



Blockchain Landscape

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Chair, IEEE Blockchain Technical Community

Member, Board of Governors, IEEE Standards Association

Feb 2, 2024

IEEE Pune Blockchain Forum



IEEE Blockchain Technical Community (BCTC)

The objective of the IEEE Blockchain Technical Community is to serve as a collaboration hub to facilitate and lead educational, technical, and standards development across the multi-disciplinary communities interested in blockchain, distributed ledgers, and related technologies.

<https://blockchain.ieee.org/>

A screenshot of the IEEE Blockchain Technical Community website. The header features the IEEE Blockchain logo and a navigation menu with items like Home, About, What's New, Communities, Events, Education, Podcasts, Publications, Tech Briefs, Standards, and Verticals. A search bar is present. A red box highlights the social media icons (Google+, Facebook, Twitter, LinkedIn) and the 'Join the IEEE Blockchain Technical Community' button. The main banner reads 'IEEE BLOCKCHAIN TECH BRIEFS' with a call to action 'Check out the latest issue now' and an image of a hand holding a tablet displaying a tech brief. Below the banner are sections for 'What's New', 'Feature Article', 'Technology Spotlight', and 'Useful Links'. The 'Feature Article' section highlights the 'IEEE BLOCKCHAIN TECH BRIEFS Q4-2022 Issue Now Available'. The 'Useful Links' section includes 'IEEE Blockchain Courses', 'IEEE Future Directions Blog', and a 'Collabratec' sign-in button.

IEEE BLOCKCHAIN™

We welcome you to join our community

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IEEE BLOCKCHAIN TECH BRIEFS

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Collabratec Sign in now

Get Involved

IEEE

IEEE Blockchain Technical Community (BCTC)

Jan 2018-Dec 2022: IEEE Blockchain Initiative (under the Future Directions Committee)

Jan 2023-Present: IEEE Blockchain Technical Community (Sponsored by 10 participating OUs)

Participating OUs



Activity Partners



IEEE Member and Geographic Activities (MGA)

IEEE Educational Activities



IEEE Blockchain Technical Community: Highlights

Community

Regional Local Groups: 60 and growing

Collabratec & Social Media: 13,000 participants (across all platforms)

Conferences/Events

2018: 1st IEEE Global Blockchain Summit, NIST, Gaithersburg, MD, USA, Sept 17-19, 2018.

2019: 2nd IEEE Global Blockchain Summit, NIST, Gaithersburg, MD, USA, Sept 16-19, 2019.

2020: IEEE Blockchain Transactive Energy Summit, Boulder, Colorado, Feb 3-4, 2020.

2020-2021: IEEE Healthcare: Blockchain & AI Virtual Series (12 Events)

2021: IEEE Blockchain Regional Virtual Series (3 Events)

2022: IEEE SmartBlock4EU – Energy & Health, Bucharest, Romania, Oct 24-25, 2022 (Hybrid)

2022: IEEE GET Blockchain Forum, Nov 7-11, 2022 (Virtual)

Educational Content

eLearning Modules (10)

Podcasts: 17 Episodes (Available on Apple Podcasts, Google Podcasts, and Spotify)

Technical Briefs: 2018-2023 (13 issues)

Standards Projects

Published Standards: 13

Blockchain Transactive Energy (BCTE)

Position Paper (Published in 2020)

POCs: 5 in 2021, 10 in 2022

IEEE Blockchain Local Groups

Local Groups form a global network of professionals interested in networking, collaborating, learning, sharing, and advancing technology.

REGION 1-7

USA and Canada

IEEE Austin Blockchain Group*
IEEE Boston Blockchain Group
IEEE Cleveland Blockchain Group
IEEE Dallas Blockchain Group
IEEE Denver Blockchain Group
IEEE Florida West Coast Section Blockchain Group*
IEEE Houston Blockchain Group*
IEEE Kitchener-Waterloo Blockchain Group*
IEEE Coastal Los Angeles Blockchain Group
IEEE Memphis Blockchain Group
IEEE New York Blockchain Group
IEEE Orlando Blockchain Group
IEEE San Diego Blockchain Group
IEEE Seattle Blockchain Group
IEEE Silicon Valley Blockchain Group*
IEEE Toronto Blockchain Group*

REGION 9

Latin America and Caribbean

IEEE North-Central Brazil Blockchain Group
IEEE Colombia Blockchain Group*
IEEE Colombian Caribbean Blockchain Group*
IEEE Puerto Rico & Caribbean Blockchain Group
IEEE Western Puerto Rico Blockchain Group

REGION 8

Europe

IEEE Benelux Blockchain Group
IEEE Estonia Blockchain Group
IEEE Finland Blockchain Group*
IEEE France Blockchain Group
IEEE Italy Blockchain Group
IEEE Latvia Blockchain Group
IEEE Luxembourg Blockchain Group
IEEE Portugal Blockchain Group
IEEE Romania Blockchain Group*
IEEE Spain Blockchain Group*
IEEE Switzerland Decentralised Systems Working Group
IEEE Ukraine Blockchain Group
IEEE UK & Ireland Blockchain Group

Middle East

IEEE Egypt Blockchain Group
IEEE Iraq Blockchain Group
IEEE Israel Blockchain Group
IEEE Kuwait Blockchain Group
IEEE Oman Blockchain Group*
IEEE Qatar Blockchain Group
IEEE Turkey Blockchain Group
IEEE UAE Blockchain Group

Africa

IEEE Ghana Blockchain Group
IEEE Morocco Blockchain Group
IEEE Nigeria Blockchain Group
IEEE Tunisia Blockchain Group

REGION 10

Asia-Pacific

IEEE Bangalore Blockchain Group
IEEE Beijing Blockchain Group
IEEE Chennai Blockchain Group*
IEEE Delhi Blockchain Group*
IEEE Gujarat Blockchain Group
IEEE Hangzhou Blockchain Group
IEEE Hong Kong Blockchain Group*
IEEE Indonesia Blockchain Group
IEEE Japan Blockchain Group
IEEE Macau/Guangzhou Blockchain Group
IEEE Malaysia Blockchain Group
IEEE Pune Blockchain Group*
IEEE Shanghai Blockchain Group
IEEE Shenzhen Blockchain Group
IEEE Singapore Blockchain Group
IEEE South Korea Blockchain Group
IEEE Taipei Blockchain Group*
IEEE Thailand Blockchain Group*
IEEE Victorian Blockchain Group

See: <https://blockchain.ieee.org/communities>

2023 Events

- ❑ Aug 13, 2023 | Toronto | IEEE Canada Blockchain Forum
- ❑ Sep 7, 2023 | Shanghai | IEEE Blockchain Conference - China Preparatory Meeting
- ❑ Sep 8-9, 2023 | Bengaluru | IEEE India Blockchain Forum
- ❑ Sep 20, 2023 | Seoul | IEEE Distributed Ledger Technology Standardization Forum (DLTSF)
- ❑ Sep 29, 2023 | San Jose | IEEE Metaverse, AI & Blockchain Workshop
- ❑ Oct 3, 2023 | Tokyo | IEEE Japan Blockchain & Metaverse
- ❑ Oct 27-29, 2023 | Kyiv | IEEE First Ukrainian Distributed Ledger Technology Forum (UADLTF) - virtual
- ❑ Nov 11, 2023 | Taipei | IEEE Taiwan Blockchain Forum
- ❑ Dec 18, 2023 | York | IEEE Workshop on Blockchain & Energy
- ❑ Dec 18-20, 2023 | Tunisia | IEEE Africa Blockchain Community Development at 11th IEEE Tunisian Students & Young Professionals Congress

IEEE Blockchain Standards & Projects

<https://blockchain.ieee.org/standards>

Published Standards: 13

2140.1-2020 - IEEE Standard for General Requirements for Cryptocurrency Exchanges

2140.2-2021 - IEEE Standard for Security Management for Customer Cryptographic Assets on Cryptocurrency Exchanges

2140.4-2023 - IEEE Standard for Distributed/Decentralized Exchange Framework Using Distributed Ledger Technology (DLT)

2140.5-2020 - IEEE Standard for a Custodian Framework of Cryptocurrency

2142.1-2021 - IEEE Recommended Practice for E-Invoice Business Using Blockchain Technology

2143.1-2020 - IEEE Standard for General Process of Cryptocurrency Payment

2144.1-2020 - IEEE Standard for Framework of Blockchain-based Internet of Things (IoT) Data Management

2146.1-2022 - IEEE Approved Draft Standard for Entity-Based Risk Mutual Assistance Model through Blockchain Technology

2418.2-2020 - IEEE Standard Data Format for Blockchain Systems

2418.7-2021 - IEEE Standard for the Use of Blockchain in Supply Chain Finance

2418.10-2022 - IEEE Standard for Blockchain based Digital Asset Management

3205-2023 - IEEE Standard for Blockchain Interoperability Data Authentication and Communication Protocol

3801-2022 - IEEE Standard for Blockchain-based Electronic Contracts

Industry Connections: 5

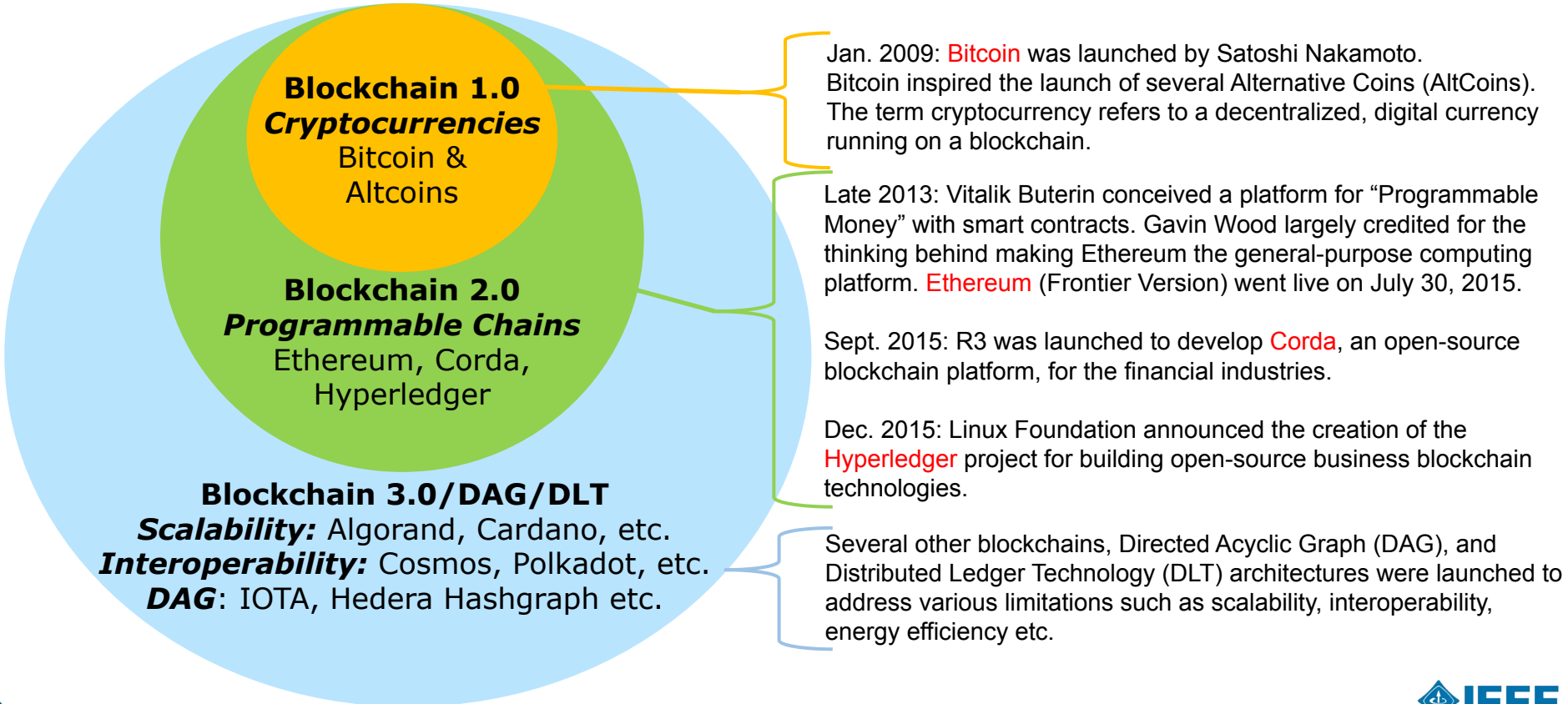
Working Groups: 40

Outline

- Introduction
 - Bitcoin/Blockchain Evolution
 - Blockchain vs DAG vs DLT
 - Classification
 - Architecture
 - Fundamentals

- Use Case
 - Public Blockchains
 - Enterprise
 - Government

Bitcoin -> Blockchain Evolution



⁹ Blockchain 1.0 & 2.0 inspired by Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, 2015.

Technology Innovations

Web3

Metaverse

Games (P2E)

CBDC

NFT

DeFi

DAO

Ethereum & other chains

Stablecoins

BitCoin & AltCoins



2009 2015 2016 2017 2018 2019 2020 2021 2022 2023

(Not to Scale)

DAO: Decentralized Autonomous Organization CBDC: Central Bank Digital Currency
NFT: Non-Fungible Token
DeFi: Decentralized Finance

Distributed Ledger Technology (DLT)

Computer Network

Sub-field

Distributed Computer Network

Database

Distributed Ledger Technology (DLT)

Types

Blockchain

DAG

A computer network refers to interconnected computing devices (nodes) that can exchange data and share resources with each other. These networked devices use a system of rules, called communications protocols, to transmit information over physical or wireless technologies.

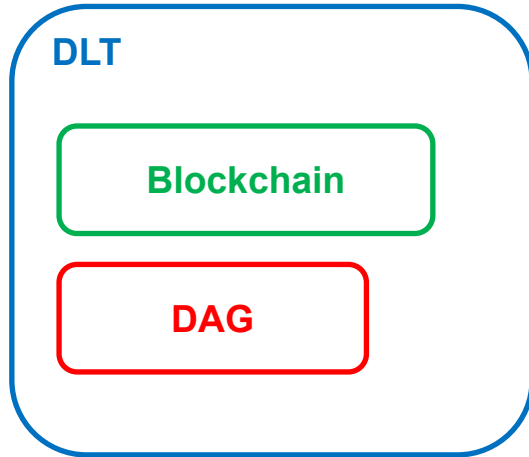
A distributed computer network (or a distributed system) is a collection of autonomous computing nodes that appears to its users as a single coherent system.

Distributed Ledger Technology (DLT) refers to a broad category of distributed database architectures that are shared among multiple participants, and updateable through a consensus mechanism.

Blockchain consists of a chain of blocks, where each block consists of a batch of transactions.

A **Directed Acyclic Graph (DAG)** is an interconnected structure that consist of vertices and directed edges that never form a directed cycle.

Distributed Ledger Technology (DLT)



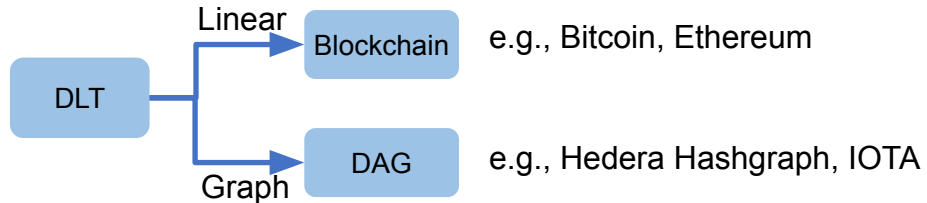
Distributed Ledger Technology (DLT) refers to a broad category of

- distributed database*** architectures
- shared among ***multiple participants***, and
- updateable through a ***consensus mechanism***.

Blockchain and Directed Acyclic Graph (DAGs) are specific types of DLT architectures.

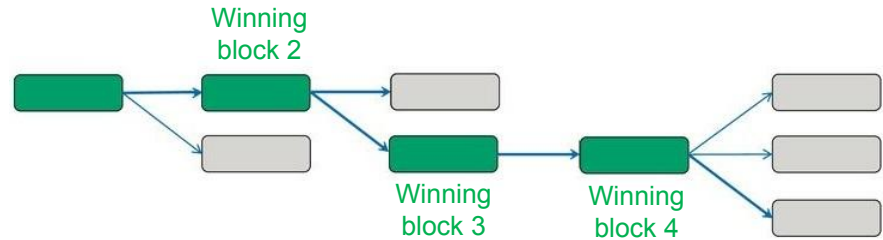
Blockchain vs DAG

Blockchain consists of a chain of blocks, where each block consists of a batch of transactions. The longest chain becomes the valid chain.

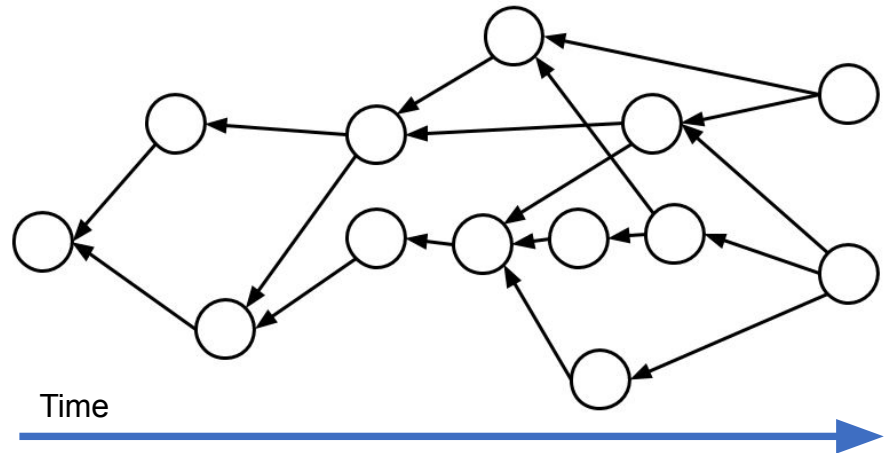


A Directed Acyclic Graph (DAG) is an interconnected structure that consist of vertices and directed edges that never form a directed cycle.

Blockchain (Linear Data Structure)

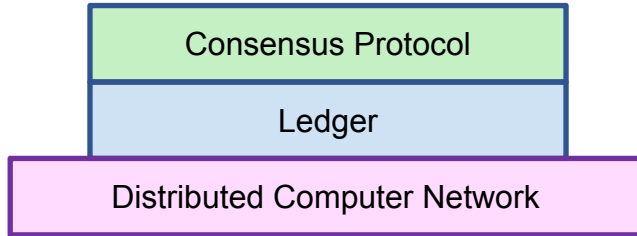


DAG (Graph Data Structure)



Blockchain/DLT Architecture

Blockchain/DLT Architecture

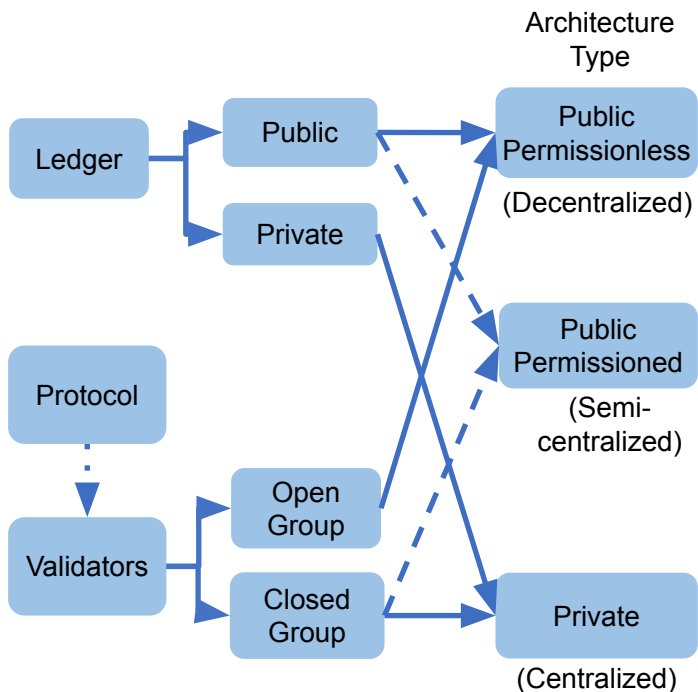


The consensus protocol defines the rules and parameters by which transactions are processed/approved by the validators in the network.

The ledger represents the conceptual layer where transactions are stored in the network.

A distributed computer network is a collection of autonomous computers (nodes) that appears to its users as a single coherent computer.

General Classification - Blockchain & DLT



Public-Permissionless Type: The ledger is visible to the public, and anyone can join the network. Also, the validators (Open Group) can be anyone on the network. These are fully decentralized architectures.

Public-Permissioned Type: The ledger is visible to the public. However, the validators (Closed Group) are selected by a governing body or a consensus algorithm. Typically, these are semi-centralized architectures.

Private Type: The ledger is private (visible to members only). The validators (Closed Group) are selected by a governing body. These are centralized architectures.

B) Consensus Algorithms

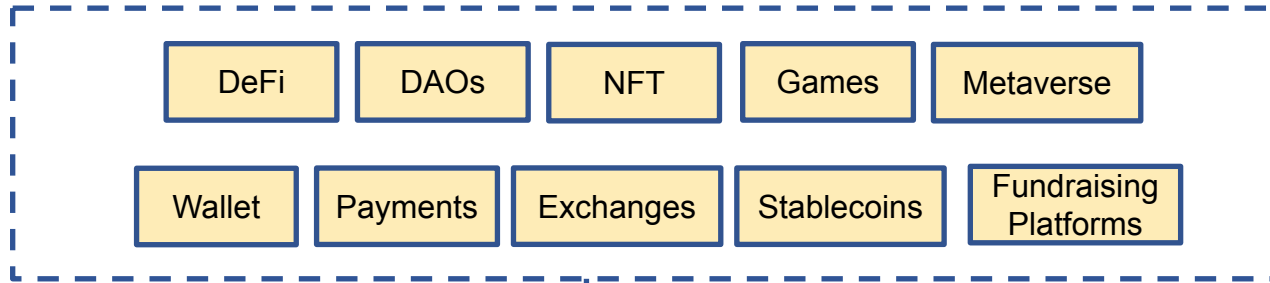
Consensus Algorithm (or Protocol): a set of rules and procedures by which agreement is reached about the inclusion of new blocks to the ledger.

Consensus Protocol	Description	Examples
Proof-of-Work (PoW)	The 'miners' compete to solve a computationally intensive problem/puzzle to verify the new block.	Bitcoin, Litecoin, Ethereum 1.0 (PoW),
Proof-of-Stake (PoS)	The validators stake their tokens to "bet" on which blocks are valid.	Algorand, Cardano, Ethereum 2.0 (PoS)
Delegated PoS	A group of elected delegates validate blocks on behalf of all nodes in the network.	EOS, Steemit, LISK
Proof-of-Authority (PoA)	The validators use the reputation associated with their identity.	VeChain, POA Network
Practical Byzantine Fault Tolerance (PBFT)	The validators are pre-selected. More than two-thirds of the total number of nodes on the network should be honest.	Hyperledger Fabric, Ripple, Stellar

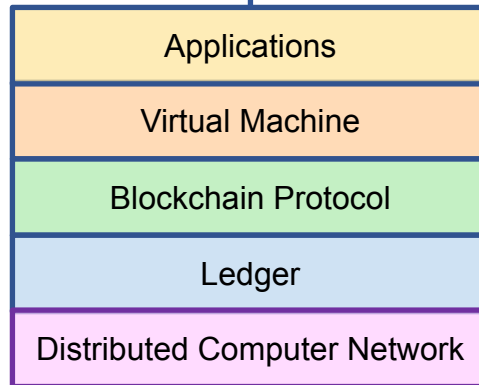
Outline

- Fundamentals
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 - Distributed Ledger Technology
 - Blockchain vs DAG vs DLT
- Use Cases
 - Public Blockchains
 - Enterprise
 - Government

Public Blockchain: Infrastructure Projects & Applications



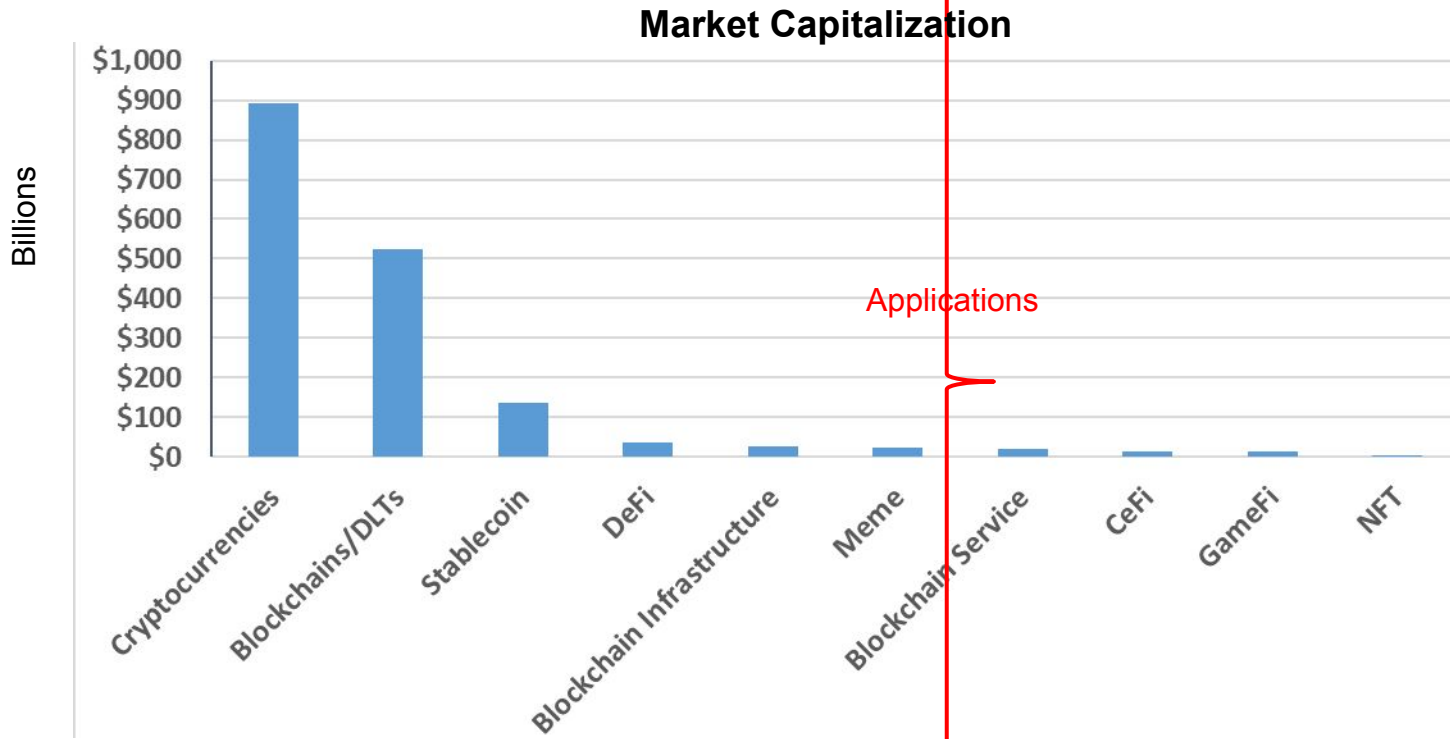
Applications



Infrastructure Projects



Public Blockchain Projects: Category





IEEE potentials

THE MAGAZINE FOR HIGH-TECH INNOVATORS

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Blockchain Technology

Societal Impacts, Education, and Research

In this issue

- Blockchain overview
- SoIsec virtual labs
- UBRI: Education & research
- Scaling up public networks
- Smart ports, many technologies
- Lightweight cryptography



Blockchain Technology



Blockchain technology:

An overview

Ramesh Ramadoss



In 2009, Bitcoin was launched as peer-to-peer electronic cash. Bitcoin inspired the launch of several other cryptocurrencies. Bitcoin set the stage for a new field called *blockchain*, which is a special case of distributed ledger technology (DLT). In 2015, programmable blockchain/DLT projects, such as Ethereum, Hyperledger Fabric, and I3 Corda, were launched. Over the last decade, blockchain/DLT has evolved to encompass a collection of distributed computer net-

work architectures implementing various data structures, decentralized consensus protocols, and economic incentive models. In this rapidly emerging field, some remarkable innovations, experimentations, and developments have been carried out by start-ups, enterprises, and governments. This article will highlight various current and future applications of this technology.

Types of blockchain/DLT

DLT refers to a broad category of distributed database architectures that are shared among multiple participants and updateable through a con-

sensus mechanism. As shown in Fig. 1, blockchain and directed acyclic graphs (DAGs) are special cases of DLT. Blockchain is a linear-type data structure that consists of a chain of blocks, where each block consists of a batch of transactions. The longest chain becomes the valid chain. Blockchain examples include Bitcoin, Ethereum, etc. A DAG is a mathematically interconnected structure that consist of vertices and directed edges that never form a directed cycle. In the case of BlockDAG, the vertices often represent blocks, and the edges represent "parent-child" references between the blocks (e.g., Hedera

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Enterprise Blockchain: Players & Use Cases

81 of top 100 companies use blockchain technology!



Source: Forbes

WWW.BLOCKDATA.TECH | INFO@BLOCKDATA.TECH

(Source: Blockdata)

Government Projects/Initiatives

European Union



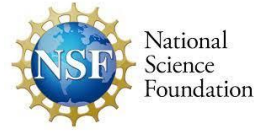
India



China



United States



Dubai



Hong Kong

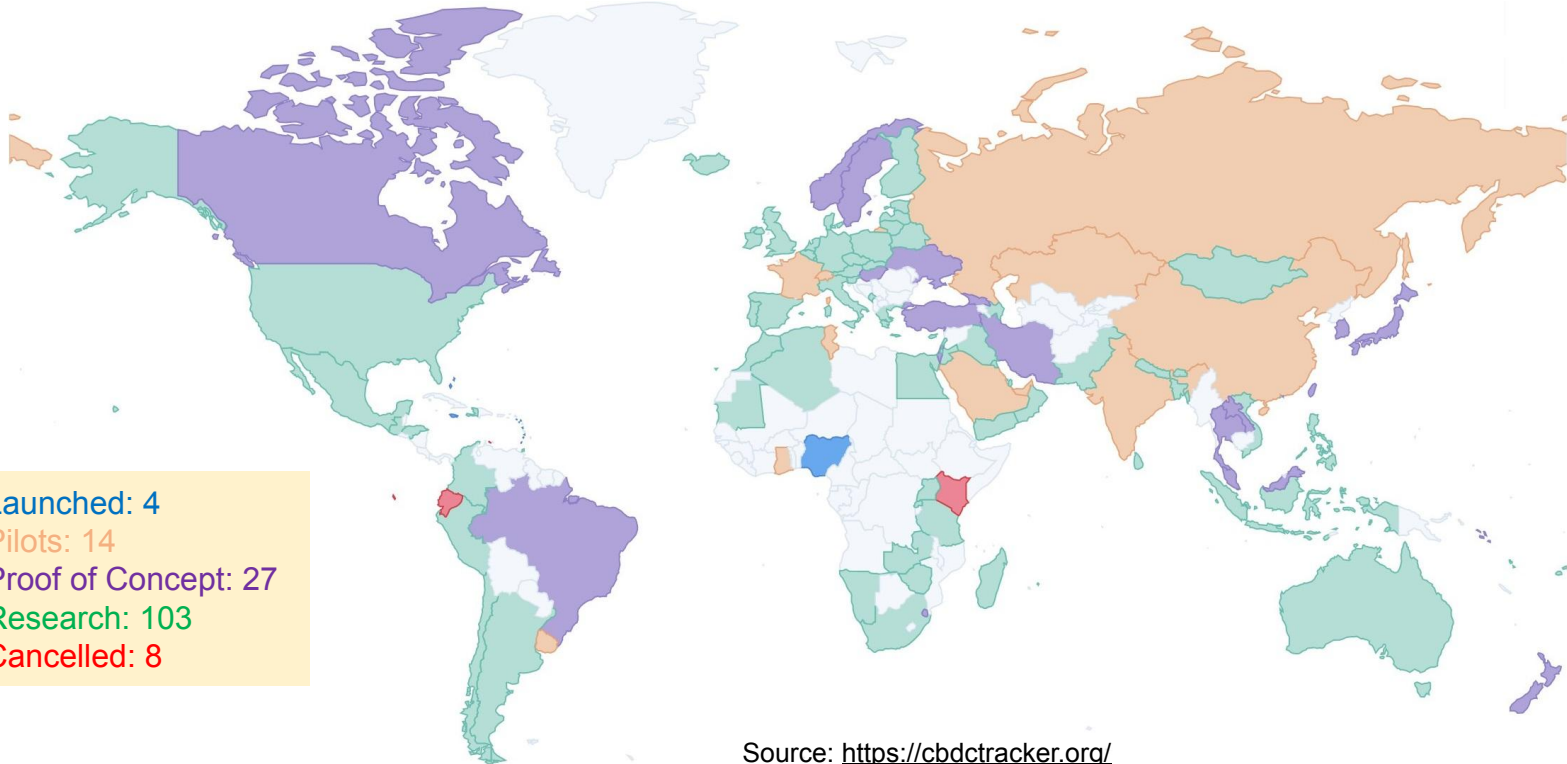


Japan



Central Bank Digital Currencies (CBDCs): Global Trend

CBDC is a digital currency issued by Central Banks on private blockchains/DLT. It will serve as the new digital medium of exchange, settlement, and payment verification.



Thank You!

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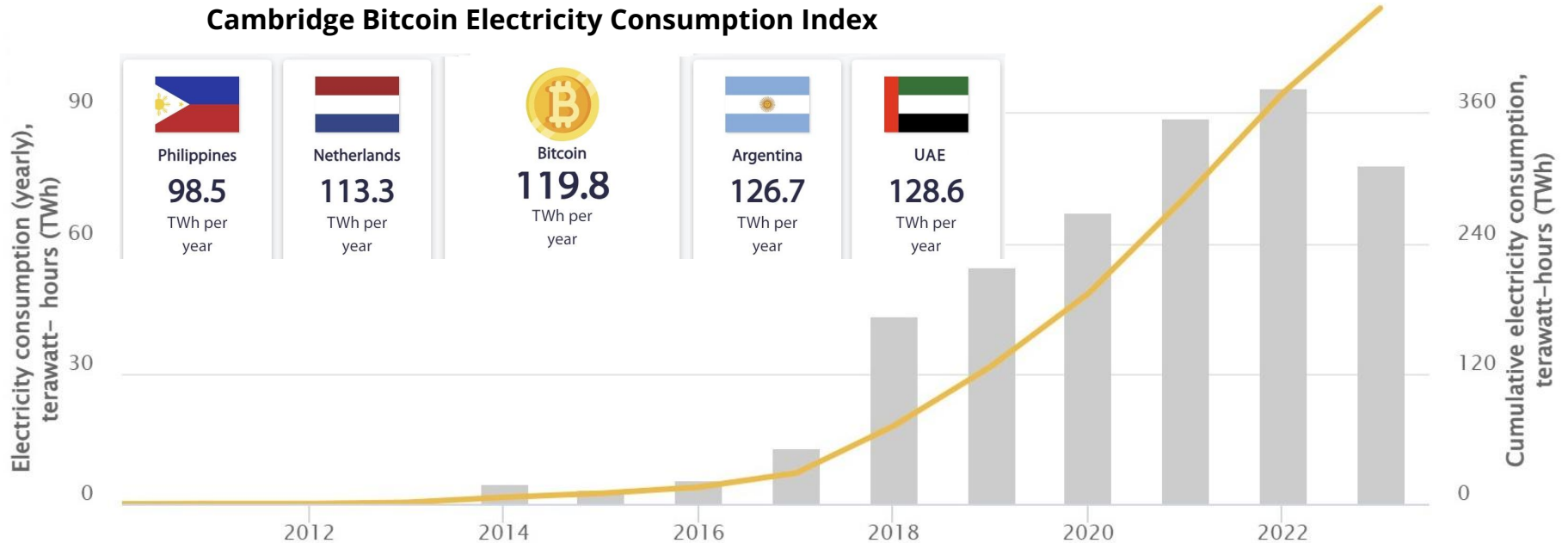
<https://blockchain.ieee.org/>



Bitcoin Energy Consumption: Proof-of-Work Computation

The annual energy consumption of bitcoin has exceeded that of some countries.

Cambridge Bitcoin Electricity Consumption Index

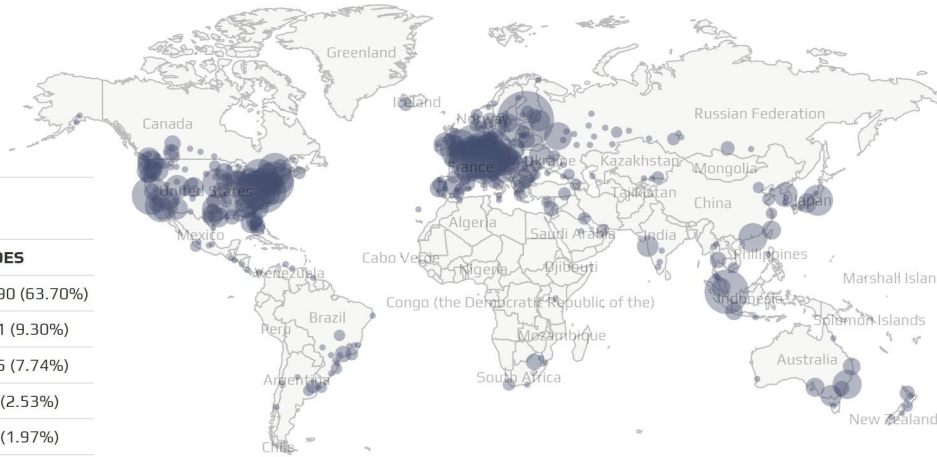


<https://ccaf.io/cbeci/index>

Bitcoin: Mining Pools (Centralization)

Mining pools (**centralized computing warehouses**) located in parts of the world with low-cost electricity have emerged as new businesses.

Bitcoin Node Distribution (As of 11/6/23)



16467 NODES

RANK	COUNTRY	NODES
1	n/a	10490 (63.70%)
2	United States	1531 (9.30%)
3	Germany	1275 (7.74%)
4	France	417 (2.53%)
5	Netherlands	324 (1.97%)
6	Canada	256 (1.55%)
7	Finland	237 (1.44%)
8	Russian Federation	170 (1.03%)
9	United Kingdom	164 (1.00%)
10	Singapore	141 (0.86%)

Source: <https://bitnodes.io>

Bitmain Mining Warehouse



Mining Pools (30 days)

