-Time Reference Rates for stablecoins are determined using the following data hierarchy:

1. The primary data input is observable transactions in an active market where the given stablecoin is the base currency and the quote currency is U.S. dollars.
2. If the above data inputs do not exist or the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, the universe of data inputs will expand to include observable transactions in an active market where Bitcoin (BTC) is the base currency and quote currency is the given stablecoin.
3. If the above data inputs do not exist or the Oversight Committee makes a determination that the above data inputs are insufficient to calculate the reference rate, the universe of data inputs will expand to include observable transactions in an active market where Ethereum (ETH) is the base currency and quote currency is the given stablecoin.

The data hierarchy for stablecoins differs from other cryptocurrencies because market convention sets stablecoins as the quote currency for the majority of active markets. The following cryptocurrencies in the coverage universe are considered to be stablecoins:

Name	Ticker
Tether	usdt
USD Coin	usdc
TrueUSD	tusd
Paxos Standard Token	pax
Dai	dai
Gemini Dollar	gusd

4.4 Calculation Algorithm

The calculation algorithm is described below.

1. Calculate the volume denominated in units of the cryptocurrency from observable transactions that occurred over the trailing 60 minutes for each of the selected markets. Calculate the volume weight for each of the selected markets by dividing the volume figure for each of the selected markets by the total volume across all selected markets. This figure is referred to as the volume

weight.

2. Convert the trade price of all observable transactions over the trailing 60 minutes for each of the selected markets to U.S. dollars if necessary using the Real-Time Reference Rate calculated for Bitcoin (BTC) or Ethereum (ETH). Calculate the inverse variance of the trade price converted to U.S. dollars for each of the selected markets using the population mean in the calculation of variance, where the population mean is defined as the mean price of all trades from selected markets over the trailing 60 minutes. If a selected market has an infinite or undefined inverse price variance, the inverse price variance for that market is set to zero. Calculate the inverse price variance weight for each of the selected markets by dividing the inverse price variance by the total inverse price variance across all selected markets. This figure is referred to as the inverse price variance weight.
3. Calculate the final weight for each of the selected markets by taking a mean of the volume weight and the inverse price variance weight.
4. Extract the most recent observable transaction from each of the selected markets. Convert the trade price of the most recent observable transaction to U.S. dollars if necessary using the Real-Time Reference Rate calculated for Bitcoin (BTC) or Ethereum (ETH).
5. Calculate the weighted median price of the most recent observable transactions, where the price is calculated in step 4 and the final weight is calculated in step 3. The weighted median price is calculated by ordering the transactions from lowest to highest price, and identifying the price associated with the trades at the 50th percentile of final weight. The resulting figure is the calculated Real-Time Reference Rate.

4.5 Data Contingency Rules

The following contingency rules are followed to address situations where data is delayed, missing, or unavailable due to periods of illiquidity, extraordinary market circumstances, or outside factors beyond the control of Coin Metrics.

1. If observable transactions from a selected market are unable to be collected due to technical problems specific to the selected market's exchange during the calculation of the Real-Time Reference Rates, the observable transactions from the selected market are not included in the calculation of the specific instance of the given index.
2. If no observable transactions from selected markets exist during the trailing 60 minutes, the value of the Real-Time Reference Rate will be determined to equal the value calculated during the previous second.

4.6 Data Exclusion Rules

The calculation of the Real-Time Reference Rates does not rely on any data exclusion rules.

5 Reference Rate Revisions

If errors are discovered in observable transactions used to calculate the reference rate or in the calculation process subsequent to the publication of the reference rate, a revised reference rate may be published within 8 hours of the Publication Time. Revisions will only be effected within 8 hours of the Publication Time and only if the change in the rate exceeds 1 percent of the original reference rate. A footnote will be published to indicate the revision of any reference rate.

6 Administration

Coin Metrics serves as the administrator for the Real-Time Reference Rates and has primary responsibility for all aspects of the Real-Time Reference Rates determination process, including the development, definition, determination, dissemination, operation, and governance of the Real-Time Reference Rates. All aspects of the production of the Real-Time Reference Rates are carried out by Coin Metrics, and Coin Metrics does not rely on any third parties for the determination of the Real-Time Reference Rates.

Coin Metrics ensures that transparency regarding significant decisions and associated rationale are published and made available to external stakeholders. Data contingency and data exclusion rules are in place to handle certain extraordinary circumstances and external factors beyond the control of Coin Metrics. The Oversight Committee reviews and provides challenge on the Real-Time Reference Rates production process.

7 Internal Oversight

The Oversight Committee provides independent oversight over the production of the Real-Time Reference Rates. The Oversight Committee's responsibilities include regular reviews of the Real-Time Reference Rates production process, the Real-Time Reference Rates definition and calculation methodology, the selection of data sources and data inputs, any uses of non-standard procedures, conflicts of interest, material changes to or termination of the Real-Time Reference Rates, reviewing the results of external and internal audits, and any complaints or questions regarding the Reference Rates from external stakeholders. Additional information regarding the responsibilities and membership of the Oversight Committee can be found in the Coin Metrics Operating Committee Charter document.

8 Conflicts of Interest

Coin Metrics enforces policies and procedures relating to conflicts of interest in connection with the production of the Real-Time Reference Rates. The conflicts of interest policy addresses the identification, disclosure, management, and mitigation of conflicts of interest. These policies and procedures are periodically reviewed by the Oversight Committee. Coin Metrics is committed to disclosing any material conflicts of interest to external stakeholders and to regulatory authorities.

9 Material Changes or Termination

Coin Metrics may initiate material changes to or terminate the Real-Time Reference Rates due to certain extraordinary market circumstances or external factors. These circumstances or external factors include, but are not limited to:

1. The Real-Time Reference Rates no longer serves, and could not be modified to serve, as a transparent and independent pricing source for the underlying cryptocurrency
2. The market liquidity in the underlying cryptocurrency declines to the extent that the input data sources no longer function as active markets
3. The underlying cryptocurrency experiences a contentious hard fork in which both forks survive

In such circumstances, Coin Metrics will review the Real-Time Reference Rates to ensure the Real-Time Reference Rates are properly reflecting their underlying cryptocurrencies, and if necessary, make changes to the methodology or definition of the Real-Time Reference Rates to properly account for changing market structure, circumstances, and conventions in the underlying cryptocurrency. Any such change or termination will be reviewed and approved by the Oversight Committee. Any approved change or termination will be publicly disclosed to external stakeholders with a detailed explanation of the rationale. In a manner appropriate to the circumstances, Coin Metrics will develop a plan to notify, solicit comments from, and consult with external stakeholders before implementing any material change or termination. Any change or termination will include a timeline explaining the timing of changes or termination and include steps to mitigate any negative effects on external stakeholders.

10 Internal Controls

Coin Metrics has implemented internal controls to protect the integrity of the Real-Time Reference Rates. These controls cover the selection of input data sources, the collection of data from input data sources, and maintaining the integrity of collected data. Staff involved with the production of the Reference Rates have been trained in the proper usage of the data and maintain proper segregation of responsibilities. Any exercise of non-standard procedures is subject to dual approval by staff members, and is logged and reported to the Oversight Committee which periodically reviews any incidents. In addition, Coin Metrics maintains a whistleblowing mechanism to facilitate the reporting of any potential misconduct.

11 Complaints

Complaints about the calculation methodology of the Real-Time Reference Rates or the value of a published Real-Time Reference Rates should be submitted in writing to support@coinmetrics.io. Coin Metrics will investigate any complaints and respond to the complainant in a fair and timely manner. Any investigation of the complaint will adhere to the following procedures:

1. The personnel receiving and investigating the complaint will be independent of any personnel who may have been involved in the subject of the complaint.
2. All records and documents submitted by the complainant and related to the investigation into the complaint will be retained for a period of at least five years and submitted to the Oversight Committee for review.
3. Any complaint that results in a change in the determination of the Real-Time Reference Rates, its calculation methodology, or its policies will be publicly disclosed that explain the action taken.

12 Internal Audit

The Oversight Committee appoints an independent internal auditor to review the Real-Time Reference Rates's adherence to its stated methodology, compliance with policies, and adherence to the IOSCO's Principles of Financial Benchmarks. The frequency of the independent internal audit is once annually.

13 Record Retention

Coin Metrics retains records, for at least five years, on the following items:

1. All market data that is collected and used in the calculation of the Real-Time Reference Rates
2. Any use of expert judgment in the calculation of the Real-Time Reference Rates
3. Any use of non-standard procedures in the calculation of the Real-Time Reference Rates
4. The identities of staff responsible for the calculation of the Real-Time Reference Rates
5. Any responses, questions, or complaints received in connection with the calculation of the Real-Time Reference Rates

14 Compliance

Coin Metrics maintains records and has processes in place to comply with requests for information from regulatory authorities. Coin Metrics commits to full cooperation with any regulatory authority in carrying out their regulatory or supervisory duties.

Appendix A: Coverage Universe

Coin Metrics produces the Real-Time Reference Rates for the following cryptocurrencies:

#	name	ticker
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1	Bitcoin	btc
2	Ethereum	eth
3	Tether	usdt
4	Litecoin	ltc
5	XRP	xrp
6	Bitcoin Cash	bch
7	EOS	eos
8	Dash	dash
9	ZCash	zec
10	Monero	xmr
11	Stellar	xlm
12	Ethereum Classic	etc
13	TRON	trx
14	Qtum	qtum
15	Bitcoin Cash SV	bsv
16	NEO	neo
17	Cardano	ada
18	Basic Attention Token	bat
19	Cosmos	atom
20	TrueUSD	tusd
21	OmiseGO	omg
22	USD Coin	usdc
23	Binance Coin	bnb
24	Paxos Standard Token	pax
25	NEM	xem
26	BitTorrent Token	btt
27	0x	zrx
28	Ontology	ont
29	Augur	rep
30	Zilliqa	zil
31	VeChain	vet
32	Status	snt
33	Dogecoin	doge
34	IOTA	miota

35	IOST	iost
36	Huobi Token	ht
37	BitShares	bts
38	Waves	waves
39	Enjin Coin	enj
40	ELF	elf
41	Dai	dai
42	Bitcoin Gold	btg
43	Tezos	xtz
44	ICON	icx
45	Bytom	btm
46	Aeternity	ae
47	Verge	xvg
48	Golem	gnt
49	Crypto.com	mco
50	Decentraland	mana
51	Bitcoin Diamond	bcd
52	ChainLink	link
53	Lisk	lsk
54	Siacoin	sc
55	Mithril	mith
56	Kyber Network	knc
57	Polymath	poly
58	Steem	steem
59	Decred	dcr
60	Loom Network	loom
61	Waltonchain	wtc
62	Nano	nano
63	Grin	grin
64	WAX	wax
65	Theta Token	theta
66	DigiByte	dgb
67	Stratis	strat
68	Loopring	lrc

69	Storj	storj
70	Komodo	kmd
71	Power Ledger	powr
72	Ardor	ardr
73	Arcblock	abt
74	Maker	mkr
75	HyperCash	hc_hypercash
76	Dent	dent
77	Civic	cvc
78	Nebulas	nas
79	GXChain	gxs
80	Odyssey	ocn
81	Metal	mtl_metal
82	iExec RLC	rlc
83	QASH	qash
84	ZCoin	xzc
85	Bancor	bnt
86	Horizen	zen
87	CyberMiles	cmt
88	Raiden Network Token	rdn
89	Gas	gas
90	QuarkChain	qkc
91	Ripio Credit Network	rcn_ripiocreditnetwork
92	Eidoo	edo
93	TenX	pay
94	FunFair	fun
95	Ravencoin	rvn
96	Enigma	eng
97	Groestlcoin	grs
98	Project Pai	pai
99	Bytecoin	bcn
100	PIVX	pivx
101	Gemini Dollar	gusd
102	Matrix AI Network	man

103	MonaCoin	mona
104	Gnosis	gno
105	Nuls	nuls
106	Aion	aion
107	Populous	ppt
108	MaidSafeCoin	maid
109	Ethos	ethos
110	Holo	hot_holo
111	ReddCoin	rdd
112	Ontology Gas	ong_ontologygas
113	Gifto	gto
114	Pundi X	npxs
115	AdEx	adx
116	BlockMason Credit Protocol	bcpt
117	Bibox Token	bix
118	UNUS SED LEO	leo
119	Time New Bank	tnb
120	AirSwap	ast
121	Libra Credit	lba
122	DATA	dta
123	Nucleus Vision	ncash
124	OST	ost
125	Aeron	arn
126	POA Network	poa
127	YOYOW	yoyow
128	OAX	oax
129	Cortex	ctxc
130	DigixDAO	dgd
131	BitKan	kan
132	Storm	storm
133	SingularityNET	agi
134	Etherparty	fuel
135	Tierion	tnt

136	Lunyr	lun
137	Theta Fuel	tfuel
138	Bluzelle	blz
139	BnkToTheFuture	bft
140	Viberate	vib
141	Request Network	req
142	IHT Real Estate Protocol	iht
143	Cindicator	cnd
144	Everex	evx
145	district0x	dnt
146	Ambrosus	amb
147	Blox	cdt
148	Game.com	gtc_gamecom
149	IoTeX	iotx
150	ContentBox	box
151	Lymbo	lym
152	Fusion	fsn
153	SIRIN LABS Token	srn
154	IoT Chain	itc
155	Ankr Network	ankr
156	Lambda	lamb
157	Orbs	orbs
158	Nxt	nxt
159	Mainframe	mft
160	UTRUST	utk
161	ETHLend	lend
162	Selfkey	key
163	WePower	wpr
164	AppCoins	appc
165	ChatCoin	chat
166	Cosmo Coin	cosm
167	Dock	dock
168	Fantom	ftm
169	Ark	ark

170	SingularDTV	sngls
171	Crowd Machine	cmct
172	Celer Network	celr
173	Medibloc [ERC20]	medx
174	Viacoin	via
175	Propy	pro
176	Red Pulse Phoenix	phx
177	Syscoin	sys
178	TTC Protocol	ttc_ttcprotocol
179	Moeda Loyalty Points	mda
180	Content Neutrality Network	cnn
181	PumaPay	pma
182	Ignis	ignis
183	NavCoin	nav
184	WaykiChain	wicc
185	Quantstamp	qsp
186	Electroneum	etn
187	Penta	pnt
188	Factom	fct
189	DeepBrain Chain	dbc
190	GoChain	go
191	Primas	pst
192	Wanchain	wan
193	Numeaire	nmr
194	Nexo	nexo
195	Elastos	ela
196	Vertcoin	vtc
197	Dragonchain	drgn
198	Crypto.com Chain	cro
199	Metaverse ETP	etp
200	Metadium	meta
201	Republic Protocol	ren
202	Quant	qnt
203	SOLVE	solve

204	Algorand	algo
205	Beam	beam