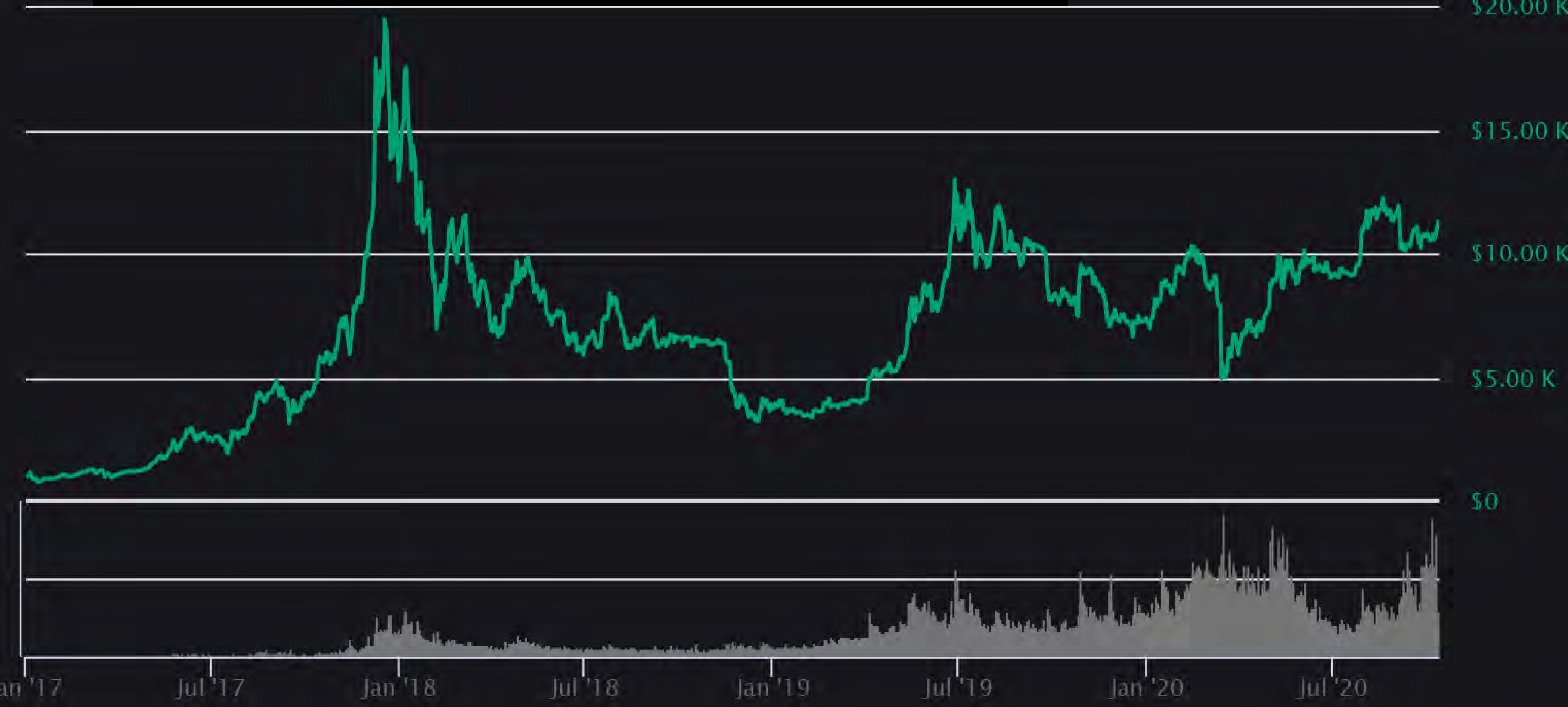
国際政治経済懇談会
2020年10月20日

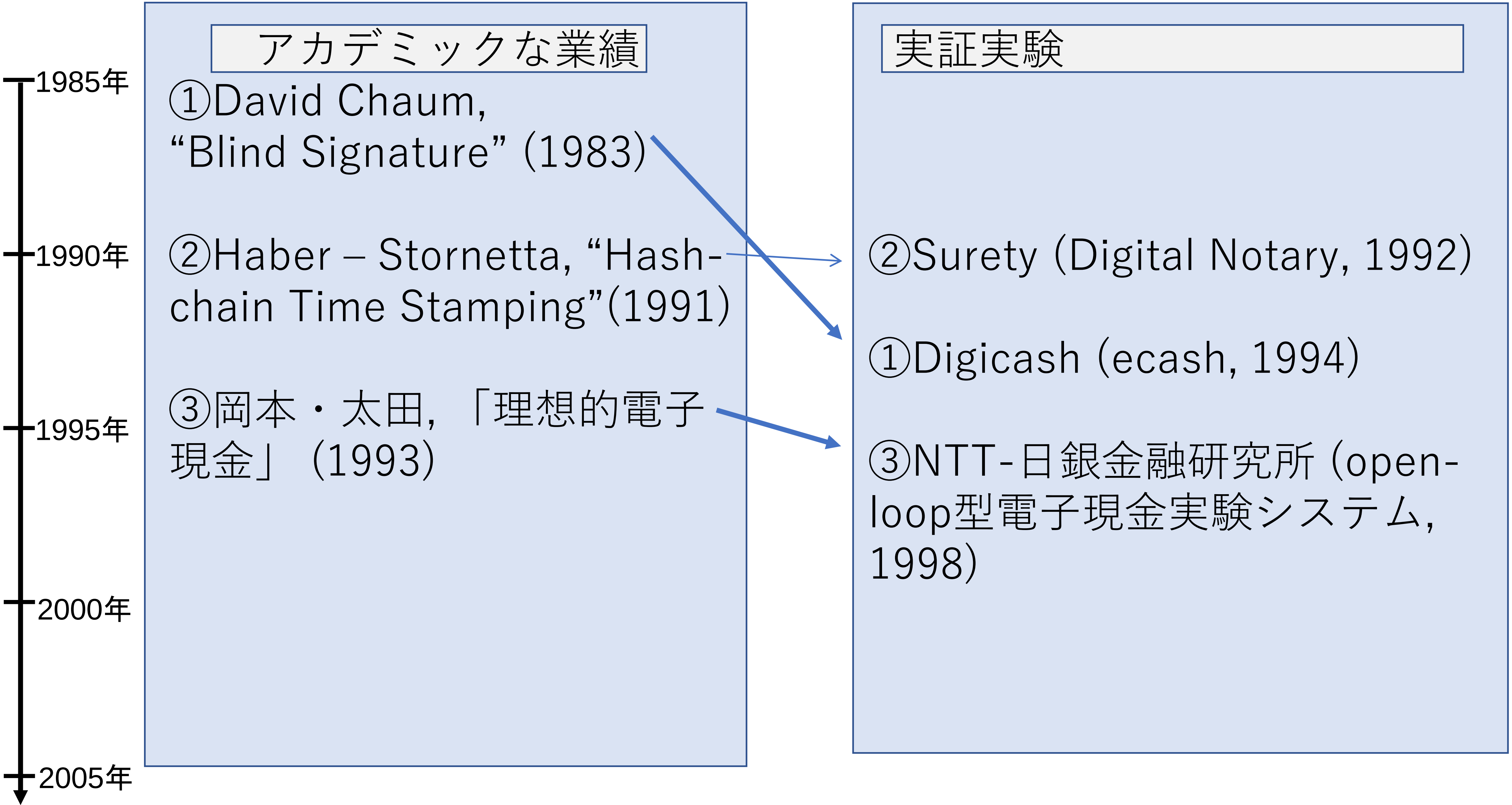
デジタル通貨を巡る論争を読み解く

京都大学 公共政策大学院
岩下 直行

Before the Bitcoin



Bitcoinに先立って開発されていた主な技術



1985年

1990年

1995年

2000年

2005年

アカデミックな業績

①David Chaum, “Blind Signature” (1983)

②Haber – Stornetta, “Hash-chain Time Stamping”(1991)

③岡本・太田,「理想的電子現金」(1993)

実証実験

②Surety (Digital Notary, 1992)

①Digicash (ecash, 1994)

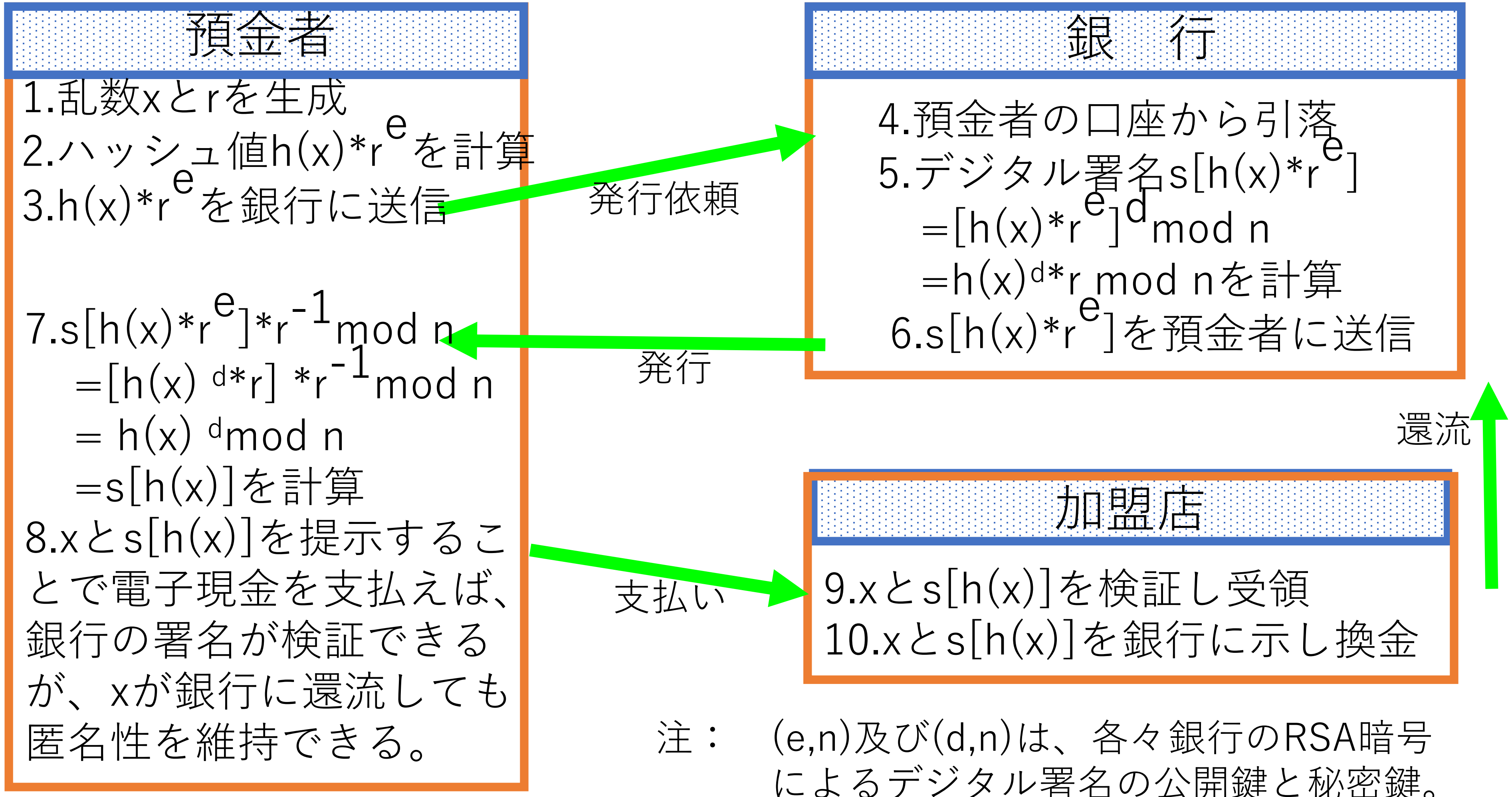
③NTT-日銀金融研究所 (open-loop型電子現金実験システム, 1998)

David Chaum（1955 -　）

Digicash社のecash

ecashは、David Chaumが発明したblind signatureと呼ばれる暗号技術により、取引の匿名性を実現したclosed-loop型電子現金。

David Chaum
（1955 - 　）



預金者

1.乱数xとrを生成

2.ハッシュ値$h(x)*r^e$を計算

3.$h(x)*r^e$を銀行に送信

7.$s[h(x)*r^e]*r^{-1}$mod n

　=$[h(x)^d*r]*r^{-1}$mod n

　= $h(x)^d$mod n

　=s[h(x)]を計算

8.xとs[h(x)]を提示することで電子現金を支払えば、銀行の署名が検証できるが、xが銀行に還流しても匿名性を維持できる。

銀　行

4.預金者の口座から引落

5.デジタル署名$s[h(x)*r^e]$

　=$[h(x)*r^e]^d$mod n

　=$h(x)^d*r$ mod nを計算

6.$s[h(x)*r^e]$を預金者に送信

加盟店

9.xとs[h(x)]を検証し受領

10.xとs[h(x)]を銀行に示し換金

注：　(e,n)及び(d,n)は、各々銀行のRSA暗号によるデジタル署名の公開鍵と秘密鍵。
r^{-1}は、$r \cdot r^{-1}$mod n=1となる正整数。

NTTと日銀金融研究所による電子現金実験システム（1998年）

（利用環境）

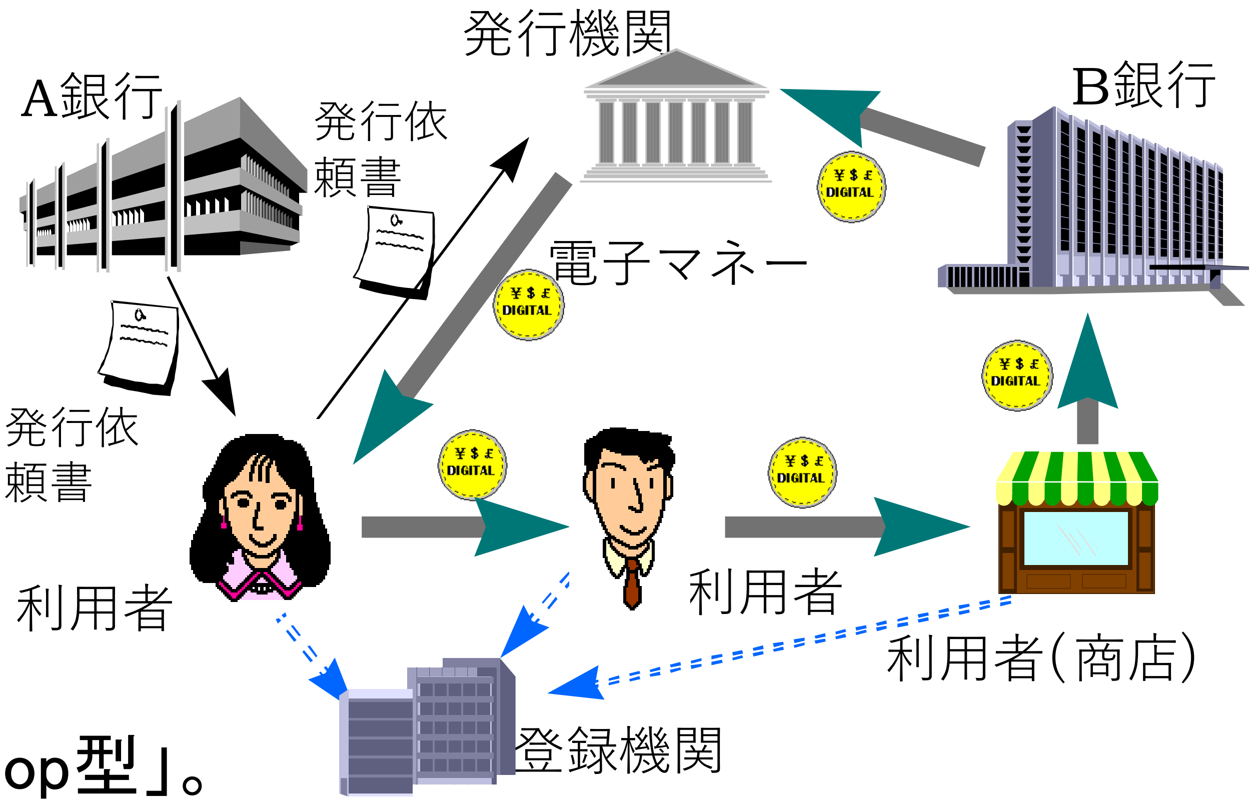
- コインを分割利用できる。
- ネットおよび商店店頭の双方で利用可能。

（セキュリティ対策の強化）

- ICカードの耐偽造性による事前対策と、電子マネーへの属性情報の埋め込みによる事後対策の二重の対策を組み込み。

（現金のメリットの継承）

- 利用者間での転々流通が可能な「open-loop型」。
- プライバシー保護の観点から、「取引の匿名性」を実現。



発行機関

A銀行

B銀行

発行依頼書

電子マネー

発行依頼書

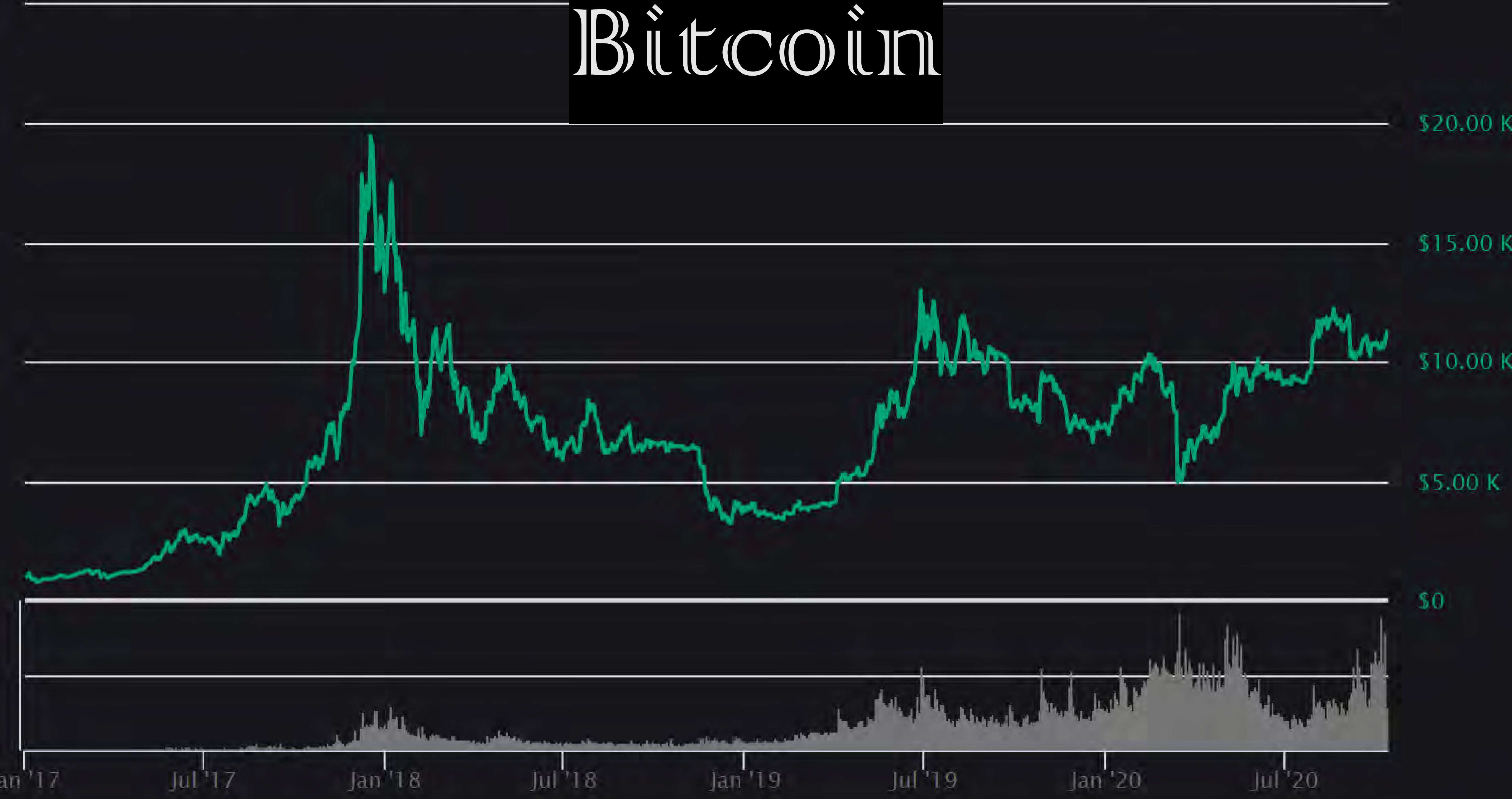
利用者

利用者

利用者（商店）

登録機関

Bitcoin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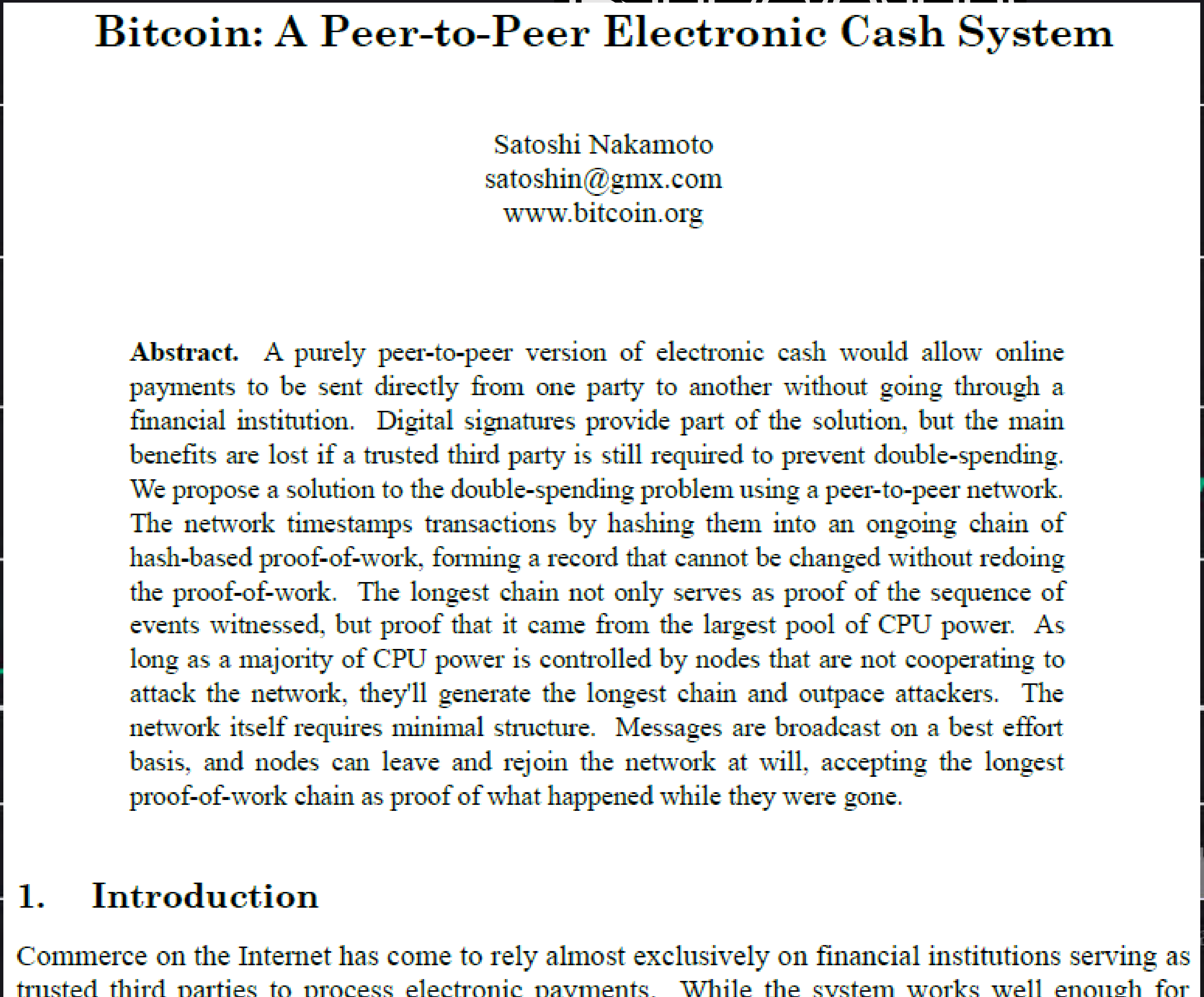


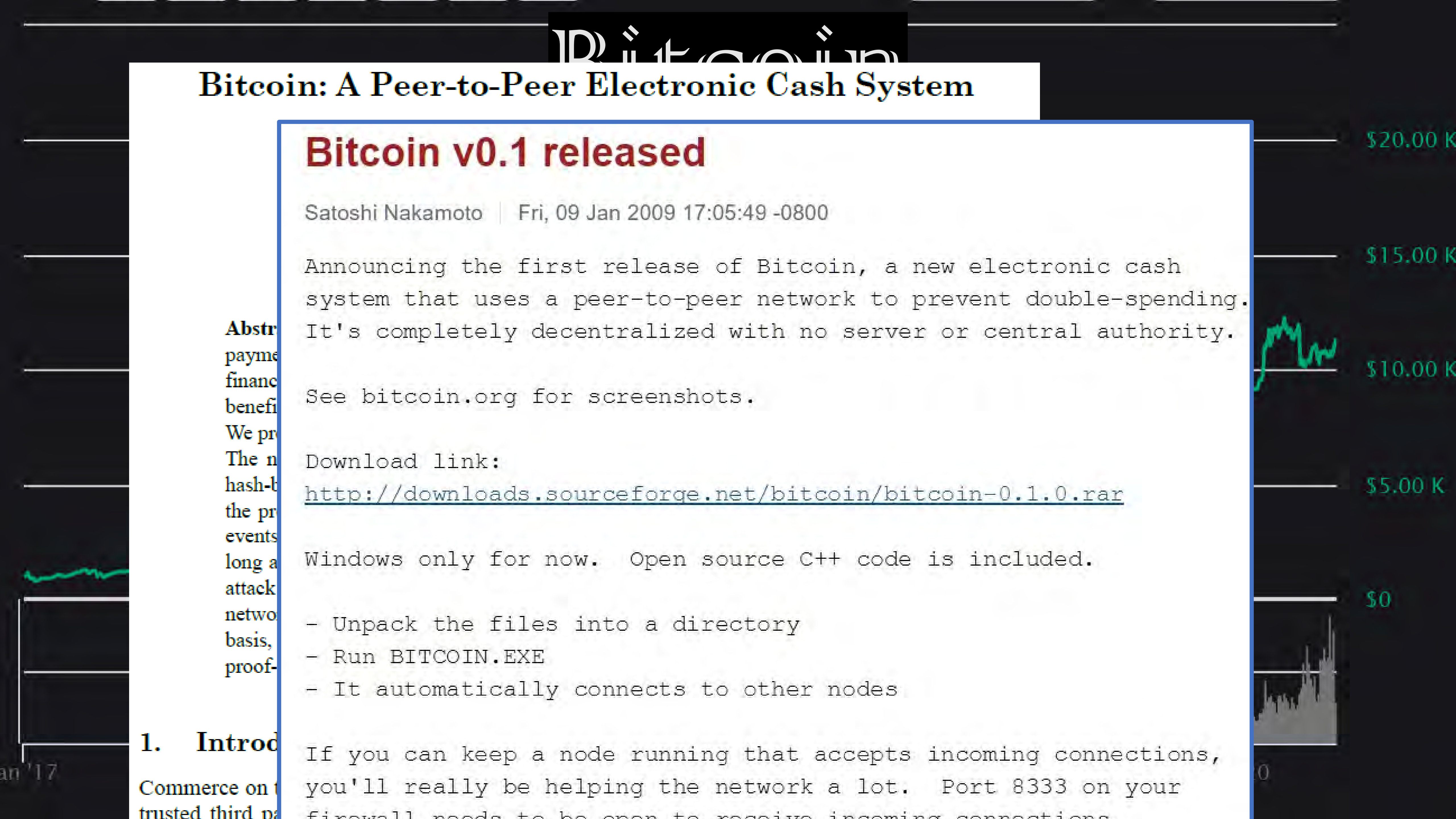
Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org

Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

1. Introduction

Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for



Bitcoin: A Peer-to-Peer Electronic Cash System

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1. Introd

Commerce on t
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Bitcoin v0.1 released

Satoshi Nakamoto | Fri, 09 Jan 2009 17:05:49 -0800

```
Announcing the first release of Bitcoin, a new electronic cash
system that uses a peer-to-peer network to prevent double-spending.
It's completely decentralized with no server or central authority.

See bitcoin.org for screenshots.

Download link:
http://downloads.sourceforge.net/bitcoin/bitcoin-0.1.0.rar

Windows only for now.  Open source C++ code is included.

- Unpack the files into a directory
- Run BITCOIN.EXE
- It automatically connects to other nodes

If you can keep a node running that accepts incoming connections,
you'll really be helping the network a lot.  Port 8333 on your
firewall needs to be open to receive incoming connections.
```

Bitcoin

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Bitcoin: A Peer-to-Peer Electronic Cash System

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See bitcoin.o

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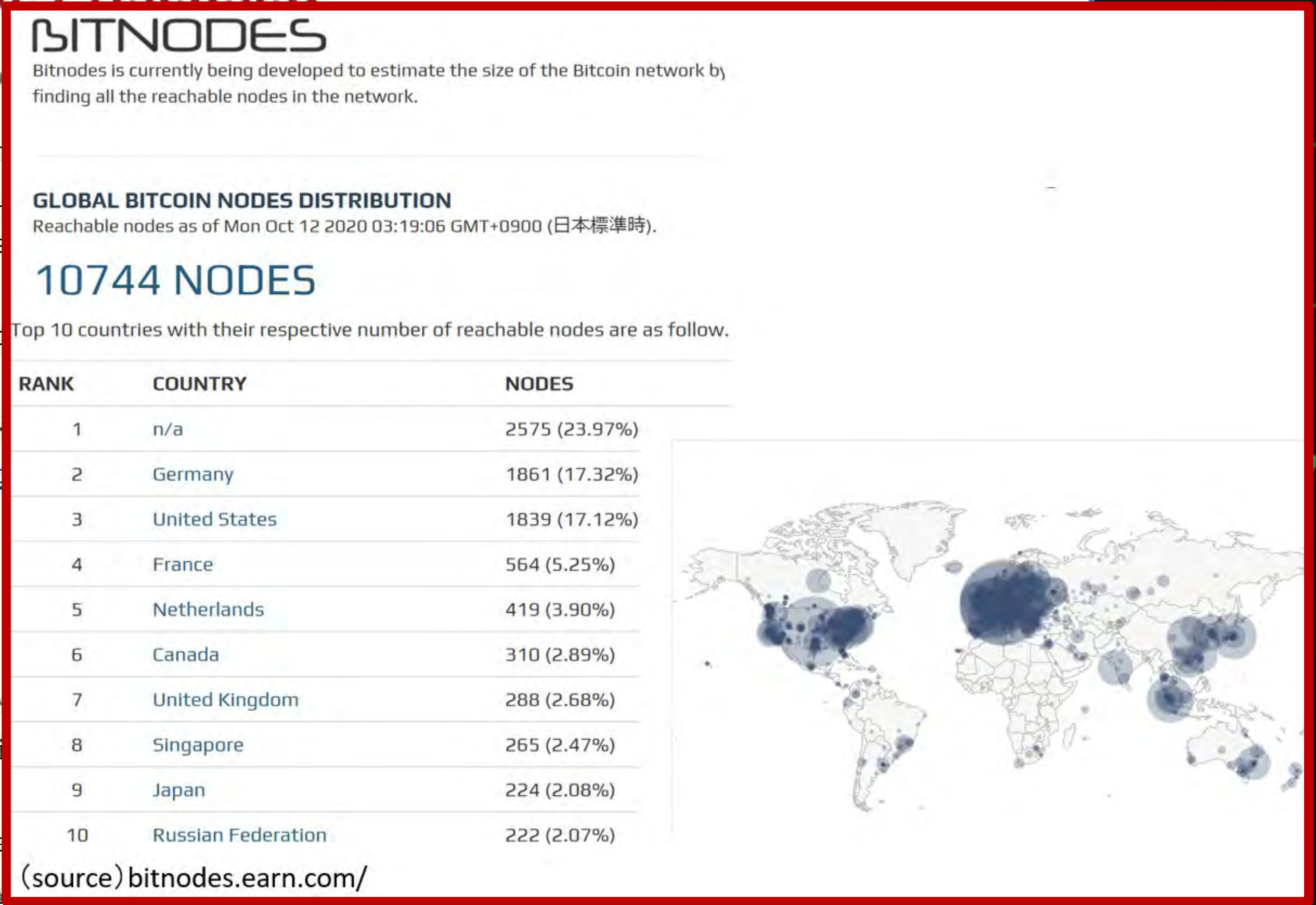


BITNODES

Bitnodes is currently being developed to estimate the size of the Bitcoin network by finding all the reachable nodes in the network.

GLOBAL BITCOIN NODES DISTRIBUTION

Reachable nodes as of Mon Oct 12 2020 03:19:06 GMT+0900 (日本標準時).

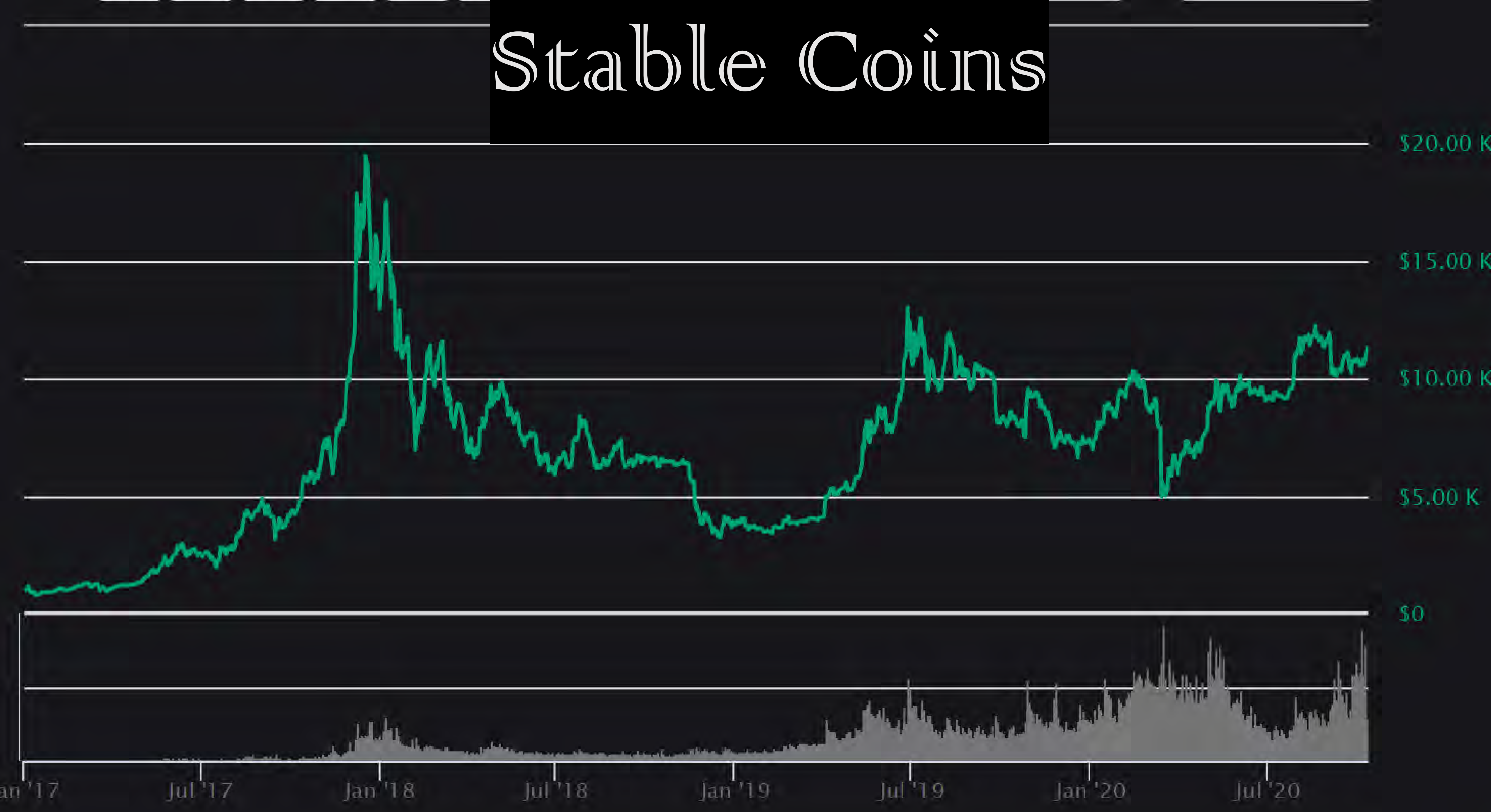
10744 NODES

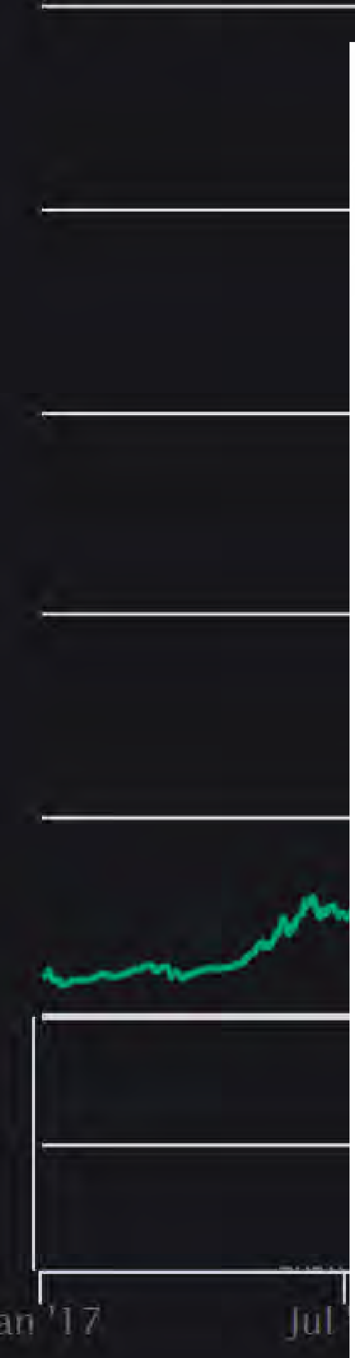
Top 10 countries with their respective number of reachable nodes are as follow.

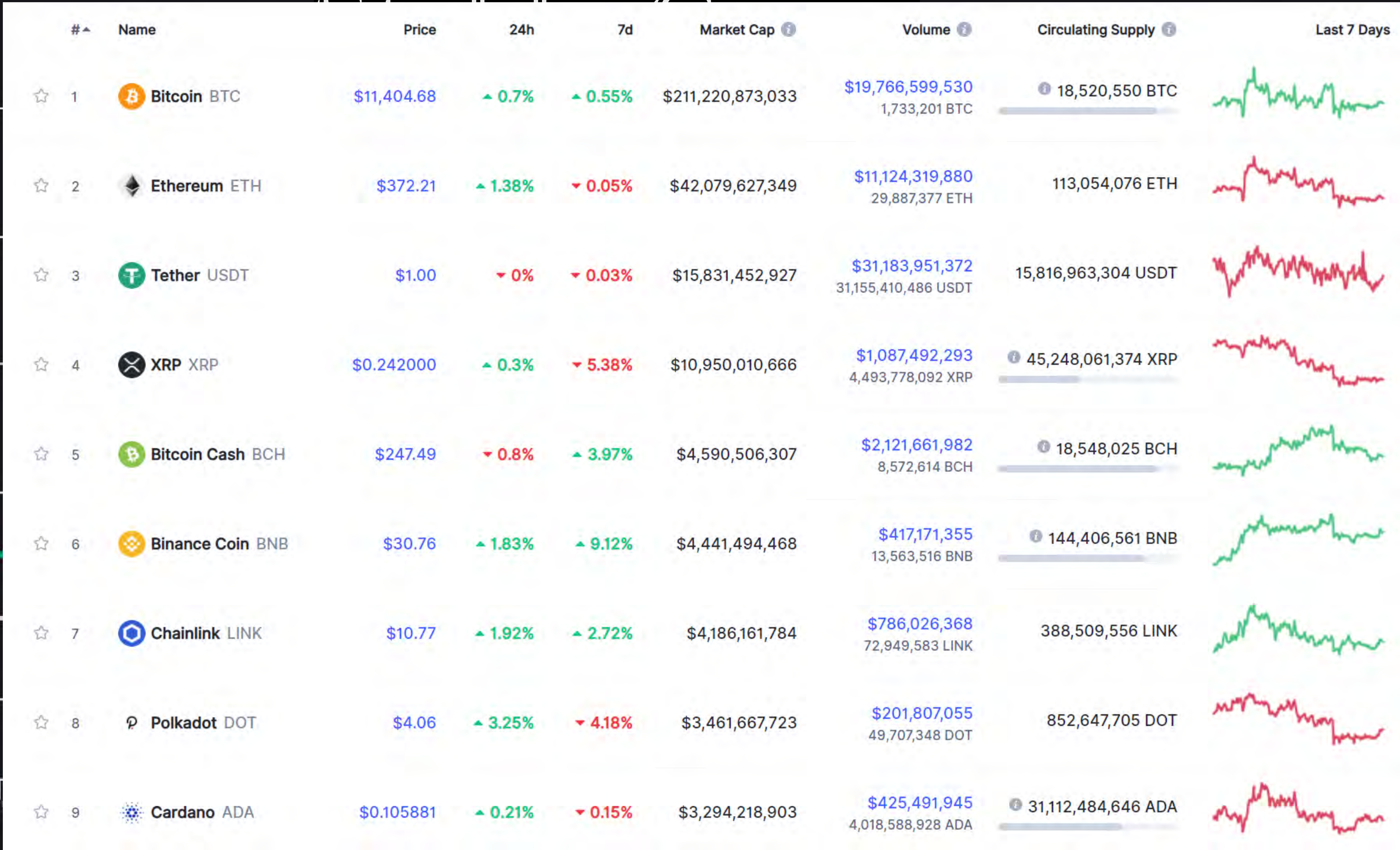
RANK	COUNTRY	NODES
1	n/a	2575 (23.97%)
2	Germany	1861 (17.32%)
3	United States	1839 (17.12%)
4	France	564 (5.25%)
5	Netherlands	419 (3.90%)
6	Canada	310 (2.89%)
7	United Kingdom	288 (2.68%)
8	Singapore	265 (2.47%)
9	Japan	224 (2.08%)
10	Russian Federation	222 (2.07%)

(source) bitnodes.earn.com/

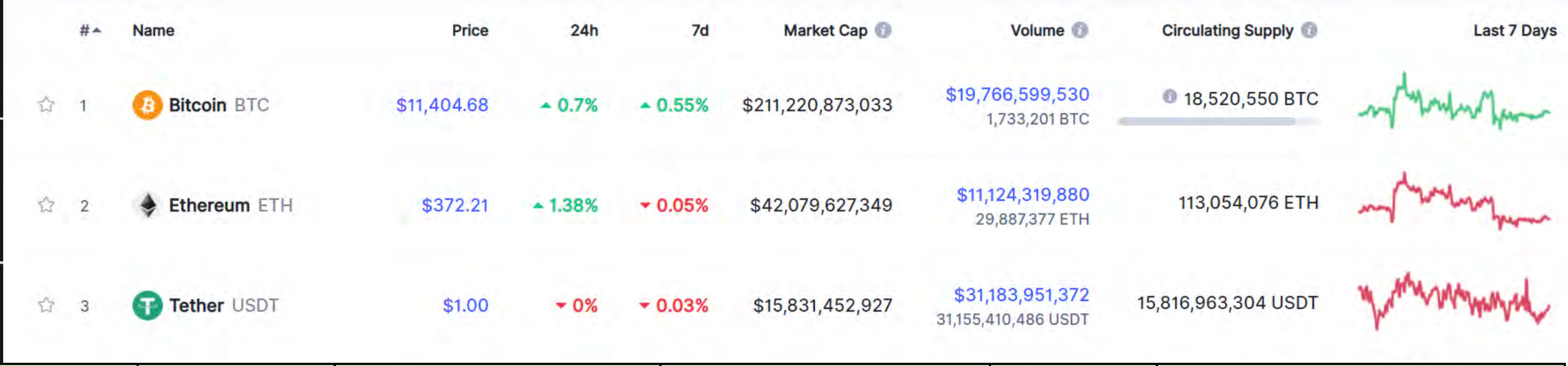
Stable Coins







	# ▲	Name	Price	24h	7d	Market Cap	Volume	Circulating Supply	Last 7 Days
☆	1	Bitcoin BTC	$11,404.68	▲ 0.7%	▲ 0.55%	$211,220,873,033	$19,766,599,530 1,733,201 BTC	18,520,550 BTC	
☆	2	Ethereum ETH	$372.21	▲ 1.38%	▼ 0.05%	$42,079,627,349	$11,124,319,880 29,887,377 ETH	113,054,076 ETH	
☆	3	Tether USDT	$1.00	▼ 0%	▼ 0.03%	$15,831,452,927	$31,183,951,372 31,155,410,486 USDT	15,816,963,304 USDT	
☆	4	XRP XRP	$0.242000	▲ 0.3%	▼ 5.38%	$10,950,010,666	$1,087,492,293 4,493,778,092 XRP	45,248,061,374 XRP	
☆	5	Bitcoin Cash BCH	$247.49	▼ 0.8%	▲ 3.97%	$4,590,506,307	$2,121,661,982 8,572,614 BCH	18,548,025 BCH	
☆	6	Binance Coin BNB	$30.76	▲ 1.83%	▲ 9.12%	$4,441,494,468	$417,171,355 13,563,516 BNB	144,406,561 BNB	
☆	7	Chainlink LINK	$10.77	▲ 1.92%	▲ 2.72%	$4,186,161,784	$786,026,368 72,949,583 LINK	388,509,556 LINK	
☆	8	Polkadot DOT	$4.06	▲ 3.25%	▼ 4.18%	$3,461,667,723	$201,807,055 49,707,348 DOT	852,647,705 DOT	
☆	9	Cardano ADA	$0.105881	▲ 0.21%	▼ 0.15%	$3,294,218,903	$425,491,945 4,018,588,928 ADA	31,112,484,646 ADA	



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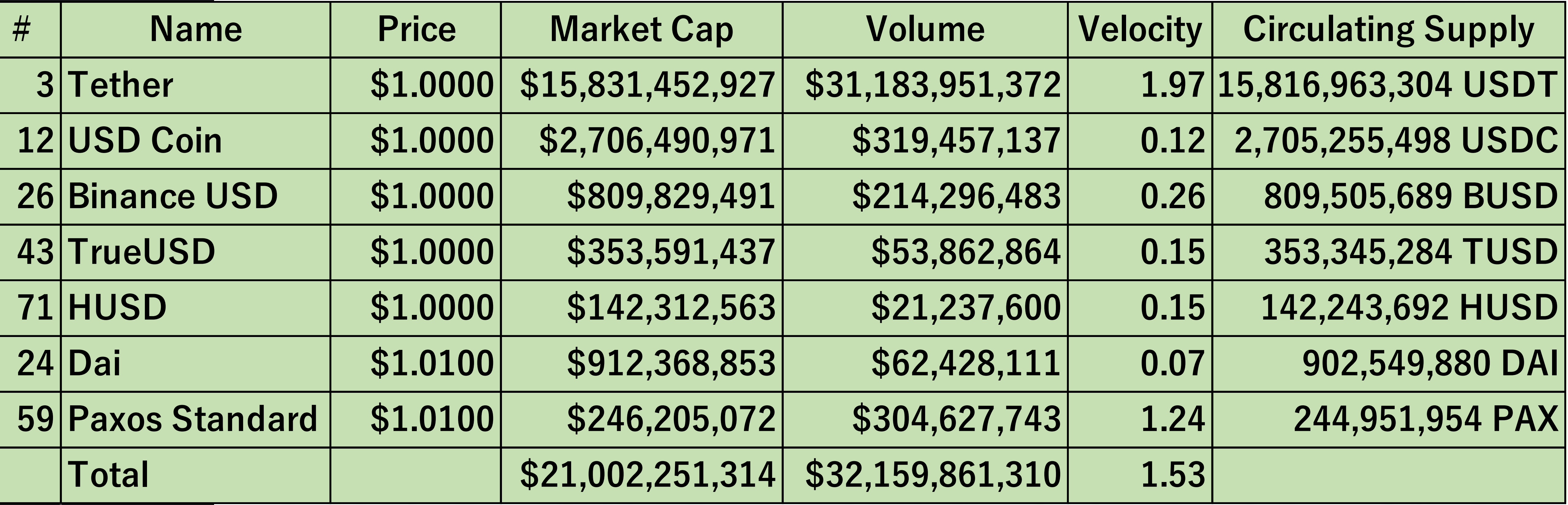
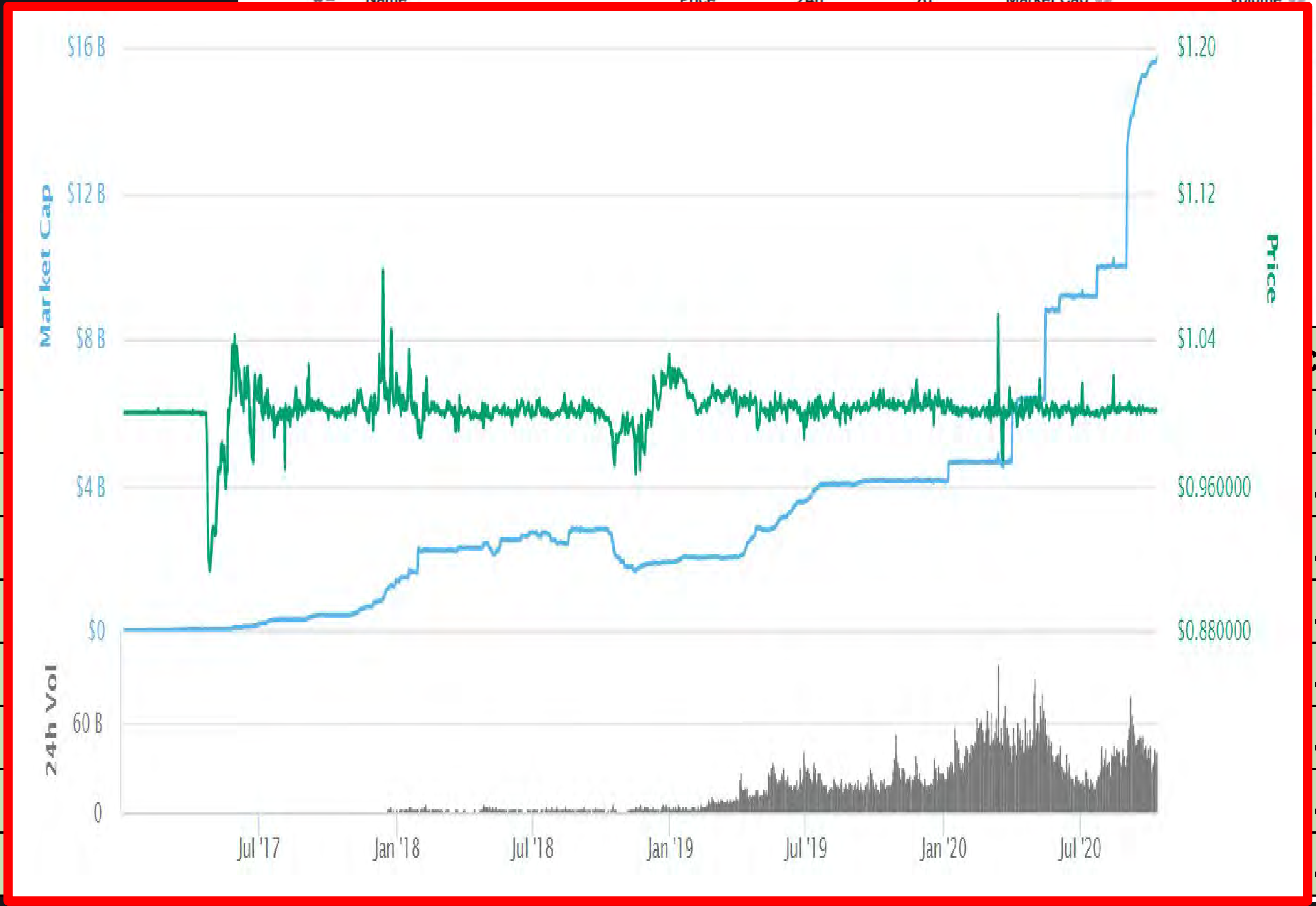
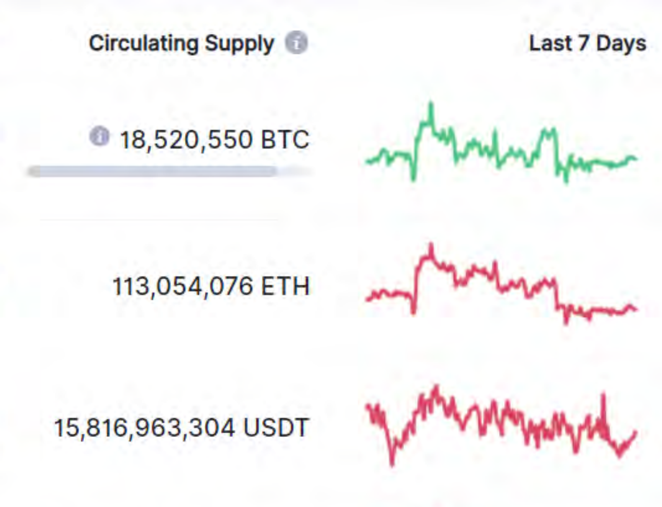


#	Name	Price	Market Cap	Volume	Velocity	Circulating Supply
3	Tether	$1.0000	$15,831,452,927	$31,183,951,372	1.97	15,816,963,304 USDT
12	USD Coin	$1.0000	$2,706,490,971	$319,457,137	0.12	2,705,255,498 USDC
26	Binance USD	$1.0000	$809,829,491	$214,296,483	0.26	809,505,689 BUSD
43	TrueUSD	$1.0000	$353,591,437	$53,862,864	0.15	353,345,284 TUSD
71	HUSD	$1.0000	$142,312,563	$21,237,600	0.15	142,243,692 HUSD
24	Dai	$1.0100	$912,368,853	$62,428,111	0.07	902,549,880 DAI
59	Paxos Standard	$1.0100	$246,205,072	$304,627,743	1.24	244,951,954 PAX
	Total		$21,002,251,314	$32,159,861,310	1.53	





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.97	15,816,963,304 USDT
.12	2,705,255,498 USDC
.26	809,505,689 BUSD
.15	353,345,284 TUSD
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