GBBC
Global Blockchain Business Council

INSIGHT REPORT

GLOBAL STANDARDS MAPPING INITIATIVE 2.0

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GLOBAL BLOCKCHAIN BUSINESS COUNCIL

DC Location:
1629 K St. NW, Suite 300
Washington, DC 20006

Geneva Location:
20 Rue de-Candolle
1205 Geneva

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SECTION I

INTRODUCTION TO GSMI 2.0

The Global Standards Mapping Initiative (GSMI) is an industry-led effort to map and assess the blockchain and digital asset landscape across five key areas:

1) legislation and regulatory guidance
2) technical standards
3) industry standards and recommendations
4) university courses and degree programs
5) industry consortia.

GSMI reports and resources are open access and intended to serve as a baseline for the establishment of thoughtful and workable frameworks and standards to enable adoption and innovation. The Global Blockchain Business Council (GBBC) and partners released version 1.0 of the GSMI in October 2020 as an interactive map of regulation and guidance across 185 jurisdictions, a legal and regulatory report, and a technical report cataloguing outputs from more than 304 technical standard-setting entities.

In response to key insights and feedback from the initial release, the GBBC has partnered with 130 leading institutions to release GSMI 2.0, an expansion and continuation of GSMI 1.0.

GSMI 2.0 was spearheaded by nine working groups, each focused on a topic of critical importance to the continued advancement of the blockchain and digital asset ecosystem, such as taxonomy, taxation, and derivatives.

This report is dedicated to the findings, key insights, and action-oriented guidance proposed by each of the working groups. GSMI 2.0 also includes a comprehensive update of the blockchain and digital asset regulations contained in the interactive map, a catalogue of accredited academic institutions offering blockchain courses and degrees, and an update to the outputs of 38 technical standards.

GSMI resources and reports are referenced and utilized by corporations, regulators, government agencies, and academics globally who seek a holistic view of the blockchain and digital asset landscape. GBBC collaborated with seven academic institutions to launch the GSMI Fellows Program, an eight-month fellowship for exceptional students to contribute to GSMI 2.0 research and analysis.

This report and the accompanying GSMI 2.0 resources are made possible by the contributions of our partners, fellows, and GBBC staff. GSMI 2.0 is intended to serve as a comprehensive resource for stakeholders in the blockchain and digital asset space.

We welcome feedback and additional contributions as we build upon this release and continue to update the datasets, particularly the interactive map and university program list.

We would like to thank our many partners, members, and supporters who worked tirelessly and enthusiastically over the past months to produce GSMI 2021, version 2.0.

Thank you to our team of contributors representing over 131 organizations:

- Accenture
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- African Tax Administration Forum (ATAF)
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- Blockchain & Law
- Blockchain Labs, Inc.
- Blockchain Technology Partners (BTP)
- Blok Solutions
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- Centers for Medicare & Medicaid Services (CMS), Department of Health & Human Services (HHS)
- Central Bank of Seychelles
- Caribbean Blockchain Alliance
- Circulor
- Cloud Compass Computing
- Commonwealth Association of Tax Administrators
- ConsenSys
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- Estonian Tax and Customs Board
- European Partners for Environment (EPE)
- Evertas
- Filecoin Foundation for the Decentralized Web
- FTSE Russell
- Genesis Global Trading
- Global Digital Finance (GDF)
- Government of Bahamas, Ministry of Finance
- Government of Bermuda, FinTech Business Unit (FBU)
- Government of Ontario, Canada, Ministry of Finance
- Government of Tamil Nadu, India
- GS1
- Her Majesty's Government of Gibraltar
- Her Majesty's Revenue and Customs (HMRC)
- Hut8 Mining
- Hyland Software
- Hyperledger Foundation
- IFC-Milken Institute Capital Markets Program
- Indicio.tech
- International Securities Services Association (ISSA)
- International Organization for Standardization (ISO)
- Institute for Austrian and International Tax Law, Vienna University of Economics and Business
- Institute of Electrical and Electronics Engineers (IEEE)
- International Telecommunication Union, United Nations (ITU-T)
- Interwork Alliance (IWA)
- IOV Labs
- JP Morgan & Chase Co.
- Kaiko
- KAIST
- Kenya Capital Markets Authority
- Kenya Revenue Authority
- Korea Blockchain Association
- Korea Blockchain Industry Promotion Association
- Korea Blockchain Startup Association
- Korea Society of Blockchain
- Latham & Watkins

- London Stock Exchange Group (LSEG)
- Lumedic
- Lykke
- Meta (f.k.a. Facebook)
- MetaMe
- Miami University, Ohio
- Milken Institute
- MIT Media Lab
- MLL Meyerlustenberger Lachenal Froriep
- Nasdaq
- Nautilus Tech
- Nigeria Securities Exchange Commission (SEC)
- nPerspective
- Ocean Elders
- Ocean Plastics Leadership Network (OPLN)
- Odyssey
- Open Blockchain and DID Association
- OpenID Foundation
- Orbs
- Portland State University (PSU)
- Power Ledger
- Proctor & Gamble (P&G)
- Protocol Labs
- QR Capital
- RecycleGo
- Reformation Group
- Rowet Capital Management
- SFS Enterprises & Advisory Services
- Shearman & Sterling
- Singapore Management University
- Sovereign Border Solutions
- SITA
- SIX Digital Exchange (SDX)
- Sky Republic
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- Sandra Ro
- Mercina Tillemann-Dick
- Paul Rapino
- Sofia Arend
- Sierra Lewis
- David Acton
- Riyad Carey
- Jackson Ross
- Brandon Pelar
- Ime Ekong
- Kefa Michael Ngoiri
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- Richard Shade (PTDL)

SECTION II

TAXONOMY INTRO

Over the last eighteen months, understanding each other has become both increasingly critical and progressively complex. As many have adapted to working, learning, and interacting remotely, the need for clear and consistent communication has been underscored. Technology has created new channels for sharing information, but it has limits. Even when common language is a denominator, achieving real understanding can feel elusive. Operating with reduced or removed unspoken tools has heightened the value and importance of the written and spoken word, underpinned by universally or generally accepted definitions.

When carefully conceived, shared language can create an invaluable foundation for understanding and progress.

Turning the potential presented by blockchain and other emerging technologies into substantive solutions that move our world in a positive direction is one of the great challenges and opportunities of our time. We have seen these tools accelerate vaccine distribution, improve the lives of refugees, change the way we create and consume art, reimagine electrical grids, facilitate corporate responsibility, and reshape efforts to combat climate change. At the core of these efforts is a shared desire to understand each other better and collaborate more seamlessly across traditional boundaries.

Innovators creating solutions to address society's toughest challenges need globally accepted standards to facilitate impactful cross-border innovation. A necessary and significant piece of this revolves around taxonomy; cooperation is frustrated when common language is not established or agreed upon.

Regulators are rarely technologists, which makes building functional regulatory frameworks for new technologies a challenge. Over the last decade, numerous blockchain taxonomies have emerged, but so far none have been universally accepted or adopted, making consistent regulations across (or within) jurisdictions difficult. Confused language remains a pain point within the industry.

This working group has taken the work of other groups focused on taxonomy and used it to inform a taxonomy that spans industries – including terms related to digital ID and the environment, which are often left out of blockchain taxonomies. The taxonomy in this report should be viewed as a work in progress.

We welcome recommendations, revisions, and additional resources that will enable us to further refine the quality and scope of this effort.

The full taxonomy is listed in Appendix A of this report.

SECTION III

DIGITAL & CRYPTO ASSETS REGULATIONS

Since GSMI 1.0, we have seen an extraordinary growth of activity and innovation across the digital asset ecosystem, including in spot and derivatives markets, decentralized finance (DeFi), Non-Fungible Tokens (NFTs), Central Bank Digital Currencies (CBDCs), and adoption by financial institutions. This has heightened regulatory and policy attention globally, bringing with it new warnings, statements, proposals, and consultations on crypto-market activity.

DCAR assessed how these regulatory developments are shaping the current global digital asset landscape across eight categories. This year, we have focused on the G20 jurisdictions, as well as 31 countries with notable approaches.

Key categories are summarized below with the full report and text available here

REGULATION OF DIGITAL ASSETS	Warnings issued to consumers, investors, and businesses concerning digital assets.
REGULATION OF ILLICIT ACTIVITY & THE TRAVEL RULE	A look at illicit activity in crypto, and which jurisdictions have implemented the FATF Recommendation 16
MARKET SURVEILLANCE	The laws and guidance in place to ensure market integrity across digital assets
CONSUMER PROTECTION	Warnings issued to consumers, investors, and businesses concerning digital assets
INNOVATION: BARRIERS VS. ENCOURAGEMENT	The barriers to innovation, the regulatory sandboxes in place, and the innovative approaches to regulating digital assets
ADOPTION: INSTITUTIONAL PARTICIPATION	Regulations on banks interacting with digital assets and digital asset businesses, as well as pilot projects in the banking sector
CENTRAL BANK DIGITAL CURRENCIES (CBDC)	The active retail and wholesale CBDC projects
TAXATION	How regulation is being developed through taxation

REGULATION OF DIGITAL ASSETS

Approaches to digital asset regulation are split between those who have brought these assets under existing legislation, some with opt-in regimes, and those who have created new frameworks designed specifically for virtual asset service providers (VASPs). As a result of fragmented and unclear approaches, industry leaders have ranked a lack of regulatory clarity as one of the top challenges that their businesses face.

On 24 September 2020, following a comprehensive consultation, the European Commission published its proposed Markets in Crypto Assets Regulation (MiCA).-[1] To date, this is the most comprehensive framework for digital assets, proposing a harmonized and mandatory regime across the entire European Economic Area (EEA) that would replace existing national frameworks and allow cryptoasset issuers and VASPs to offer their services across the Single Market.

The increase in regulatory and policy attention has not necessarily been followed by concrete actions. Many public consultations have been issued in 2021, including from the FATF,[2] the UK HM Treasury (HMT),[3] the Bank of International Settlements (BIS),[4] and Dubai Financial Services Authority.[5] A clear focus area for these consultations have been stablecoins, with special attention to consumer protection and monetary stability. MiCA includes substantial coverage of stablecoins.[6] The UK HMT consultation regarding digital financial market infrastructure similarly focuses on stablecoins. This keen focus is reflected in the acceleration of many CBDC programs globally.

Other jurisdictions have issued blanket bans on cryptocurrency. Qatar has issued a ban on cryptocurrencies,[7] citing price volatility, the possibility of financial crimes, and lack of central government support. The UK FCA ban on retail access to crypto derivatives became law in January of this year.[8] and there is talk of "tough love" for the crypto sector from the Governor of the Bank of England. On September 24, 2021, China issued a blanket ban on cryptocurrency trading,[9] declaring all forms of digital asset transactions and financing as illegal activities that are strictly prohibited due to the risks to consumers.

In the U.S., SEC Chairman Gary Gensler has testified multiple times that the cryptocurrency sector needs stronger investor protection,[10] particularly in the instance of platforms that allow investors to borrow against cryptocurrencies. Chairman Gensler has told lawmakers that investor protection rules should apply to crypto exchanges,[11] and said that the SEC will regulate cryptocurrency markets to the maximum extent possible using its existing authority,[12] while asking for more scope and resources for the SEC to oversee the sector.[13]

DECENTRALIZED FINANCE (DEFI)

Additionally, the growth of DeFi caught many policy makers and regulators off guard, with the total value locked (TVL) in the global DeFi ecosystem rising from $5 billion in August 2020 to $80 billion in August 2021.[14] In response, IOSCO organized a private call earlier this year with some DeFi market leaders and included other regulators. CFTC Commissioner Dan Berkovitz has indicated that many DeFi apps could be illegal,[15] and SEC Chairman Gensler is concerned about protection for retail customers and has questioned the level of "decentralization" of DeFi, citing concerns about the nature of financial incentives of some of the networks. Chairman Gensler has kicked off an investigation into the DeFi industry using a software analytics firm to analyze industry transactions.[16] This will remain a top emerging priority for regulators in the following year.

REGULATION OF ILLICIT ACTIVITY AND THE TRAVEL RULE

The increase in crypto activity has come with an increase in attention to the apparent risks of money laundering and terrorist financing activity across digital asset markets. However, market analysts estimate there was a decrease in illicit activity — from 1.1 percent of total market activity in 2019 to 0.34 percent in 2020[17] — while market activity tripled in the same period.

Nevertheless, regulators and central banks have issued statements warning of the risks of illicit activity. In January 2021, U.S. Secretary of the Treasury Janet Yellen stated that cryptocurrencies were being used "mainly for illicit financing."[18]

THE TRAVEL RULE

The FATF published updated guidance for virtual assets (VAs) and VASPs in October 2021.[19] For the FATF guidelines to function effectively, there needs to be complete adoption to ensure that there are no regulatory gaps. Though it has been noted that the industry has made considerable efforts to develop and implement solutions in preparation for Travel Rule compliance, there are still concerns that only 58 out of 128 reporting jurisdictions have implemented the recommendations into their legislation.[20] A further 26 jurisdictions have reported that they are in the process of implementing the recommendations.

Of the 58 jurisdictions, 52 reported that they have implemented regimes that permit VASPs, while six jurisdictions have prohibited them. 31 jurisdictions have established registration regimes for VASPs, while 17 have established licensing regimes and a further four have implemented regimes with both licensing and registration.[21] The registration requirements for VASPs seem to be a challenge globally, with many regulators approving only a handful of VASPs despite having implemented these regimes.

The FATF monitors countries to ensure they have fully and effectively implemented the recommendations, and to hold countries accountable who do not comply. Since 2000, the FATF has maintained a blacklist and a greylist of non-compliant nations that FATF members believe to be uncooperative with other jurisdictions in international efforts against money laundering.[22]

IMPLEMENTATION OF THE TRAVEL RULE

Evidence on the status of Travel Rule implementation for VASPs in the following jurisdictions is based on the FATF's 4th Round Ratings Document.[23] The FATF's reviews are done periodically. Some jurisdictions' last reviews were before the guidance on VASP was issued. Where this is the case, further evidence has been provided to bring clarity to the status of the jurisdiction's progress.

Australia	2018 MER: COMPLIANT	On May 25th, 2021, the CEO of AU.S.TRAC announced that talks are underway to decide if the agency should implement the FATF Travel Rule for crypto asset exchanges. In August 2021, the Australian Department of Home Affairs said it agrees with submissions from industry that the government currently does not have the technological capability for implementing a travel rule for cryptocurrencies.[24]
Bahrain	2018 MER: LARGELY COMPLIANT	In Feb 2019, the Central Bank of Bahrain introduced new legislation, including rules for licensing, governance, minimum capital, control environment, risk management, and AML/CFT. It is unclear if these meet FATF's R16 requirements for VASPs.[25]
Brazil	NON-COMPLIANT	Unclear
Canada	2021 MER: LARGELY COMPLIANT	Canadian VASPs are expected to comply with Travel Rule guidance as of June 1, 2021. Under the new rules, Money Services Businesses (MSBs) and foreign MSBs are required to identify clients from which they are receiving the virtual currency equivalent of $10,000 CAD or greater. The transfer, exchange, or remittance of virtual currency equivalent to $1,000 or greater will likewise trigger KYC verification requirements.[26]
China	2020 MER: PARTIALLY COMPLIANT	China was partially compliant with R16; it has recently banned all transactions related to cryptocurrencies.[27]
El Salvador	UNCLEAR	Unclear
European Union	MANDATED	The Crypto Travel Rule is mandated in the European Union as of June 20, 2021.[28] The European Commission published a proposal to regulate information accompanying transfers of funds and certain crypto assets, which called for consistency with the FATF Travel Rule.

France	**MANDATED**	The Crypto Travel Rule is mandated in the European Union as of June 20, 2021.29 The European Commission published a proposal to regulate information accompanying transfers of funds and certain crypto assets, which called for consistency with the FATF Travel Rule.[30]
Germany	**MANDATED**	Germany mandated the Travel Rule on May 26th, 2021, the Federal Ministry of Finance (BMF) released a draft bill, Crypto Securities Transfer Regulation (German: KryptoTransferV), which mandated the Travel Rule.[31] The Crypto Travel Rule will be mandated in Germany by the end of 2023, once the German Federal Ministry of Finance approves the ordinance. Minimum threshold for the applying this rule will be E.U.R 1,000
Gibraltar	**2019 MER: COMPLIANT**	Though Gibraltar's last MER was in 2019, in March 2021 the government published the Proceeds of Crime Act 2015 (Transfer of Virtual Assets) Regulations 2021 (Transfer of Virtual Assets Regulations).[32] These regulations implement the Travel Rule and introduce new terms such as 'virtual asset service provider', 'virtual asset transfer' and 'virtual asset account'. The rule applies to transactions equal to or above €1,000.
Hong Kong	**2019 MER: LARGELY COMPLIANT**	The framework proposed by the Securities and Futures Commission (SFC) will extend Hong Kong's traditional AML obligations for wire transfers to all VASPs operating in Hong Kong.[33] If passed, fund transfers above $8,000 HKD will require the originating institution to send information that would comply with the Travel Rule. The final proposal for this framework is set to be introduced to the Legislative Council in 2021.
Israel	**2018 MER: PARTIALLY COMPLIANT**	While Israel applies the basic requirements for originator and beneficiary requirements for cross-border transfers, Israel otherwise relies on general Customer Due Diligence (CDD) obligations instead of providing specific requirements for wire transfers. Particularly, MSBs whose business model often entails the provision of wire transfers are not subject to specific obligations.[34]
Japan	**2021 MER: LARGELY COMPLIANT**	The Financial Services Agency (FSA) will enforce the travel rule in the crypto industry effective April 2022.[35]
South Korea	**2020 MER: LARGELY COMPLIANT**	Korea's amended Act on Reporting and Use of Specific Financial Transactions requires VASPs to register an authorized real-name bank account and report it to the Financial Intelligence Unit (FIU).[36] In addition, each Korean VASP will have to apply for an information security certificate that requires them to first fulfill new regulatory requirements, specifically implementing a suitable technical travel rule solution.
Singapore	**2019 MER: COMPLIANT**	The Monetary Authority of Singapore (MAS) covers the Travel Rule in paragraph 13 of Notice PSN02. This requires VASPs to prove ownership of non-custodial wallets. The minimum threshold is not specified, but transactions under $1,500 SGD have a reduced set of requirements. The act came into effect January 28, 2020.[37]

South Africa	UNCLEAR	The Intergovernmental Fintech Working Group (IFWG) introduced a policy paper for the crypto industry on April 14, 2020.[38] It states that crypto businesses must comply with the Travel Rule, but it does not specify a transaction threshold. The paper estimates that it will take 6-9 months for local regulators to implement these guidelines. It introduces the term Crypto Asset Service Provider (CASP) as a new class of regulated institutions that aligns with the FATF VASP definition. CASPs are required to comply with FATF's AML/CFT measures like FATF's Recommendation 16 on the Travel Rule.
Switzerland	2020 MER: LARGELY COMPLIANT	The Crypto Travel Rule went into effect on January 1, 2020.[39] It requires VASPs to implement the travel rule for transaction amounts above 1,000 CHF and prove ownership of non-custodial wallets. The minimum threshold was originally set at 5,000 CHF, but this was lowered to 1,000 CHF in February 2020.
Thailand	2021 MER: LARGELY COMPLIANT	Thailand has largely fulfilled the requirements for accurate originator and beneficiary information accompanying cross-border wire transfers, and explicit provisions for wire transfers below 50,000 THB ($1,000 U.S.D). However, there are still deficiencies, such as retaining originator and beneficiary information with all cross-border wire transfers.[40]
Turkey	2019 MER: LARGELY COMPLIANT	In its 2019 Mutual Evaluation Report, the FATF determined that Turkey is largely compliant with the travel rule.[41] There are some minor gaps regarding lack of explicit requirements for VASPs to consider information on both originator and beneficiary sides, but FIs must verify the identity of customers when the amount of a single transaction or the total amount of linked transactions in wire transfers is greater than 2,000 TRY.
United Arab Emirates	2020 MER: COMPLIANT	In Feb 2020, the Financial Services Regulatory Authority (FSRA) of Abu Dhabi Global Market (ADGM) announced the enactment of various amendments to the FSRA's regulations and rules concerning the authorization and supervision of virtual asset-related activities within ADGM. The key amendments include changing the terminology of "Crypto Asset" to "Virtual Asset", to be aligned with the terminology used by the Financial Action Task Force and moving the applicable regulations and rules from a bespoke category of "Operating a Crypto Asset Business", to their respective underlying Regulated Activities (e.g. Providing Custody; and Operating a Multilateral Trading Facility, Dealing in Investments, etc.).[42]
United Kingdom	2018 MER: COMPLIANT	On July 22, 2021, HM Treasury released Amendments to the Money Laundering, Terrorist Financing and Transfer of Funds (Information on the Payer) Regulations 2017 Statutory Instrument 2022, which included a chapter on the transfers of crypto assets. This will be an update to the Money Laundering Regulations, will include an unspecified grace period for compliance solution integration, and proposes that full Travel Rule data transfer requirements will apply to all VASP-to-VASP transfers over £1,000.[43]
United States of America	2020 MER: PARTIALLY COMPLIANT	The Travel Rule has already been implemented in the U.S. but was seldom enforced, although it has been refocused on since 2020 with the introduction of a proposed rule change that would dramatically reduce the transfer amount that would trigger collection of data.[44]

MARKET SURVEILLANCE

Market manipulation continues to be a top concern for regulators. Most upcoming licensing regimes emphasize the need for demonstrably intentional, comprehensive risk programs that automate and unify transaction monitoring and market surveillance. In early 2020, Hong Kong,[45] Singapore,[46] Japan,[47] and Indonesia[48] implemented licensing regimes which had strict trade monitoring requirements.

Regulatory frameworks in development across the E.U., Hong Kong, and Singapore are expected to include requirements for specialized third party-provided surveillance systems. The E.U.'s proposed MiCA framework would aim for continent-wide digital asset risk monitoring requirements.[49]

CONSUMER PROTECTION

The increase in activity across crypto markets has seen many regulators express concerns over consumer risks associated with digital assets. In 2021, the India Reserve Bank,[50] Saudi Arabia,[51] the UK's Financial Conduct Authority,[52] Australian Securities and Investment Commission,[53] Bank of Ireland,[54] and the European Supervisory Authority[55] were among the many regulatory bodies to issue or renew previous warnings against consumer risks of trading digital assets.

China named consumer protection as the main reason for its ban on all virtual currency-related business activity.[56] Although they have issued similar warnings in the past, there is a consensus that this ban will be followed with stricter enforcement. The announcement has already had an impact on the industry: as of September 2021, leading exchange Huobi has announced it will discontinue service for mainland users.[57] Users of OTC services also appear to be leaving the market, with stablecoin issuer Tether breaking its peg against RMB in the aftermath of the announcement, suggesting heavy outflows.[58]

DeFi has exposed further issues in consumer protection, as evinced by large exploits of Poly Network ($611 million U.S.D) and Compound ($147 million U.S.D), and many other, smaller exploits. Consumers may be exposed to a variety of risks, including smart contract risks, scams (i.e., "rug pulls"), and blockchain failure risks. The non-custodial nature of DeFi (and crypto generally) means that users can choose their crypto wallet; this presents new risks, as users may be unaware of the implications of their choices. Regulators, including the FATF, have expressed concerns in addressing these risks across P2P platforms.[60]

INNOVATION: BARRIERS VS ENCOURAGEMENT

The focus of this section is two-fold: Firstly, the bid for protection of consumers and market integrity may create barriers to innovation in the industry. Secondly, it is worth noting the jurisdictions that have had innovative approaches towards the regulation itself. Hong Kong's voluntary opt-in registration scheme[61] has been relatively efficient, demonstrated by the fact that it is a popular jurisdiction for service providers. A more unorthodox approach towards cryptocurrency innovation was taken by El Salvador, which was the first country to adopt Bitcoin.[62] Brazil's legislature recently approved the draft of Bill 2.303 / 15, which seeks to regulate digital currencies; there is also a proposal to update the draft bill and give Bitcoin legal status as a "payment currency" in the country.[63]

In 2021, the Central Bank of Argentina took a novel approach towards innovation by asking domestic banks to forward them information about their customers who perform any other kind of crypto transactions.[64] The purpose of the measure is to provide further information to evaluate whether the crypto market needs further regulation. Elsewhere, regulators have provided sandboxes to encourage innovation.

JURISDICTIONS THAT HAVE REGULATORY SANDBOXES

Bahrain	The Regulatory Sandbox is a virtual space for both CBB-licensed financial institutions and other firms to test their technology-based innovative solutions relevant to FinTech or the financial sector in general. The Sandbox will last up to nine months with a maximum extension of three months.[65]
Brazil	In 2020, the Securities Commission launched its Regulatory Sandbox Framework with the Central Bank and the Private Insurance Superintendence (SU.S.EP), which is expected to give regulatory waivers for innovative projects testing new technologies in the capital and financial markets infrastructure.[66]
Canada	Launched a securities law regulatory sandbox for fintech businesses in 2017.[67]
Caribbean	In 2018, the Financial Services Commission and Central Bank launched a regulatory sandbox for the financial services sector. The government then extended its regulatory sandbox to include blockchain and crypto companies.[68]
European Union	The E.U. launched a sandbox-like regulatory regime for the issuance of DLT-based security tokens in September 2020.[69]
Israel	A regulatory sandbox was proposed in July 2020 that will give Israeli financial technology startups an environment to experiment with products and services."[70]
Japan	In June 2018, the government introduced a sandbox regime to accelerate the introduction of new business models and innovative technologies. Organizations and companies, both domestic and foreign, can apply to experiment with new technologies such as blockchain, artificial intelligence, and Internet of Things in fields such as financial services, healthcare, and transportation.[71]
Mexico	The Financial Technology Institutions Law created a regulatory sandbox for startups, which allows them to operate for two years with a temporary license without meeting all regulatory requirements. CNBV issued its first license on January 22, 2020, to a cryptocurrency market, and as of February 2020, at least 85 entities had filed applications.[72]
Singapore	Singapore created a regulatory sandbox to help firms receive Capital Markets Services Licenses.[73]
South Korea	There are a series of sandboxes in different municipal ordinances around South Korea, including BU.S.n.[74]
Switzerland	Launched a regulatory sandbox in 2017.[75]
Thailand	The Bank of Thailand launched a sandbox under regulatory guidelines introduced in 2019. The regulatory sandbox allows financial service providers to test their financial services that incorporate new technologies and fintech innovations. In addition, the regulatory sandbox encourages financial service providers to cooperate with one another in the development of fintech innovations and new technologies.[76]
United Arab Emirates	The Abu Dhabi Global Market launched a sandbox in 2018. The ADGM digital sandbox provides a marketplace for open collaboration between FIs, FinTech firms, and regulators to facilitate testing and adoption of innovative digital financial products and services that can benefit the industry.[77]

ADOPTION: INSTITUTIONAL PARTICIPATION

This year saw a considerable increase in institutional activity in digital assets. Fidelity Digital Assets' report showed that U.S. and European interest in digital asset investment products increased by 12 percentage points year-on-year, with 84 percent of surveyed investors interested in purchasing institutional investment products that hold digital assets.[78]

Within Europe, there is a concern that MiCA favors incumbents over new market entrants. For example, existing providers with MiFID licenses can provide cryptoasset services, provided they comply with the operational requirements of MiCA; credit institutions that comply with the Capital Requirements Regulation will not have to apply for authorization under MiCA;[79] and cryptoasset service providers are required to be authorized as a payment institution under PSD2 in order to make a payment. These requirements operate on the assumption that traditional market participants are in the best position to manage risk.

TAXATION

An emerging trend across jurisdictions is market guidance and legislation occurring through taxation, rather than through direct regulation. Jurisdictions around the world continue to diverge in their tax approaches to cryptocurrency. India has announced plans to tax cryptocurrency,[80] while South Korea may further delay its law to tax cryptocurrency.[81]

Most jurisdictions treat cryptoassets as non-currencies for tax purposes, which means that transfers of cryptoassets can result in tax liability in many jurisdictions. With bitcoin reaching an all-time high price in 2021,[82] tax authorities are trying to ensure that they can collect any taxes that are due and are increasingly focused on information reporting by exchanges and other VASPs.

In the U.S., the Internal Revenue Service (IRS) has the authority to collect information from brokers regarding transactions they effectuate on behalf of customers.[83] Although the IRS has been working on regulations to extend broker reporting to crypto asset exchanges, the U.S. Congress has passed a law to expand the definition of broker to "any person who (for consideration) is responsible for regularly providing any service effectuating transfers of digital assets on behalf of another person."[84] Industry participants are concerned that the language could be applied to participants in the ecosystem that are not acting as traditional brokers and do not have insight into the underlying transactions, such as miners, stakers, providers of hardware/software wallets, or developers of digital assets or protocols.

Similarly, the E.U. has been working on its eighth update of the Directive on Administrative Cooperation (DAC8),[85] which would expand the collection and exchange of information to include transactions involving crypto assets. The OECD is working on proposals for reporting and exchange of information with respect to crypto assets.[86] It is unclear how these developing information reporting regimes will apply to decentralized protocols.

SHARIAH LAW

The topic of Sharia compliant products and services in the context of cryptocurrencies is growing and warrants further development into 2022. For example, Rain is the first cryptocurrency exchange in Bahrain to graduate from the regulator's sandbox and apply for a license and be compliant with Sharia law. The Shariah Compliance Certificate is issued by the Shariah Compliance Body, licensed by the Central Bank of Bahrain to be a Shariah consulting company, and authorized to issue Shariah compliance certificates.[87]

LOOKING AHEAD

As the digital and crypto assets markets continue to grow, additional areas of research and mapping should include NFTs, DAOs, social tokens, and the metaverse. As these markets become simultaneously more developed and more complex, novel legal and regulatory issues will arise. It is critical that stakeholders, regulators, and legislators maintain an understanding of new developments, and thus GSMI 3.0 will likely address some of the aforementioned areas of focus.

SECTION IV

POLICY

Blockchain is a fundamentally borderless technology that exists in a world with many borders.

The tension that this reality creates will continue to lead to difficult policy decisions for governments. The most successful jurisdictions will find a way to balance anti-money laundering/know-your-customer (AML/KYC) requirements, consumer protection, taxation, and more with innovation. But it is not enough for individual governments to develop effective regulatory frameworks as delineated in the DCAR section; governments must work together, facilitated through international bodies (See Appendix B), to minimize frictions that stand to hamper blockchain technology's potential. The GSMI Policy Working Group examined two crucial cross-border policy topics that are currently at the forefront: AML/KYC and CBDCs.

AML/KYC

Cryptocurrency users carry out many transactions around the world every day; the Bitcoin and Ethereum blockchains facilitate around 260,000[88] and 1,260,000[89] transactions daily. The active universe of transactions conducted in cryptocurrency, however, remains stymied by a variety of policy challenges. According to the Bank for International Settlements (BIS,) the key challenges facing the use of cryptocurrency in cross-border transactions include "aligning regulatory, supervisory and oversight frameworks for cross-border payments, Anti-Money Laundering/Combating the Financing of Terrorism (AML/CFT) consistency, Payment versus Payment (PvP) adoption and payment system access."[90] The BIS has framed the problem with two perspectives: (a) the "practical perspective" for how one would set up a cross-payment infrastructure; and (b) the "macro-financial perspective," including "examining the potential increase in cross-border flows, possible financial stability risks and currency substitution, and reserve currency configurations and backstops."[91]

The "practical" concerns related to anonymous payments are largely associated with money laundering and terrorist financing. The "macro-financial" concerns involve the difficulty in coordinating the relationship between central banks to allow for access to, and settlement of, funds transfers to facilitate the cross-border use of digital currency from two or more jurisdictions. Such an arrangement would require strong cooperation among central banks, and a network of relationships that is not currently sufficiently robust to handle cross-border cryptocurrency transactions, especially if adoption becomes more widespread.[92] The BIS has recognized that an international system of cross-border transactions in cryptocurrency requires countries to agree on the design of a transfer system that limits the risk of currency substitution.

> Central banks are also concerned that cross-border transactions would create volatility in the flow of capital that will upset markets as well as "contagion risk," or the fear that financial instability in one country will spill over into another country through high numbers of these transactions.

A lack of standardized definitions of virtual currencies, cryptocurrencies, and cryptoassets poses further challenges for cross-border transactions and regulations. India offers a prime example of

these challenges. Indian law defines "currency" with a specific list of categories, including currency notes, money orders, cheques, and credit cards.[93] But virtual currencies are not included in this list. In 2015, the Reserve Bank of India issued a regulation interpreting the statute which added to the definition of currency to include "debit cards, ATM cards or any other instrument by whatever name called that can be used to create a financial liability."[94] The challenge here is that "in the case of virtual currencies such as Bitcoin, there is no entity that is accepting financial liability in connection with the instrument."[95]

HOW COUNTRIES AND ORGANIZATIONS ARE ADDRESSING THESE ISSUES

National regulators and organizations around the world are working to develop rules to govern digital assets. The G20 is focused on enhancing cross-border payments and has endorsed a comprehensive program to address challenges.[96] Regulators also see the value of digital currency in the world economy. According to the BIS, "Faster, cheaper, more transparent and more inclusive cross-border payment services would deliver widespread benefits for citizens and economies worldwide, supporting economic growth, international trade, global development and financial inclusion."[97]

The consistent theme, however, indicates that while some governments have become increasingly receptive to virtual currency and cryptocurrencies, many have yet to develop laws that specifically regulate virtual currency. The lack of clarity in the marketplace has made accepting virtual currencies for cross-border payments difficult because their use still involves risk under some laws. Moreover, it is unclear how and whether enforcement authorities would apply these laws to cryptocurrencies.

Some countries, such as India, have attempted to regulate the transfer of cryptocurrency across borders through their customs laws. Several commentators have suggested that cross-border transfers of cryptocurrency may fall under India's Foreign Exchange Management Act, which would regulate cross-border cryptocurrency transactions as a movement of "goods."[98]

Despite ongoing debate about whether certain cryptocurrencies are securities, some regulators treat virtual currency under the current regulatory framework for "goods" or "property" as part of their efforts to apply existing rules applicable to guard against money laundering and terrorist financing to virtual currency.[99]

FATF AND CROSS BORDER CONSIDERATIONS

According to the FATF guidance, Virtual Asset Service Provider (VASP) is defined as any natural or legal person who, as a business, conducts one or more of the following activities or operations for or on behalf of another natural or legal person:

- Exchange between virtual assets (VA) and fiat currencies.
- Exchange between one or more forms of virtual assets.
- Transfer of virtual assets.
- Safekeeping and/or administration of virtual assets or instruments enabling control over virtual assets.
- Participation in and provision of financial services related to an issuer's offer and/or sale of a virtual asset.

As set out above, the definitions do not depend on the technology employed by the service provider. The obligations in the FATF Standards stem from the underlying financial services offered without regard to an entity's operational model, technological tools, ledger design, or any other operating feature. One key advantage of the FATF guidelines is that they focus on the types of services provided, not on terminology or nomenclature used to describe the services, which could lead to greater consistency within the global regulatory framework.

However, the FATF recognizes that its

approach can bring practical challenges to competent authorities in identifying which entities are VASPs and defining their regulatory perimeter. Launching a service that will provide virtual asset services, for instance, does not relieve a provider of VASP obligations, even if those functions will proceed automatically in the future, especially, but not exclusively, if the provider will continue to collect fees or realize profits, regardless of whether the profits are direct gains or indirect. For purposes of determining VASP status, launching a self-propelling infrastructure to offer VASP services is the same as offering them, and similarly commissioning others to build the elements of an infrastructure is the same as building them.

Where there is a central developer and governance body which is a financial institution (FI) or a VASP, it could be held accountable for the implementation of AML/KYC controls across the arrangement and for taking steps to mitigate ML/TF risks. These organizations should consider taking steps to limit the scope of customers' ability to transact anonymously and/or ensuring that AML/KYC obligations are fulfilled on an ongoing basis (e.g., by using software to monitor transactions and detect suspicious activity). Not all stablecoins may have a readily identifiable VASP/FI central body once launched. However, it may be more likely that a party needs to exist to drive the development and launch of such an arrangement before its release. If this entity was a business and carried out VASP functions, this would create scope for regulatory or supervisory action in the pre-launch phase.

NEXT STEPS FOR CROSS-BORDER COLLABORATION

The law, and technology, is constantly changing, and there will need to be an effort to provide more direct guidance to users of virtual currencies. The international community will need to reach a consensus on whether regulation should focus on stopping the use of virtual currency or on monitoring and reporting on its use.

Cryptocurrencies are facing increased regulation in several countries, including the United States. The focus of the regulations, however, has largely been on increasing transparency and central management in exchanges rather than structuring more efficient means of exchange. U.S. regulators proposed reducing the threshold for transaction reporting from $3,000 to $250 because of claims that

> "[c]riminals are using smaller value transfers and virtual currencies to facilitate terrorism financing, narcotics trafficking and other illicit activities, like cybercrime." [100]

It will be important, as regulation moves forward, to have accurate data on actual use patterns by both legitimate users and illicit actors. Some have argued, however, that this feature is built into cryptocurrency

transactions.[101]

It is still early, but there is technology being developed to improve and manage processes for KYC and AML compliance, including some which offer zero-knowledge proof (ZKP) solutions that protect personal information without having to sacrifice safety and functionality. These and other "reg tech" offerings seek to leverage the security and verifiability of blockchain technology and provide regulators with assurance that bad actors are not using decentralized systems to conduct illicit transactions. Companies like Coinfirm, Chain Analysis, and Ciphertrace are among the burgeoning field of crypto analytics companies that monitor blockchain transactions and provide real-time alerts to flag potential sources of risk, among other services.

In July 2021, a group called the Global DeFi Coalition, which includes a half-dozen international blockchain-related trade groups, representing more than 350 companies, issued an open letter to FATF calling for "well-balanced" regulations, including ways to streamline AML and KYC requirements; for example, by allowing financial intermediaries to collaborate when identifying clients so that these checks don't have to be run multiple times to execute a single transaction.[102]

CBDCs

In a relatively short period of time, CBDCs went from a niche technological idea to a concept that over 80 countries representing over 90 percent of global GDP are investigating.[103]

While most central banks are first considering the domestic implications of CBDCs, there have been numerous cross-border experiments. Central banks are interested in CBDCs for a variety of reasons, including limiting the influence of private stablecoins, improving financial inclusion, and reducing costs. As the response to COVID-19 demonstrated, CBDCs could also be used to improve the efficiency of "helicopter drops," as stated by the U.S. House

of Representatives Committee on Financial Services:

> "In CBDC models where every citizen has a digital wallet, or the government has visibility into wallet ownership, the speed at which these distributions can be made increases considerably while also ensuring that those who are traditionally not served by the banking sector and most in need of countercyclical assistance would be able to benefit."[104]

WHAT ARE THE MAIN ISSUES THAT CBDCs PRESENT?

As detailed in a joint BIS, International Monetary Fund (IMF), and World Bank Group report to the G20 on CBDCs for cross-border payments, the proliferation of CBDCs has a wide variety of opportunities and consequences which will vary widely depending on the design of each CBDC. The report states that "cheaper and more accessible remittances will benefit senders and recipients, help to buffer economic shocks, and stimulate growth. Markets should also become more integrated, thus offering investment and risk-sharing opportunities. This would facilitate hedging, though it could increase contagion risks."[105]

Additionally, as CBDCs could make it easier and cheaper to store and spend foreign currency, "already established international currencies [could become] even more attractive... This would contribute to more widespread currency substitution via the adoption of a foreign CBDC, especially in countries with high inflation and volatile exchange rates." This could have significant effects on countries' ability to control their monetary policy and "increase risks for runs on both domestic banking sectors and currencies." The report speculates that currency substitution could also undermine central banks' ability to act as a lender of last resort.

These represent just some of the manifold risks associated with the proliferation of CBDCs. Other risks include consumer protection, privacy, tax avoidance, and increased volatility in FX rates.

HOW COUNTRIES AND ORGANIZATIONS ARE ADDRESSING THESE ISSUES

Perhaps most significantly, China has undertaken a number of pilots, including a trial with the BIS and the central banks of Hong Kong, Thailand, and the U.A.E, called the mCBDC Bridge. According to the post-phase two report, the prototype tested enabled the central banks "to control the flow of their CBDC and to monitor transactions and balances of their issued CBDC, with programmable levels of transaction privacy and aspects of automated compliance. The prototype demonstrates a substantial increase in cross-border transfer speed from days to seconds, as well as the potential to reduce several of the core cost components of correspondent banking."[106] The next phase will involve "further experimentation with design choices and technology trade-offs and a future roadmap from prototype to a production-ready network that can serve the broader central banking community as a public good through open-sourcing."

This is just one example of central banks collaborating to test cross-border CBDCs. In July 2021, the Banque de France and the Monetary Authority of Singapore completed an experiment that "simulated cross-border and cross-currency transactions for Singapore Dollar CBDC and Euro CBDC, and was conducted using a permissioned, privacy-enabled blockchain based on Quorum technology." [107]

Recently, the central banks of Australia, Malaysia, Singapore, and South Africa announced that they would be conducting a cross-border CBDC trial.[108]

Reflecting the general attitude towards current CBDC research, China's e-CNY whitepaper stated that "cross-border payment involves various complicated issues such as monetary sovereignty, foreign exchange policies and arrangements, as well as regulatory and

compliance requirements... Therefore, though technically ready for cross-border use, e-CNY is still designed mainly for domestic retail payments at present."[109] President Xi Jinping has also called on the G20 to "discuss developing the standards and principles for central bank digital currencies with an open and accommodating attitude, and properly handle all types of risks and challenges while pushing collectively for the development of the international monetary system."[110]

NEXT STEPS FOR CROSS-BORDER COLLABORATION

It is encouraging to see central banks, especially those of some of the largest economies in the world, are closely examining the risks associated with CBDCs. Countries engaging in cross-border research and experimentation should continue these efforts, and more countries should join the effort. Thoughtful and deliberate planning and design, including information sharing between central banks, will become more critical as larger economies, such as Nigeria,[111] begin to release their CBDCs on a wider scale.

In October 2021, the G7 released a statement on CBDCs, stating that strong "international coordination and cooperation on these issues helps to ensure that public and private sector innovation will deliver domestic and cross-border benefits while being safe for users and the wider financial system."

The statement further notes "the importance of considering interoperability on a cross-border basis," while also recognizing "a shared responsibility to minimise harmful spillovers to the international financial system."

The G7, G20, Financial Stability Board, BIS, regional blocks, and other international organizations must facilitate international coordination and ensure that countries are not rushing to release a CBDC in competition with one another, creating a race to the bottom that could have serious consequences.

MARKET MANIPULATION

Today's digital assets market closely resembles the capital markets that existed a century ago.[112] Cross-border transactions of digital assets can add yet another layer of complexity, making manipulative transactions more difficult to track and flag. While it has been confirmed that intentional market manipulation does occur, there are also instances where market manipulation

Figure 2: Geographic Distribution of Market Manipulation Activity (Source: Amplyfi.com/insights)

occurs through unintentional transactions.[113] Either way, regulation and surveillance are paramount in ensuring equality and fairness in newly emerging exchanges, while ensuring that cross-border transacting is not used to camouflage intentional manipulation.

Other than some anecdotal events, little research has been done to confirm the intentional manipulation of cryptocurrency across borders, or to identify how traders may leverage the lack of regulation across borders to gain quick wins. However, what is known is the potential that cross-border transactions have to cause more confusion around both intentional and unintentional transactions, resulting from the lack of transparency among the various regulated and non-regulated exchanges, and across regulatory bodies.

HOW CRYPTOCURRENCIES ARE MANIPULATED BY MARKETS

There are several known strategies used by some nefarious traders to intentionally manipulate the cryptocurrency markets. Some will use initial coin offerings (ICOs) to gain leverage on a particular exchange, especially where ICOs are not regulated to prevent unfair leverage through large purchases of digital assets. These ICO events, if not properly regulated, can lead to unfair leverage and temporary spikes in market price that will work to the advantage of the buyer. Some will use the classic pump and dump strategy to create the illusion of an artificial increase in market activity, also leading to temporary spikes in market prices, which can lead to quick gains through the sudden selloff of digital assets.[114]

Other manipulation strategies involve setting up ghost accounts that can help disguise large trade volumes by a single company or individual, thereby manipulating market prices. This is known as wash trading, which takes advantage of the anonymity associated with some cryptocurrency accounts. Spoofing is yet another strategy; it uses illegitimate orders, often leading to manipulated spikes and dips in prices. The introduction of leveraged derivatives has made these price-impacting strategies even more effective, especially when combined with the ability to quickly sell on the spot market. The combination of wash trading, spoofing and leveraged derivatives can potentially have an impact on cross-border manipulation, and can potentially be used as an act of international political aggression if not properly regulated.

CHALLENGES WITH TRACKING AND CONTROLLING MANIPULATION EVENTS

The digital currency marketplace has evolved so quickly that regulators continue to struggle to keep up.[115]

Additionally, transactions can occur so rapidly that it is virtually impossible to detect intentional acts of manipulation and prevent them from happening in real time. New trading instruments and services are constantly being created, thus perpetuating the complexity and difficulty to regulate. To add to the challenges of regulation, traders will often use multiple exchanges and instruments, and transact across multiple borders. With all of these avenues for potential fraud and abuse, it can be difficult, or impossible, to detect legitimate transactions and trades from those that are done with the intent of fraudulent manipulation.

NEXT STEPS IN PREVENTING MARKET MANIPULATION ACROSS BORDERS

Regulation alone will not provide the security and safety for all traders and investors in this space. Addressing this problem will require transparency and cooperation among various national regulatory bodies, exchanges, and service providers. For example, the formation of one centralized governing body, or the expansion of an existing cooperative work group like the Financial Action Task Force (FATF), that can work to oversee the activities of all exchanges in all countries and provide guidance and tools towards enhanced regulation and control within the exchanges.[116]

In any type of financial market, there are two approaches used for internal control. These are preventive and detective controls. While the latter attempts to quickly identify and prevent an unauthorized transaction from occurring, the latter relies on the belief that such a transaction cannot be prevented, but can be detected, and followed up with a reversal of that transaction, or a penalty, thus discouraging such events from happening. Applying such controls around those areas most likely to be abused, such as leveraged derivatives, spot markets, etc., could be a first line of defense for regulators.

Exchanges themselves must provide real-time surveillance and monitoring of transactions, so that events showing signs of deception can be flagged and addressed.[117] Self-certification requirements in spot markets can also thwart devious activities, as well as imposing tighter controls and requirements around highly leveraged crypto derivatives.

Artificial intelligence and machine learning technologies offer another means of actively monitoring the transaction landscape across diverse trading platforms. Vetted AI and machine learning algorithms could be used to detect nefarious patterns in trading. This can be done at a pace and consistency level that would be impossible for humans to achieve, potentially leading to a more preventive type of control mechanism.

CONCLUSION

The cross-border nature of blockchain, cryptocurrencies, and CBDCs is creating novel problems and opportunities for legislators, regulators, businesses, and organizations to address. When crafting guidelines for this new industry, it is important that governments do not become fixated on cryptocurrency as a tool for criminals. Its illicit use is a problem, but as the FATF estimated in 2015, "between hundreds of billions and a trillion U.S. dollars" are laundered each year in cash, with a majority of countries surveyed indicating "that cash smuggling is an increasing problem."[118] This is not intended to serve as whataboutism, but rather to indicate the vastly different scopes of the problem: the total crypto market cap is $2.5 trillion as of this writing, with an estimated $10 billion in criminal activity in 2020.[119] Governments therefore must attempt to balance innovation and regulation, ideally in communication with other governments so as to harmonize regulations and learn from mistakes and successes.

SECTION V

DIGITAL ID

EXECUTIVE SUMMARY

The rapid deployment of global decentralized networks has created large gaps with respect to data disclosure, financial transactions, and the degree of privacy to which individuals are entitled regarding digital assets. Digital assets come in many forms, but the Covid pandemic and rapid development of Web 3.0 decentralized networks has incited a need for a foundational, global, interoperable framework for modern digital identity. Personal data also carries value, which can be protected and exchanged on decentralized ledger technologies (DLT) with the individual in control. Beyond that goal, decentralized exchanges (which are often autonomous with no central governing body,) in combination with non-custodial wallets, provide a major hurdle for regulatory and enforcement agencies to use existing KYC/AML frameworks to prevent illicit activity.

Decentralized identity solutions, sometimes synonymously referred to as "self-sovereign identity" (SSI) frameworks, have been recommended for many use cases and align well with the UN's sustainable development goals (SDGs), especially SDG 16, and can serve as a foundation for Web 3.0 and beyond. Applications include globally interoperable frameworks for government, healthcare, finance, and physical interactions. In combination with biometrics, digital asset wallets, and other technologies, SSI may serve as a foundation to enhance KYC/AML integrity while affording financial access to underserved populations. It can help remedy archaic administrative costs in different verticals like healthcare and financial services. A decentralized approach to identity can also offer the least fortunate among us some form of documentation by which one can verify another for issuance of first aid, food, water, and other essentials in times of crisis. As reports suggest, over a billion people lack proper identification.[120]

Access the full version of the Digital ID report here.

Government Issued/ attested primary credentials and identifiers	National IDs like SSN, Passport, Driver's License, Standard ID, Real ID, birth certificates
Attestation	Acknowledged evidence or confirmation of the existence of something, whether by an individual or organization.The broader community must prioritize finding greater consensus on common definitions and taxonomy.
Credential	A qualification, trait, achievement, or authority assigned to a person or entity which can be issued in physical or digital form.The broader community must prioritize finding greater consensus on common definitions and taxonomy.

Digital Identity	Identity issued by an organization that is considered to be either "Siloed" or "Federated."[121]
Federated Identity	Means of linking a person's electronic identity and attributes, stored across multiple distinct identity management systems.[122] Federated identity is related to single sign-on (SSO), in which a user's single authentication ticket, or token, is trusted across multiple IT systems or organizations. SSO is a subset of federated identity management, as it relates only to authentication and is understood on the level of technical interoperability and would be impossible without some sort of federation.
Decentralized Identifier (DID)	A globally unique identifier developed specifically for decentralized systems as defined by the W3C DID specification. DIDs enable interoperable decentralized Self-Sovereign Identity management: A DID is associated with exactly one DID Document.[123]
Decentralized Identity	A portable set of identity credentials (which may be issued or attested to by third parties) controlled by the individual owner in a digital wallet underpinned by a DLT platform.[124]
Self-Sovereign Identity	An identity system architecture based on the core principle that identity owners have the right to permanently control one or more identifiers together with the usage of the associated identity data.[125]
Verifiable Credential	Much existing regulation and standardization focuses specifically on digital assets, as opposed to blockchain or DLT technology more broadly. As new uses for the technology continue to emerge, dynamic or principles-based guidance will be better suited to adapt. Regulators should take advantage of regulatory sandboxes and innovation hubs to create more effective regulations.
Zero-Knowledge Proof	A Proof that uses special cryptography and a Link Secret to support Selective Disclosure of information about a set of Claims from a set of Credentials. A Zero Knowledge Proof provides cryptographic proof about some or all of the data in a set of Credentials without revealing the actual data or any additional information, including the Identity of the Prover.

SSI Principles Elaboration

Table 3: Various "Principles of Identity"

Kim Cameron[125] (2005)	Chris Allen[126] (2016)	World Bank[127] (2017)	ID 2020[128] (2017)	WEF[129] (2018)	Access Now[130] (2018)
	Existence	Universal Coverage	Universal Coverage	Existence	
User Control and Consent	Control	User Privacy and Control	Control	Control	Control
Human Integration	Access	Remove Barriers to Access and Usage	Access	Access	Access
	Transparency	Open Standards	Open Standards	Transparency	Transparency
	Persistence	Sustainability	Persistence	Persistence	Persistence
Consistent Experience Across Contexts	Portability	Independent Oversight	Portable	Transportable	
Pluralism of Operators and Technology	Interoperability	Interoperable and User-Responsive	Interoperability	Interoperability	
Justifiable Parties	Consent	Legal and Regulatory Framework	Permissioned	Consent	Consent / Accountability
Minimal Disclosure for a Constrained Use	Minimalization	Mandates and Accountability	Private	Minimization	Minimization
Directed Identity	Protection	Unique, Secure, Accurate Identity	Secure[131]	Protection	Protection[132]

Table 3 courtesy of New America. View the original here.

In an increasingly complex global internet and financial system, black swan events can pose greater economic risk. The right to owner-centric control becomes a prerequisite to digital identity and its corollaries constitute basic human rights. To ensure personal identity and related data are protected, the individual should have the option to take complete ownership and custody of her data. Shifting trust to the edges of communication networks also has the potential to reduce complexity and increase security.

PRINCIPLES AND SOLUTIONS

- Privacy
- Inclusion
- Security
- Global Interoperability and Economic Efficiencies
- Decentralization
- User Focus

PRIVACY

Under a digital ID solution, entities should control the privacy of their information, including minimal, selective, and progressive disclosure of attributes or other data. The sheer volume of data and value in aggregate makes centralized systems much less resilient. Affording control to the user enhances privacy, which becomes especially valuable in the healthcare and financial services verticals.

INCLUSION

Inclusion for all is the first step toward a brighter shared future. SSI technologies and principles align congruently with the Sustainable Development Goals in their unique purpose to provide irrevocable agency of an individual's identity to any human on Earth, regardless of place of birth, bank account, or social status.

SECURITY

Cybersecurity infrastructure is an absolute prerequisite for the safe creation, issuance, storage, and transfer of all digital data for purposes of commerce or verification. Those credentials or claim sets relatable to an individual person typically carry value and are broadly disseminated and traded. Unfortunately, and ubiquitously, global data breaches have become the norm, putting identity fraud and identity-related crimes at the forefront of international economic and social threats. The need for privacy-protecting infrastructure embedded in global data transfer networks grows every second.[126]

GLOBAL INTEROPERABILITY AND ECONOMIC EFFICIENCIES

Increasing globalization calls for frictionless trade of physical and economic resources, cross-border transactions, and valued data exchange. Thus, sound digital identity infrastructure and governance should be integrated with Web 3.0 architecture.

DECENTRALIZATION

Decentralization can create new economic models that incentivize "good" behavior; DLT infrastructure base layers allow for security, decentralized custody, peer-to-peer transactions, a programmable spectrum of privacy, and automation of modern financial and identity data transactions.

USER FOCUS

Personal data is currently monetized in commercial settings as well as through social media and advertising channels. Because of the ever-present tension between hacking and cybersecurity, individual ownership of identity in a decentralized framework may allow for the greatest security of our personal data. Those preparing for Web 3.0 and decentralized technology should consider a transparent and viable governance framework capable of achieving the virtues invoked by Self-Sovereign Identity principles.

VERTICAL FOCUS #1: HEALTHCARE & TRAVEL APPLICATIONS

CURRENT STATE OF PRACTICAL DID APPLICATION FOR CROSS-BORDER TRAVEL AND "COVID HEALTH PASSES"

- **The Commons Project Foundation and the World Economic Forum** have launched the Common Trust Network in collaboration with a broad voluntary network of public and private stakeholders. CommonPass is the traveler App, which will store, and display COVID-19 test results and eventually vaccination records. Five airlines are part of this initiative as well as the Airport Council International, representing 2000 airports globally.[127]

- **IATA Travel Pass** is a mobile application (available in March 2021) allowing travelers to store and manage certifications for COVID-19 tests or vaccines. The information provided through the IATA Travel Pass can be used by governments requiring testing or vaccination proofs as a condition of international travel during and after the COVID-19 pandemic. Emirates Airlines is one of the first Airlines to partner with IATA for the adoption of Travelpass.[128]

- **World Health Organization (WHO)**: Initiated the development of a digitally enhanced International Certificate of Vaccination, a 'smart yellow card'. WHO also set out the Smart Vaccination Certificate Working Group. It is intended to bring together experts to focus on defining specifications and standards for a digital vaccination certificate.[129]

- **International Chamber of Commerce (ICC)** has partnered with International SOS, to launch the new ICC AOKpass mobile app, to provide trusted recognition of individuals' COVID-19 compliance status. Singapore Airlines has trialed the AOKpass service for inbound travelers from Malaysia and Indonesia.[130]

- **Vaccine Credential Initiative (VCI)** is working to enable individuals vaccinated for COVID-19 to access their vaccination records in a secure, verifiable, and privacy-preserving way. The coalition (CARIN Alliance, Cerner, Change Healthcare, The Commons Project Foundation, Epic, Evernorth, Mayo Clinic, Microsoft, MITRE, Oracle, Safe Health, and Salesforce) is developing a standard model for organizations administering COVID-19 vaccines to make digital credentials available in an accessible and interoperable.[131]

- **Good Health Pass Collaborative** is a cross-industry group, established in 2020, in response to COVID-19 shutting down international travel, to provide guidance on travel pass creation and use. The resulting Interoperability Blueprint makes recommendations for adoption that include the early standards and specifications from Trust Over IP, DIF, and W3C.[132]

IMPACTS ON STANDARDS & INTEROPERABILITY

Despite the number of initiatives listed above, there are no unified standards to define precisely how Digital Health Credentials mechanisms — from issuance to verification — would work. For example, the Good Health Pass Interoperability Blueprint proposes a new set of interoperability specifications while acknowledging that there is a lot of work remaining to reach true standardization and interoperability.[133] Additionally, technology firms have their own way to implement standards specifications which often limit interoperability. The (limited) list below shows standards, consortiums, and foundations that are working on various technology stack layers used in a Digital Health Credentials solution (authentication protocol, communication, encryption data storage, etc.)

- **World Wide Web Consortium (W3C)** has been working on building web standards since the early 2000s. They have primarily focused on developing the browser and have been instrumental in making browser interoperability possible. They are specifically involved in a working group to specify the architecture, data model, and representation of Decentralized identifiers (DIDs) that enable verifiable, decentralized digital identity

- **JavaScript Object Notation (JSON)** is an open standard file format, and data interchange format, that uses human-readable text to store and transmit data objects. JSON is used for passenger QR code presentation. It is important to note that though JSON is a standard, the schemas required for interoperability have not been standardized.

- **Decentralized Identity Foundation (DIF)** is an engineering-driven organization acting as a center for development, discussion, and management of all activities required to create and maintain an interoperable and open ecosystem for the decentralized identity stack. DIF has the capability to set up intellectual property rights (IPR) protected working groups, deliver specs and standards, and offer infrastructure for the community.

- **Trust over IP Foundation** is an organization hosted at the Linux Foundation that is defining a complete architecture for Internet-scale digital trust that combines both cryptographic trust at the machine layer and human trust at the business, legal, and social layers.

- **Hyperledger Foundation** is an organization hosted at the Linux Foundation which promotes collaboration from a variety of industry stakeholders building implementations in open-source communities for a variety of use cases around decentralized ledgers and blockchains (Aries, Ursa, Indy).

- **The DID Communications Working Group (DIDComm)** was spun out of the Hyperledger Aries community and is now hosted at the DIF. This group develops and contributes to the standards and technology for authentication protocols. It is working to enhance and standardize protocols over the next year, with an emphasis on interoperability.

- **The Sovrin Foundation** is a 501(c)(4) non-profit entity that provides business, legal, and technical support for the Sovrin Network, an open-source project. Using DID technology, the Sovrin Network allows for digital credentials to be privately issued, controlled, managed, and shared. The growth of the Sovrin Network partly depends on contributions from an active open-source development community.

- **The Kantara Initiative** is an international ethics-based non-profit industry commons. Its mission to grow and fulfill the market for trustworthy use of identity and personal data.[134]

Currently, numerous organizations, including governments, financial institutions, and technology companies, are taking a "working code first" approach. Stakeholders recognize that the standards are not ready for broad adoption and are building out ecosystems using code that meets their needs while also shaping the standards and specifications that will be required for full interoperability. One key trend is the adoption of a consistent technology stack of Hyperledger Aries and Hyperledger Indy and the establishment of ecosystems around the globe (Canada, Finland, Germany, and more). These projects are driving several things forward:

- ## Interoperability Testing
  The Hyperledger Aries Interoperability Test[135] is being used to drive multiple areas of alignment, which is particularly crucial for governments. This approach is being used to drive other specifications such as the Wallet and Credential Interaction (WACI[136]) effort hosted at DIF.

- ## Trust Over IP 4-Layer Mode
  The Aries/Indy codebases align well with the Trust Over IP 4-layer model. Aries operates at Layers 2 and 3, while Indy provides the Layer 1 utility. Each project that is operating provides the Layer 4 ecosystem.

- ## Machine Readable Governance (MRG)
  This is a way of orchestrating governance rules and the functions of a conventional trust registry at the agent software level. MRG was developed by Indicio.tech and SITA for the Cardea Project, a complete ecosystem based on Indy and Aries for sharing digital health credentials and data in a privacy-preserving way. After a successful pilot with the Aruban government and health authorities, it was donated to Linux Foundation Public Health for use by public health agencies. The key advantages of MRG are flexibility (everyone can publish their rules, and these can be incorporated and updated according to hierarchy and need), speed (there is no transaction delay required by the need to contact a Trust Registry), and the ability to cache governance rules so that the system can work offline. Critically, Indicio and SITA found that Machine Readable Governance was the most effective way for the Aruban government to exercise its sovereignty over the process of COVID testing.[137]

The adoption of Digital Health Credentials will increase if interoperability allows travelers to share, issue, hold, and verify digital credentials across multiple networks. In practice, this would allow a traveler who received their COVID-19 test result credential from a health information exchange in one country and is able to present that credential to immigration officials in another country.

Thus, it is unlikely that there will be a single, shared ledger where credentials are anchored. Many ledgers will likely be involved in exchanging verifiable credentials, often referred to as a "network of networks." The governance and technical architecture of these networks must be carefully designed for interoperability and governed by principles that are consistent with privacy, security, and individual data ownership.

VERTICAL FOCUS #2: GOVERNMENT AND INTERNATIONAL INTEROPERABILITY

Various governments have started initiatives (some of them are listed below) in Decentralized Identity with user privacy as a key focus. Importantly, the trending privacy legislation of Europe, Canada, the U.S., and other global leaders addresses data transparency in commercial settings and the right as the data owner to have full control of their personal data and how it is used.

Canada	Province of Ontario's Digital ID Plan The Pan Canadian Trust Framework Public Sector Profile of the Pan-Canadian Trust Framework CIO Strategy Council - an official standards development organization
Estonia	Estonia Global ID Solution
European Union	Video Highlights of the European Commission Proposal Proposal for New E.U. ID News on Proposal for E.U. Digital Identity
Great Britain	Framework Solution
India	India's Digital Identity Program - Aadhar Digital IDs to Land Family Digital ID
Adoption of VC standards and/ or "progressive" or potentially Decentralized or Self-Sovereign Identity	ISO/IEC 29794 Series ISO/IEC 29109 Series ISO/IEC 24745 ISO/IEC 24761 ISO/IEC 19784-1:2018 ISO/IEC 24709-1:2017 ISO/IEC TR 29194:2015 ISO/IEC TR 29196:2015 ISO/IEC TR 30125:2016 ISO 19792:2015 ISO 24714:2015 ISO/IEC 29100 Privacy ISO/IEC 27018 Privacy ISO/IEC 29190 Privacy ISO/ IEC 29184 Management ISO/IEC 24760 Series

The Hindawi Survey on SSI provides a summary of the pioneering technical working groups and technology leaders in the space. But more comprehensive lists and descriptions may be found in the accompanying appendices, which may be updated.[136]

VERTICAL FOCUS #3: FINANCIAL SERVICES AND TAXATION

DeFi platforms are built upon DLT infrastructure and many expected CBDC deployments are expected to leverage the same technologies. A universal, user-centric access point to global financial infrastructure would create efficiencies alongside the development of these transaction networks. The Institute of International Finance published a detailed framework in the Global Assured Identity Network (GAIN) white paper which also details use cases.[139] The U.S. Financial Crimes Enforcement Network (FinCEN) is also pursuing solutions, using collaboration and innovation platforms to explore the efficacy of SSI implementations for financial services.[140]

Beyond creating an interoperable global financial network which allows rapid value exchange without an expensive intermediary, privacy engineering made possible by Decentralized Public Key Infrastructure (DPKI) would allow for efficient compliance tools to be developed such that capital markets participants can protect the anonymity of holdings while still being properly identified to challenge source of funds and identity of end users. This can root out bad actors and create further safeguards to prevent illicit activity.

Perhaps the most valuable application of Decentralized Identity in the long run will be the automation and standardization of tax laws. Currently, there is great political impetus to reduce tax avoidance and evasion, as evidenced by the new Global Minimum Tax proposal.[141] A more complete description of Taxation, standards, and applications can be found in the Global Taxation section of the GSMI 2.0 Report.

GAPS AND CHALLENGES AS IDENTIFIED IN THE HINDAWI SURVEY

Standards for Data Management and Wallets

Standard protocols, practices, and policies around user experience, data management, and data exchange should be carefully defined and implemented.

Key Management

In the SSI model, the responsibility for key management and its associated risks are placed on the shoulders of the users.

Consent

As stated in the General Data Protection Regulation (GDPR) consent given by the user must be meaningful, well-formed, unambiguous, specific, and freely given, specifying clear decisions.

Access

Certain DLT systems are public, allowing any entity to read or write to the ledger, while others are permissioned and allow only a selection of authorized entities to read or write new records into the ledger. If not carefully designed, the permissioned approach possesses the risk of forming a centralized architecture similar to an oligopoly among the few authorized entities.

Accountability and Governance

Certain identity management operations such as identity claim issuance, identity lookup, and secure storage of data may rely on some degree of centralization and dependence on trusted intermediaries.

Trust in Data

While there may be trust in the underlying SSI network as a secure, robust, and decentralized platform, the methods to form trust among the entities, and the trust in data including the verifiable credentials exchanged must be carefully designed. The authentication and data validation may need to be done through a trusted authority and outside of the blockchain network.

New Technology Adoption

As a new identity model, SSI requires various modifications to the existing system architectures. Particular attention must be given to the user experience, including the user interactions from the operator's perspective.

Investment and Commercialization

Any entity intending to adopt SSI must design a strategic plan that supports the investment and risk involved in the deployment and operation of such a system. The SSI economic model may lead to the chicken and egg problem where user adoption depends on the support of the service providers and vice versa.

RECOMMENDATIONS

- Governments are gradually adopting versions of the SSI framework, and this trend is likelyto continue. The first solutions will not be perfect, but experimentation will prove valuable. The beauty of Web 3.0 is the open-source nature of documentation, projects, pilots, and case studies made available to all who can contribute.

- Open standards and technologies will pave the way for wider adoption of decentralized identity standards globally. Stakeholders should stay informed of open-source community developments. The Hyperledger Foundation and other open-source consortiums frequently publish vast research repositories and case studies.

- Basic identifiers like national IDs, passports, etc. will always be issued by the founding authority. But in an SSI framework, the user will control their identifiers and with whom they would like to share them. Most developed nations are providing a legislative template for the rest of the world to follow.

- Interoperability and inclusion will be critical features in decentralized identity solutions going forward.

CONCLUSION

Leveraging decentralized public key infrastructure as the basis for SSI frameworks is a frontier development. Standards for DID methods, protocols, verifiable credential formats, and other technical ambiguities are being explored through trial and error. Although the end goal involves direct interaction with the individual, enterprise and government adoption are critical for rapid iteration and proliferation.

Institutions which adopt SSI frameworks will create economic efficiencies and rebuild eroding public trust. The open-source nature of early implementations will help create a robust and interoperable framework which laggards will benefit from, but early adopters will pave the way forward. The more intangible benefits of SSI will be portrayed in human form. By providing agency, basic digital identification, the ability to prove ownership of digital property, and banking services, each human being will have greater potential to self-actualize.

Data exchange networks envisioned by leaders today will allow for the "self-sovereign individual" to monetize their own data with control, autonomy, and privacy without sacrificing convenience. Travel across borders will be seamless. Electronic healthcare records will be accessible by the user regardless of location or insurance provider.

Financial services will be accessible to more people, who will be able to prove their identity with multiple sources of attestation without recurring registration or the creation of another set of siloed credentials vulnerable to data breaches.

The combination of public communication networks and privacy-preserving identity management tools will allow frictionless flow of data and value with automated accounting trails and transactions. To learn more about Digital ID, read the full report here.

SECTION VI

TECHNICAL

Landscape Assessment of Standards in Blockchain for Industry

TECHNICAL STANDARDS MAPPING

Building upon the work of GSMI 1.0 which mapped 34 technical standards, the GSMI 2.0 technical mapping matrix includes updates to existing mapped standards, removing two dormant standards initiatives, and five additional standards, expanding the net total mapping to 37 blockchain and distributed ledger technology (DLT) standards.

This landscape assessment updates the state of standardization for blockchain technology and DLT and specific examples of some of these efforts discovered in our research. Three case studies are highlighted: 1) ITU, 2) MOBI, 3) IWA TFF, as well as an update summary of technical upgrade proposals, and we conclude with next steps for GSMI 3.0 in 2022.

FORMAL ORGANIZATIONS

ENTITY *Denotes New	GEOGRAPHY	PURPOSE	TOPIC
Baseline Protocol[142]*	GLOBAL	The Baseline Protocol is an open-source initiative that combines advances in cryptography, messaging, and blockchain to execute secure and private business processes at low cost via the public Ethereum Mainnet. The protocol will enable confidential and complex collaboration between enterprises without leaving any sensitive data on-chain.	Data; Tokens; Security; Zero Knowledge Proofs (Cryptography)
BSI[143]	UNITED KINGDOM	The British Standards Institution (BSI) is the national standards body of the United Kingdom. It aims to share knowledge, innovation and methodologies to help people and organizations make excellence a habit.	DLT requirements
CCSA China Communications Standards Association[144]*	CHINA	The China Communications Standards Association is a professional standards organization responsible for developing communications technology standards. 1. Blockchain Innovation and Intellectual Property Development White Paper: 33 blockchain standards were included. 2. Financial Distributed Ledger Technology Application Guideline is the first financial blockchain international standard project led by China. It was approved in 2020. China wants to use this standard as a framework to: Contribute to the planning and layout of the financial blockchain international standards system; Create sub-standards such as reference frames, risk control, security and privacy protection, and financial blockchain business specifications in various fields.	Communication Technology

CEN[144] CENELEC[145]	BELGIUM	The European Committee for Standardization (CEN provides a platform for the development of European standards and other technical documents in relation to various kinds of products, materials, services and processes European Committee for Electrotechnical Standardization (CENELEC) prepares voluntary standards in the electrotechnical field, which help facilitate trade between countries, create new markets, cut compliance costs and support the development of a Single European Market.	Defence & Security, Quantum Technologies, Artificial Intelligence, Smart Grids, Environment and Sustainability, Cybersecurity, Digital Society,
CESI[146]	CHINA	The China Electronic Standardization Institute (CESI) works with standardization, conformity assessment, and measurement activities in the field of electronic information technologies. In the past couple of years, CESI has come up with a vision to introduce three blockchain standards on smart contracts, privacy, and deposits in a bid to better guide the development of the blockchain industry in the country The 2021 Global Industrial Internet Conference opened in Shenyang, the capital city of northeast China's Liaoning Province, on Oct. 19, 2021. CESI released the White paper on the Integration and Development of Blockchain and Industrial Internet at the Conference. According to the "Made in China 2025" national strategic plan and the current development of industrial blockchain in China, the White Paper aims to accelerate the adoption of industrial blockchain applications by making a standard system for industrial blockchain in China.	Tokens; Security
DCSA[147]	NETHERLANDS	The Digital Container Shipping Association (DCSA) was created to develop standards that facilitate the interoperability of technology solutions across the container shipping industry.	Cross-technology interoperability
ETSI[148]	FRANCE	The European Telecommunications Standards Institute (ETSI) provides the opportunities, resources and platforms to understand, shape, drive and collaborate on globally applicable standards.	Permissioned distributed ledgers
GS1[149]*	BELGIUM	GS1 develops global standards for business communication. Best known for the barcode, GS1 standards aim to improve the efficiency, safety and visibility of supply chains across physical and digital channels. Blockchain technology is addressed by certain standards.	Data; traceability
IEC[150]	SWITZERLAND	The International Electrotechnical Commission (IEC) promotes quality infrastructure and international trade in electrical and electronic goods.	Internet of things (IoT), Infrastructure Development, Sustainable energy
IEEE[151]	U.S.	The purpose of the Institute of Electrical and Electronics Engineers (IEEE) is to promote the development and application of electrotechnology and allied sciences for the benefit of humanity, the advancement of the profession and the well-being of its members.	Internet of things (IoT); cryptocurrency exchange and payment; tokens; energy; digital assets; - Focus on Blockchain in Healthcare (IEEE P2418.6) - Agriculture DLT (IEEE P2418.3) - Blockchain Governance (IEEE P2145 & IEEE P3212) - Smart Legal Contracts (IEEE P2963)
IETF[152]	U.S.	The purpose of the Internet Engineering Task Force (IETF) is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.	Cryptocurrency payment, Internet of Things (IOT), Security and Privacy

International Chamber of Commerce (ICC)[153]	FRANCE	The ICC launched the Digital Standards Initiative (DSI)to enable interoperability between blockchain and other technology platforms in the global trade space.	Digital interoperability
IRTF[154]	U.S.	The Internet Research Task Force (IRTF) aims to promote research for the evolution of the internet.	Identity; digital assets
ISO[155]	SWITZERLAND	The International Organization for Standardization (ISO) is an independent, non-governmental, international organization that develops standards to ensure the quality, safety and efficiency of products, services and systems.	Security; privacy; identity; interoperability; governance; smart contracts
ITU-T[156]	SWITZERLAND	The International Telecommunication Union Telecommunications (ITU-T) sector ensures the efficient and timely production of standards covering all fields of telecommunications and information communication technology (ICTs) on a worldwide basis, and defines tariff and accounting principles for international telecommunication services.	Security; IoT; identity; DLT requirements; mobile payment security; digital financial inclusion; digital assets including digital currency
SAC[157]	CHINA	The Standardization Administration of the P.R.C. (SAC) exercises administrative responsibilities by undertaking unified management, supervision and overall coordination of standardization work in China.	DLT requirements
Standardization Technical Committee of China Food Association New*	CHINA	The Standardization Technical Committee is responsible for verifying all drafted standards and making development strategies for the Association. Recent updates: Management Requirements for Food Traceability Blockchain Application (under released).	Standardization Technical Committee of China Food Association
Standards Australia[158]	AUSTRALIA	Standards Australia coordinates standardization activities and facilitates the development of Australian standards.	Security; DLT taxonomy
WIPO[159]	SWITZERLAND	The World Intellectual Property Organization (WIPO): 1) promotes the protection of intellectual property throughout the world through cooperation among states and, where appropriate, in collaboration with any other international organization; and 2) ensures administrative cooperation among unions.	Application of blockchain to intellectual property
W3C[160]	N/A	The Worldwide Web Consortium (W3C) is developing protocols and guidelines that ensure long-term growth for the web. It is an agreement amongst 4 host participants: MIT, INRIA (France), Keio University (Japan), and Beihang University (China) + its nearly 400 members.	Identity, Verifiable claims
Zhejiang Blockchain Standardization Technical Committee*	CHINA	The Blockchain Standardization Technical Committee was initiated by the Economy and Information Technology Department of Zhejiang Province with committee members like Zhejiang University, Ant Financial and 8BTC. The Committee is working to promote the advancement of the blockchain industry by undertaking and developing blockchain standards for Zhejiang Province.	dApps, DID

INDUSTRY GROUPS

ENTITY *Denotes New	GEOGRAPHY	PURPOSE	TOPIC
BIA[161]	ESTONIA	The Blockchain Industrial Alliance (BIA) seeks to promote cross-blockchain transactions and interconnectivity. The goal of this alliance is to create a globally accepted standard for connecting blockchains and to bring innovations together.	Interoperability, Smart Chains, Blockchain Platforms
BIG[162]	CANADA	The Blockchain Industry Group (BIG) is dedicated to the advancement and adoption of blockchain technologies through the development and promotion of blockchain standards, education, certifications and collaboration.	DLT requirements (in progress), Governance, Education
BiTA Standards Council[163]	U.S.	The Blockchain in Transport Alliance (BiTA) Standards Council is seeking to develop and embrace a common framework and standards from which transport/logistics/supply-chain participants can build blockchain applications.	Interoperability; DLT requirements
EEA[164]	U.S.	The Enterprise Ethereum Alliance (EEA) builds, promotes, and broadly supports Ethereum-based technology methodologies, standards and a reference architecture.	Interoperability; security; cross chain, NIST-compatible Ethereum;
GDF[165]	UK	Global Digital Finance (GDF) is an industry membership body that promotes the adoption of best practices for cryptoassets and digital finance technologies, through the development of conduct standards, in a shared engagement forum with market participants, policy- makers and regulators.	DLT requirements
Hyperledger Foundation[166]	U.S.	The Hyperledger Foundation is an open-source community focused on developing a suite of stable frameworks, tools and libraries for enterprise-grade blockchain deployments. It serves as a neutral home for various distributed ledger frameworks, including: Hyperledger Besu, Burrow, Fabric, Sawtooth, Iroha, and Indy; tools such as Hyperledger Avalon, Caliper, Cactus, Cello, Explorer, and Firefly; domain-specific projects such as Hyperledger Grid; and libraries such as Hyperledger Ursa, Aries, Quilt, and Transact.	Interoperability; tokens; blockchain platforms; identity
Institute of International Finance (IIF) and TSVCM[167]	U.S. AND GLOBAL OFFICES OF IIF	The Taskforce on Scaling Voluntary Carbon Markets (TSVCM) is a private sector-led initiative working to scale an effective and efficient voluntary carbon market to help meet the goals of the Paris Agreement. The task force is led by the Institute of International Finance (IIF) The Taskforce's unique value proposition has been to bring all parts of the value chain to work intensively together and to provide recommended actions for the most pressing pain-points facing voluntary carbon markets.	Core Carbon Principles (CCPs), Governance, Legal Principles & Contracts Credit Level Integrity in Voluntary Markets
IWA[168]	U.S.	The InterWork Alliance (IWA) is working to: develop standards-based interworking specifications at the token and smart contract level; simplify and standardize multi-party exchanges; and build specifications and tools to define tokens and smart contracts in a platform-neutral way. IWA does not focus on the underlying technology, as digital interchanges of value must work regardless of the underlying technology to grow at scale. Instead, IWA focuses on defining token/smart contract requirements, and developing taxonomies and definitions for tokenization and smart contracts for identified use cases such as carbon markets and debt/equity issuance.	Interoperability; tokens (Token Taxonomy Framework); smart contracts (InterWork Framework); carbon markets; debt/equity issuance

JWG[169]	U.S. AND UK	The Joint Working Group on interVASP Messaging Standards (JWG) identified the need for VASPs to adopt uniform approaches and establish common standards to enable them to meet their obligations resulting from the FATF recommendations as they apply to affected entities. To tackle this, a cross-industry, cross-sectoral joint working group of technical experts was formed in December 2019 and a new technical standard developed by the group.	Tokens
MOBI[170]	U.S.	The Mobility Open Blockchain Initiative (MOBI)'s Vehicle Identity Working Group (VIWG) aims to use DLT to make mobility safer, greener, cheaper and more accessible.	Vehicle identity; usage-based insurance; electric vehicle grid integration; connected mobility and data marketplace; supply chain and finance; securitization and smart contracts
National Blockchain and Distributed Ledger Technology Standardization Technical Committee[171]	CHINA	This is a group of organizations that have joined a national committee focused on creating standards for blockchain technology.	DLT requirements; DLT terminology

MAJOR STANDARD-SETTING EFFORTS – PROPOSALS

- Bitcoin improvement proposals (BIPS)[172]
- Ethereum improvement proposals (EIPs)[173]
- zCash improvement proposals (ZIPs)[174]
- -XRP ledger amendments[175]
- Diem improvement proposals (DIPS)[176]

CASE STUDY #1: ITU-T STANDARDIZATION SECTOR STANDARDIZATION WORK ON DLT UPDATE

BACKGROUND

The FG DLT was established in May 2017 and completed its work in 2019. It aimed to:

- Identify and analyze DLT-based applications and services
- Draw up best practices and guidance
- Propose a way forward for related standardization work in ITU-T study groups.

STANDARDS

Several specifications and reports have been made available through the FG DLT, such as DLT terms and definitions, DLT use cases and assessment criteria for DLT platforms. Next to the FG DLT, ITU-T consists of several study groups focusing on a specific topic together with DLT.

In particular, Question 22 of ITU-T Study Group 16 focuses on multimedia aspects of DLT related systems and their use in e-services (e.g., healthcare, supply chain logistics, telecom, financial services, etc.). Study items in Question 22 include, but are not limited to:

- concepts, coverage, vision, and use cases of e-services based on DLT;
- characteristics and requirements for e-services based on DLT;
- architectural framework and communication technologies of e- services based on DLT;
- analysis and evaluation of the current status of DLT and its maturity to support e-services;
- investigate the relations between DLT, digital fiat currencies and crypto tokens, including management, exchange and transactions, etc.;
- define general requirements and framework for DLT;
- research security and privacy aspects related to e-services based on DLT;
- examine means for extending online trust in the context of e-services using DLT;

In addition, other study groups where standardization work on DLT is happening include:

- ITU-T Study Group 3: Economic and Policy Issues. The standardization work on DLT here focuses on its application in accounting/ settlement process in telecoms
- ITU-T Study Group 13: Future networks, with focus on IMT-2020, cloud computing and trusted network infrastructures
- ITU-T Study Group 17: Security
- ITU-T Study Group 20: Internet of things (IoT) and smart cities and communities (SC&C)
- ITU-T Focus Group on Environmental Efficiency for Artificial Intelligence and Other Emerging Technologies (FG-AI4EE)

Following the completion of the work of the ITU-T Focus Group on Digital Currency including Digital Fiat Currency in 2019, the ITU established the Digital Currency Global Initiative in collaboration with Future of Digital Currency Initiative of Stanford University in 2020. The Digital Currency Global Initiative work is to investigate areas where technical standards would be needed for integrating central bank digital currencies, stablecoins and cryptocurrencies to existing payment system and also study the applications of DLT in enabling this to happen. The Digital Currency Global Initiative consists of three working groups:

- Policy & Governance,
- Architecture, Interoperability Requirements and use cases

CASE STUDY #2: MOBI UPDATE

The standards developed by MOBI serve as a foundation for the mobiNET network. The mobiNET will offer mobility stakeholders and related businesses an open and inclusive core services infrastructure for decentralized transactions at the edge. The goal is to unlock monetization opportunities across mobility and transportation services by allowing application interoperability and multi-party data sharing.

- New standards from the Vehicle Identity (VID), Electric Vehicle Grid Integration (EVGI), Connected Mobility Data Marketplace (CMDM), Finance, Securitization, and Smart Contracts (FSSC), and Supply Chain (SC) working groups

Updated description for the VID working group:

> The **VID working group** aims to define a digital document that is a verifiable link to a specific vehicle, a minimum representation of that vehicle's digital twin. VID can be used to establish existence, manage access control, confirm ownership history, and contain key events in the life of a vehicle.

Descriptions for the other working groups:

> The **EVGI working group** aims to aid the increasing adoption of electric vehicles by creating interoperable systems for governments, utilities, and the mobility industry alike. These systems will enable a better way to manage the grid load, calculate carbon offsets, and generate carbon credits, facilitating the implementation of peer-to-peer services. The first standard defines the system, and data requirements for three core use case areas: Vehicle to Grid (V2G), Peer to Peer (P2P), and Tokenized Carbon Credits (TCC).

> The **CMDM working group** aims to enable a DLT-based data marketplace for all stakeholders of the mobility ecosystem — including OEMs, insurance providers, infrastructure operators, and others — to effectively share data with their business partners while complying with emerging regulatory and industry best practices for preserving data privacy and property rights. The CMDM Standards provide a foundation for a multitude of applications, including but not limited to V2X data exchange, connected vehicle commerce, and sharing/monetizing AV driving data for better driving algorithms through machine learning.

> The **FSSC working group** strives to improve accuracy and transparency, create operational efficiencies, minimize fraud risks, and save on costs and time in the execution of financings, including securitizations, for all entities in the financing lifecycle. The FSSC Standards leverage distributed ledger technologies to create a trust layer for transactions and data exchange within a shared digital ecosystem.

> The **SC working group** assesses the value proposition of blockchain in mobility supply chain management for stakeholders of the procurement, logistics, and finance or accounting divisions, including Original Equipment Manufacturers, N-tier suppliers, and further business partners. The group aims to create interoperability standards to bring operational efficiencies and increased visibility through the N-tiers; enable provenance, tracking, and authenticity of parts and vehicles; and improve conflict resolution and settlement with distributed ledger technology (DLT).

MOBI are also working on a layer above the mobiNET, which is named Citopia. Citopia is a multimodal mobility payments platform built on blockchain that allows for the monetization of infrastructure use (i.e., road usage) and other new mobility services. The following information was pulled from the MOBI website on the specific MOBI Working Group standards: MOBI has a number of working groups that are creating different types of standards. Anyone can gain full access to their white papers and use cases and business requirements documents and partial access to the technical

specifications and reference implementation architectures. MOBI members are provided full access to the technical specifications and the reference implementation architectures.

0001 – Business White Papers (WP)	MOBI Business White Papers are high-level business reviews that discuss issues and propose solutions to the world's most pressing transportation challenges with consideration to ecosystem stakeholders, new strategies, emerging technologies, and global policies.
0002 – Use Cases and Business Requirements (UC)	MOBI Use Cases and Business Requirements documents describe pain points, stakeholder responsibilities, and high-level business requirements potential solutions must meet in order to resolve stakeholder needs. UCs also detail workflows for particular applications and are technology-agnostic.
0003 – Technical Specifications (TS)	MOBI Technical Specifications define recommended minimum interfaces between systems/modules and data specification exchanged in the process leading up to a reference implementation. This process allows independently developed systems to be interoperable.
0004 – Reference Implementation Architectures (RI)	MOBI Reference Implementation Architectures prescribe and recommend a solution architecture stakeholders can refer to when they deploy solutions, ensuring that stakeholder requirements described in TS and UC are met in the process. RIs are vendor-agnostic.

Standards in Vehicle Identity (3 new/updated standards since GSMI 1.0)	• MOBI VID0001/WP/2021 — VERSION 2.0 – VID Business White Paper • MOBI VID0003/TS/2019 — VERSION 1.0 – VID I Technical Specifications • MOBI VID0002/UC/2021 – VERSION 2.0 – VID II Use Cases and Business Requirements • MOBI VID0004/RI/2021 – VERSION 1.0 – VID II Reference Implementation Architecture
Standards in Electric Vehicle Grid Integration (EVGI) (new since GSMI 1.0)	• MOBI EVGI0001/WP/2020 – Version 1.1 – EVGI Business White Paper • MOBI EVGI0003/TS/2020 – Version 1.0 – EVGI Technical Specifications
Standards in Connected Mobility Data Marketplace (CMDM) (new since GSMI 1.0)	• MOBI CMDM0001/WP/2021 – Version 1.0 – CMDM Business White Paper • MOBI CMDM0003/TS/2021 – Version 1.0 – CMDM Technical Specifications
Standards in Finance, Securitization, and Smart Contracts (FSSC) (new since GSMI 1.0)	• MOBI FSSC0001/WP/2021 – Version 1.0 – FSSC Business White Paper • MOBI FSSC0003/TS/2021 – Version 1.0 – FSSC Technical Specifications
Standards in Supply Chain (SC) (new since GSMI 1.0)	• MOBI SC0002/UC/2021 – Version 1.0 – SC Use Cases and Business Requirements • MOBI SC0004/RI/2021 – Version 1.0 – SC Reference Implementation Architecture

CASE STUDY #3: TOKEN TAXONOMY FRAMEWORK OVERVIEW, SPECIFICATIONS, AND IMPLEMENTATIONS

Tokens will disrupt global economics and radically change how commerce will be transacted. While various implementations exist today for tokens specific to numerous blockchain platforms, the industry lacks a venue for all participants to collaborate on a shared description and approach – resulting in a lack of interoperability, reuse, and common ground to address regulatory issues. The IWA is a member-led non-profit with over 30 organizations mapping requirements and artifacts into a variety of use cases. The IWA working groups are developing a clear definition and scope of the token concept including use cases, taxonomy and terminology, and a specification neutral to the underlying technology.

BACKGROUND

The Token Taxonomy Framework (TTF) is an open-source, extendable framework for defining and tokenizing digital assets, and serves as one of the core technical frameworks for the InterWork Alliance (IWA), a GBBC initiative focused on creating standards around tokenization to promote interoperability and cooperation. The goal of the TTF is to provide a language by which tokens can be discussed, architected, and standardized across industry verticals.

The view of the TTF is that a token can be broken down into a core set of attributes: a token base type (e.g., fungible or non-fungible), properties (data contained in the token, e.g., manifest data), and behaviors (e.g., transferable, burnable, etc.). Using these artifacts, one can construct a whole new token based on a repository of artifacts that are contributed by the IWA membership. This open source, composable framework allows for artifacts to be repurposed to meet the requirements of new use cases.

The Token Taxonomy Framework bridges the gap between developers, line of business executives, and regulators, allowing them to work together to model existing and define new business models based on tokens. The Framework's purpose is to:

- Clearly define common token concepts and terms in non-technical and cross-industry language using real world, everyday analogies so that business, technical, and regulatory participants can understand them.
- Produce token definitions that have clear and well-understood requirements for token properties and behaviors that are implementation neutral for developers to follow and standards organizations to validate.
- Establish a base Token Classification Hierarchy, driven by metadata, that is simple to understand and navigate for anyone interested in learning and discovering tokens and underlying implementations.
- Deliver tooling meta-data that enables the generation of visual representations of classifications, and modelling tools to view and create token definitions mapped to the taxonomy.
- Produce standard artifacts and control message descriptions mapped to the taxonomy that are implementation neutral and provide base components and controls that consortia, startups, platforms, or regulators can use to work together.
- Encourage differentiation and vertical specialization while maintaining an interoperable base.

RESOURCES

REAL-WORLD TTF (7-STEP JOURNEY)

TOKEN TAXONOMY FRAMEWORK PUBLIC GITHUB

INTRODUCTION TO TOKEN TAXONOMY FRAMEWORK

TOKEN TAXONOMY SPECIFICATIONS

TOKEN TAXONOMY IMPLEMENTATIONS

TOKEN TAXONOMY AND CENTRAL BANK DIGITAL CURRENCY (CBDC)

TOKEN TAXONOMY AND VOLUNTARY ECOLOGICAL MARKETS WHITE PAPER

CARBON REMOVAL AND THE DIGITAL MEASUREMENT, REPORTING & VERIFICATION FRAMEWORK BUILT WITH THE TOKEN TAXONOMY FRAMEWORK

HEDERA & THE HBAR FOUNDATION ANNOUNCE THE FIRST OPEN SOURCE TTF REFERENCE IMPLEMENTATION FOR PARTNER ECOSYSTEMS.

IWA OPEN-SOURCE TOKEN DESIGNER TOOL

GITHUB – INTERWORKALLIANCE/TOKEN-DESIGNER: VS CODE EXTENSION THAT FACILITATES MANIPULATION OF ARTIFACTS IN THE TOKEN TAXONOMY FRAMEWORK

GSMI 1.0 WEF APPENDIX A

REFERENCE ARCHITECTURE COMPARISON: FUNCTIONS OF STANDARDS IN KNOWLEDGE-INTENSIVE INDUSTRIES

NEXT STEPS

Blockchain and DLT standards, both formal and industry-led, continue to evolve and remain at nascent stages. Areas of further technical mapping include interoperability, Layer 2 protocols, DeFi protocols, Decentralized Autonomous Organizations (DAOs), and other standards bodies which emerge as the industry evolves in 2022 for GSMI 3.0. In addition to mapping technical standards, there is development work in the areas of standards in blockchain / DLT audit, certification, security, and environmental impact metrics which may be explored in the future. The GSMI Technical Working Group welcomes suggestions for improvements and additions.

SECTION VII

GREEN ECONOMY

The word "green" has been used for years as a vague placeholder for taking care of, and improving, the world's natural resources. Our working group's goal is to make "green" quantifiable. A significant number of organizations are using technology to tackle the world's environmental problems; this working group has examined their work, documented the most relevant initiatives, and highlighted key topics to inform and recommend how those in the market can address these challenges moving forward.

DEFINING THE 'GREEN ECONOMY'

The International Chamber of Commerce (ICC) defines a green economy as "embedded in the broader sustainability development concept" and "as an economy in which economic growth and environmental responsibility work together in a mutually reinforcing fashion while supporting progress on social development."[177] More simply, a green economy is defined as an economy that is low carbon, resource efficient, and socially inclusive. The Organisation for Economic Co-operation and Development (OECD) has identified six strategic pillars in its Green Growth Strategy, including:

1. Climate change
2. Resource saving and management
3. Circular economy
4. Environmental protection
5. Ecosystem protection and recovery
6. Water conservation and natural disaster prevention.[178]

Regulatory changes across the developed world are obliging institutions to be more honest about carbon neutrality claims. Entities are now working to reduce carbon dioxide emissions or other greenhouse gases to compensate for emissions made elsewhere. This is known as carbon offset. The demand for voluntary carbon offsets is estimated to be at U.S.$50B by 2030; this is still in a very early growth phase.[179] The success of carbon credit offsets has been constantly hampered by two constant challenges:

1. The data available for buyers of carbon credit offsets does not meet sufficient due diligence standards for most global corporations; and

2. The supply of carbon credit offsets associated with removing CO2 from the atmosphere accounts for only around 5% of the market.

Many expect carbon credit offsets related to removal of CO2 to become the most dominant part of the market given the correct governance framework.[180] Where will these offsets be found? According to Drawdown by Paul Hawken, the top solutions to global warming (with a total potential carbon savings of 584 Gigatons of CO2e by the year 2050)[181] will be found in refrigeration, wind turbines, reduced food waste, plant rich diet, tropical forest, women's education, family planning, solar farms, silvopasture, and rooftop solar.

Because CO2 emissions in these areas are harmful, organizations are working together to target net-zero carbon emissions. While carbon credits are not the only solution, they have a quantifiable impact and identify core principles that are critical to driving such an impact.

GREEN MARKETPLACE

For this paper, "green" is defined as an aggregate of players from both the supply and demand side who want low energy consumption and less waste; they use sustainable materials, follow environmental laws and regulations, and want to both quantify and verify their valuations in an auditable way. A "green" product, service or solution is one that contributes to the marketplace by reducing or offsetting carbon/pollution footprints. This can often be achieved

by purchasing Renewable Energy Certificates (RECs), Carbon Credits, or using other systems – such as 24-hour renewable power procurement.

The cost of offsetting corporate carbon emissions is expected to surge over the next decade.[182] As more organizations take on "green" initiatives, the growth in demand for carbon credits will outpace the supply of measurable and verifiable offsets. In addition to the demand for carbon credits, organizations are looking to offset energy usage with RECs. Corporate giants like Microsoft have recognized that "while we can't control how our energy is made, we can influence the way that we purchase our energy."[183]

Electricity currently generates 25% of the world's greenhouse gas emissions.[184] A carbon-free electricity sector, is considered the foundation for decarbonizing other sectors of the economy, establishing net-zero emissions, and creating a green global economy.[185]

Traditionally, matching energy supply and demand has been one of the largest problems of the transition to renewable energy.[186] Today, technologies facilitate 24/7 carbon-free energy,[187] which focuses on matching the temporal and spatial particulars of clean energy and an organization's energy load profile.[188] The new trend of 24/7 energy procurement will pave the path to true net-zero emissions for many.

There are two major types of carbon markets: voluntary and regulated. The voluntary markets are not under any governmental agency or regulatory control or sanction, which means participants are active based on natural market forces or social responsibility to the consumers in the market. For example, environmental, social and governance (ESG) criteria, defined by socially conscious investors, are used to screen potential investments based on company operations. Regulated markets, on the other hand, require a governmental agency, either a nation-state or treaty, to enforce industry compliance.[189]

ROLES AND RESPONSIBILITIES

To effectively impact communities and focus recommendations, it is important to understand participants in the global marketplace. Key players and their roles in the marketplace include:

- **Supra-national organizations**
  Agenda setting and global initiatives and commitments
- **Governments**
  Regulations, task force investigations into "green" systems and enhancement, as well as Voluntary Carbon Market Investment Promotion Agencies (IPAs), branches of existing investment agencies or as new institutions, helping countries attract private investment from the VCM and support national climate objectives.
- **Producers/Project Developers**
  Carbon offsetting and renewable energy procurement solutions, following market and technical standards organizations (IWA, TSVCM, ISO, EWF, RMI, AIR, CCA, VCS, "The Gold Standard", CAR, ACR)
- **Financial Institutions/ Exchanges**
  Providing a way to easily trade carbon credits/ tokens, creating tokens to trade.
- **Financiers**
  Providing energy projects finance (e.g., sequestration project funding, Rabo Carbon Bank).
- **Standards Organizations**
  Managing measurement standards, additionality, permanence, preventing leakage.
- **Registries**
  Institutions that can record and validate if an organization has followed specific protocols.
- **Verifiers/Auditors**
  Individuals who have the authority to determine if the claims of an organization are correct.

- **Retailers**
  Using carbon offsets in their production and other operations.

- **Consumers**
  Purchasing from retailers who are following green standards.

- **Decarbonization consultants**
  Working with businesses on supply chain and Scope 3 emissions (the result of activities from assets not owned or controlled by the reporting organization[190]), measurement, reduction, and offset.

- **Tech companies**
  Providing trackers (including trackers integrated with bank account or spending data), as well as bilateral offset solutions.

- **HR/Employee solutions**
  Offsetting for businesses in terms of their employee and operational footprint.

HOW DO THESE ROLES FUNCTION WITHIN THE VOLUNTARY AND MANDATORY MARKETS?

The Voluntary Carbon Market (VCM) offers tools to estimate and measure GHG emissions and removals, and - by utilizing a range of standards, protocols, and greenhouse gas (GHG) crediting programs - enables the creation of tradable carbon credits. The VCM enables private actors to drive climate benefits beyond their own operations. The VCM typically complements the United Nations Framework Convention on climate change known as the Kyoto Protocol, and other regulated carbon markets, with VCM project developers filling gaps left by the mandatory market.

Both the direct and indirect economic impacts of the VCM and their subsequent contributions to the Green Economy can be significant. A study from the Imperial College and the International Carbon Reduction & Offset Alliance (ICROA) estimates that each ton of emission reduction from a voluntary project creates value two orders of magnitude greater than the average carbon price.[191] These benefits include local employment

in the projects, the use of local products and services when implementing and operating projects, provision of services or products for the local economy, conservation of domestic ecosystems, technology transfer, capacity building using new technologies, and empowerment of local communities.

Entities engage in the VCM to identify cost-effective solutions to reduce their corporate carbon footprint or to meet carbon neutrality or net-zero goals. While some companies prefer to purchase carbon credits from small, locally owned mitigation projects, corporations typically look to purchase credits from larger-scale (often "charismatic") projects. These projects generate high volumes of credits, thereby reducing buyers' transaction costs, while providing social and environmental co-benefits. Corporations also seek to avoid reputational damage by requiring robust environmental integrity of the carbon credits they purchase.[192] The surge in companies seeking to offset both direct and indirect carbon generation has precipitated a supply and demand issue. Trends worth noting include:

- Carbon pricing (sufficiently high) is considered part of the essential framework for creating real value implications for high carbon activity, thereby changing business and consumer behavior
- Business, consumer, finance, and investment product development around carbon offsets and markets is increasing
- Incentives include the ability to connect with consumers, maintain social responsibility, and improve the effects of climate change
- Voluntary blockchain-based carbon projects include DOVU, puro.earth, REDD+, UPCO2, Nori, CarbonX, Moss.earth, AIR Carbon, and Xpansiv; these projects are in the early stages of development; many have secured significant financial backing to support their efforts – most are contributing market requirements to develop correct mapping for standardization.

Carbon registries and standards vary in diligence and stringency. Requirements and obligations between parties must be contractual to ensure the necessary standards are met. Carbon registries have their own terms of use and explicit provisions limiting their liabilities. Arguably, a better regulated market would provide for greater environmental integrity, transparency, and legal certainty.

Mandatory Markets are used by entities required to show proof of offsetting carbon emissions. The United Nations Framework Convention on Climate Change (UNFCCC), formed in 1992, established the foundation upon which the Kyoto Protocols of 1997 and the subsequent Paris Agreements of 2016 were built. These internationally binding agreements created the Nationally Determined Contributions (NDC) by which Countries party to the U.N.'s Framework Convention on Climate Change (UNFCCC) may set up mandatory reporting programs to improve national inventory estimates.

NATIONAL, REGIONAL, AND SUBNATIONAL JURISDICTIONS WITH MANDATORY AND PROPOSED MANDATORY REPORTING REQUIREMENTS INCLUDE:

Australia	National Greenhouse and Energy Reporting Scheme
California	Mandatory GHG Reporting Program
Canada	GHG Emissions Reporting Program
China	Proposed national reporting program
European Union	E.U. Emissions Trading System
France	Bilan d'Emission de GES
Japan	Mandatory GHG Accounting and Reporting System
Mexico	National Emissions Registry
Norway	Emissions Trading System
South Africa	Proposed national GHG reporting program
Turkey	GHG Reporting Scheme
United Kingdom	GHG Reporting Program
United States	GHG Reporting Program

In the U.S. in 2009, GHGs that represent the largest drivers of human-caused climate change (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) were ruled to endanger public health by the U.S. Environmental Protection Agency (EPA). They are thereby subject to the Clean Air Act. Starting in 2010, large emitters of greenhouse gases were required to begin collecting data under a new reporting system. In 2011, fossil fuel and industrial GHG suppliers, motor vehicle and engine manufacturers, and facilities that emit 25,000 metric tons or more of CO2 equivalent per year began to report GHG emissions data to EPA annually; these metrics have formed the basis of NDC reporting under the Paris Agreement in the U.S.[193]

These NDCs help to develop economy-wide or sector-specific programs that address national and subnational priorities and objectives. The Paris Agreement is one of the most prominent examples of a mandatory market and is the basis for most demand metrics. Its goal is to limit global warming to well below 2 (preferably 1.5) degrees Celsius, compared to pre-industrial levels. This is the basis for most demand metrics. The Paris Agreement provides a framework for financial, technical, and capacity building support for interested countries.

IT'S NOT EASY BEING GREEN

The latest Intergovernmental Panel on Climate Change (IPCC) report stated that climate change is "widespread, rapid, and intensifying."[194]

> Stabilizing the climate will require significant, sustained reductions in greenhouse gas emissions.

If green or carbon markets are going to be used as the primary vehicles for responding to climate change, certain issues must be addressed. Organizations including the Science Based Targets Initiative, Science Based Targets Network, Natural Climate Solutions Alliance, Oxford Principles for Net-Zero Aligned Carbon Offsetting, Greenhouse Gas Protocol, Climate Disclosure Standards Board, and Task Force on Climate-Related Financial Disclosures agree the following climate principles are critical to aligning carbon markets with the ambitions of the Paris Agreement:

- **Science-based action**
  Companies align with science-based mitigation hierarchy – emission reductions should be first-order priority in value chains
- **Comprehensive action**
  Climate targets and action are built on accurate and complete greenhouse gas inventories in-line with the requirements set out in the GHG Protocol
- **Equity oriented**
  Climate targets should be consistent with achievement of broader sustainable development goals and the concept of a "just transition"
- **Nature-positive**
  Efforts should prevent or mitigate nature and biodiversity loss; move toward a nature-positive state of recovery and renewal
- **Rapid action**
  Goals should target immediate action on climate, recognizing this decade is critical if we are to avert potential tipping points
- **Scaled up action**
  Ambitions must be raised to make significant investments in climate mitigation outside of immediate value chains
- **Transparent action**
  The scope, boundary, use of carbon credits, and terminologies used in commitments must be transparent; progress and learnings are publicly reported
- **NDC enabling action**
  Companies contribute to the finance flows needed to achieve climate ambition in Nationally Determined Contributions (NDCs) under the Paris Agreement
- **Consistent action**
  Companies require climate action plans that fully align their businesses with net zero, including everything from investments, governance structures, lobbying efforts, and the advocacy of affiliated industry associations
- **Collective and predictable action**
  Companies align VCM engagement with host country policies and work in partnership with other corporations, NGOs, and local stakeholders

THE CHALLENGES - *DIFFERENT, SILOED STANDARDS AND METHODOLOGIES*

Though reputable carbon standards seek to verify carbon credits, there is not yet a formalized standard for real and verified carbon credits regarding common quality features: (i) robust baselines; (ii) additionality; (iii) permanence of emission reductions or removals; (iv) addressing leakage; and (v) absence of double counting. VCM registries enable the public to view some details about projects and carbon credits, but differences in methods used to collect and organize data make comparison difficult. Data is not always

detailed enough to conduct independent assessments of carbon credit quality features, and the price may not always be indicative of the quality of carbon credits.

VALIDATING CLAIMS - *NET ZERO, CARBON NEUTRAL CLAIMS OR ASPIRATIONS*

It is critical to ensure claims are true, clear, and relevant to their target audience and substantiated with objective, transparent, and up-to-date data. Additionally, they should not overstate their beneficial environmental impacts and avoid creating a false impression or hiding trade-offs.

HOW DO WE SCALE UP HIGH QUALITY CARBON PROJECTS TO ACCELERATE OUR TRANSITION TO NET-ZERO, AND HOW CAN BLOCKCHAIN HELP ACHIEVE THESE GOALS?

Some companies make environmental or ecological claims regarding environmentally friendly practices they follow. To push companies in the right direction while making green practices easily adoptable, organizations like the Taskforce for Scaling Voluntary Carbon Markets (TSVCM), Crypto Climate Accord (CCA), and others have published standards to reduce carbon in our atmosphere. Blockchain can help solve these problems. However, it is important to note that energy use is an increasing problem for the climate. Although the Proof-of-Work (PoW) consensus, popularized by Bitcoin, provides immense security and decentralization, it uses much more energy than other consensus mechanisms like Proof-of-Stake (PoS). The Bitcoin blockchain has about the same carbon footprint as the country of Chile.[195] Several blockchain protocols are being developed that address this problem; it is critical that blockchains are interoperable and allow for multi-party interaction so that they do not contribute to this problem.

ALIGNMENT, SCALE, AND SOLUTIONS

The problems outlined above cannot be addressed if technology solutions are not aligned for specific use cases. Many legacy technology solutions are not working because they are not scalable, measurable, or results are not tangible, leading to incentives that are not aligned. But blockchain is proving to be a powerful technology because it can facilitate an ecosystem of value exchange across

industries.

Robert Opp, Chief Digital Officer for the United Nations Digital Program, stated that blockchain can play a significant role in creating digital ecosystems by understanding the ecosystems, identifying their core use cases, and validating the areas they can impact by providing a scorecard on impact toward the SDGs[196].

The results can be measured, promoted, and funded. Blockchain technology is either introducing or improving the following digital ecosystems: digital identification, supply chain traceability, energy, remittances, financial inclusions, and land registries by:

Allowing for efficient multi-party tracking, traceability, and proof of green reporting, making it possible to track the journey of the carbon credits and carbon in the atmosphere

Preventing "double-spending," a vital piece when it comes to offsetting carbon

Enhancing transparency, security, and creating a trustless environment.

Green Standards Organizations are also defining and aligning basic taxonomy, especially around tokenization, which is covered in depth in the technical and taxonomy sections of GSMI 2.0.

DEFINING AND TRADING DIGITAL VERSIONS OF TANGIBLE ASSETS

An example of this is TSVCM's Core Carbon Principles for tokenization of digital assets. TSVCM published this blueprint to create a large-scale, transparent carbon credit trading market. A large-scale voluntary carbon market is critical to reaching the goals of the Paris Agreement as it enables companies to turn net-zero commitments into action through investments in emissions abatement projects.

For a voluntary market to flourish, a standard must be defined for the tokenization of assets.

On the demand side for removals via credits, IWA mapped an open source, interoperable token that aligns with the TSVCM's Core Carbon Principles (CCP). The CCP defines a "token" as representing a specified volume of metric tons of GHG emissions reduced or removed by a project. The technique for reduction or removal of GHGs in a project, its measurement, and verification methodology are found in the Verification Contract and the issuing standard registry.

The CCP is a tradeable digital asset whose price is determined by the market using the associated information. The CCP has standard data elements that represent the shared view required by the parties in the carbon market from suppliers, buyers, validation and verification bodies (VVBs), registries, and exchanges. These standard data elements are based on the recommendations from the TSVCM.

Working together with TSVCM, IWA introduced its tokenization recommendations in May 2021. Every CCP must be unique to derive value in a market. The following is an overview of the artifacts of data that are unique and valuable. Public blockchains make these features applicable and useful within a green market. The CCP Token has the following behaviors and properties: It is a fungible token (think of this as a quantifiable asset for exchange) that represents one metric ton of CO2 (mtCO2) or 1 mtCO2e that validates either a reduction, avoidance, or removal.

- It is divisible, transferable, encumbered, revokable, delegable, offsetable, and mintable with role support
- It includes a Unique identifier (ID) that is assigned when issued and sets this specific asset apart and gives it unique value; established and anchored on a public blockchain along with any relevant static data about the asset and any dynamic "events" associated with the asset
- Includes an Owner: The ID of the account that is the owner of the token

- Includes an Issuer: The ID for the issuing standard registry or record of activity

It must also validate the following Core Carbon Attributes (CCA), or a set of properties where the values can differ significantly between CCPs and allows comparisons and groupings of like CCPs together. Core Carbon Principles will contain some or all of the following:

- **AssetID**
  The serial number or unique identifier of the referenced credit on the standard registry that the token represents, where this identifier is established and anchored on a public blockchain along with any relevant static data about the asset and any dynamic "events" associated with this asset.
- **Issuance Date**
  The date of creation.
- **Verification Standard:**
  VCS, GS, etc.
- **Reference to Project/MBP/Claim**
- **Reference to Contract/Verified Claims**
- **Date Range**
  The verified period of the benefit claim.

Only through public blockchains can the market confirm that the token is a unique representation of the actual data and cannot be corrupted. Furthermore, it can be trusted because it is decentralized and distributed with a consensus or agreement through the technology and not through extraneous or onerous touchpoints. This in turn gives the token a unique value that is more secure and can be quickly settled between parties. Several blockchain projects are already implementing this token framework in their product specifications. Future work on these standards includes an MRV (Management, Reporting, and Verification) framework based on international standards for environmental management or ISO 14064-1:2018. This will improve and provide additional implementations for tokenization certification.

This is just one example of how a business problem is identified, creating a large-scale, transparent carbon credit trading market, in which blockchain technology is used to capture significant value through tokenization. There are numerous use cases following a similar model - identify a problem, map a blueprint solution, and use an open source, technology neutral standard that scales on any platform.

RECOMMENDATIONS

Invest people and funds into voluntary markets

Voluntary markets are not under governmental control, which means participants engage because of natural market forces or social responsibility. Regulated markets, on the other hand, require a governmental agency to compel industry compliance.

- Identify a specific use case that can make a tangible difference to solve a problem area.
- Understand and Invest in ESG Standards Working Groups to engage and align ESG investments.
- Make a commitment to a working group backed by a financial investment and man-hours. By having a more robust voluntary market we can go to the mandatory markets with specific, detailed requests for alignment, and help drive impactful ecosystem development.

DIGEST - READ AND LEAD

We recommend the following readings

- COP26 Explained
- Paris Agreement Explained
- Ceres Roadmap 2030 |
- The InterWork Alliance's Voluntary Ecological Markets Overview
- White & Case LLP
- VCMI Synthesis Report

WHAT IS YOUR ESG STRATEGY

Review the Sustainable Development Goals (SDGs) and communicate your accountability and alignment

- Do not assume understanding; take time to understand and educate constituents
- Measure your results and be accountable - communicate goals to constituents
- Invest in technology that offers impact; solutions should be quantifiable and interoperable

Organizations can remove or reduce harmful greenhouse gas emissions, improve data required to measure and validate, reduce the cost of bringing solutions to markets, and increase the speed of this work through these steps. By mapping this level of detail, the marketplace can derive a value and focus investors' minds on the sustainability strategies of the companies and institutions in which they invest across the globe. The usefulness of carbon credits depends on liquidity and consistent price generation in the markets on which they are traded, which in turn depends on reliable and consistent data, taxonomies, and benchmarks. GSMI has set out concrete steps to accelerate and scale up the development of these markets as the axis for generating liquidity, pricing, data, taxonomies, and benchmarks — ultimately achieving real and swift mitigation of climate change.

SECTION VIII

GLOBAL TAXATION

In a report on Distributed Ledger Technology (DLT)[197] published in January 2016, the United Kingdom (UK) Government stated that DLT "has the potential to redefine the relationship between government and the citizen in terms of data sharing, transparency and trust."[198] The report went on to identify a tax collection of incidences as a major use case for DLT that governments should instigate and be actively involved with as the technology matures.

Historically, the fundamental redistributive role of the state has been based on centralized and fiat-based systems. But with DLT, individuals, corporations, and states can exchange identity, trust, data, and value without the need for the (inter-)mediation of a central authority. DLT enables a move away from bilateral trust relationships. Now tax authorities can join trust networks, be part of their governance arrangements and witness in real-time the tax events that create obligations to the state. Tax authorities can make decisions about the tax implications of those events as they happen. Simply put, tax can 'just happen'. Such adoption and synchronization of all DLT elements in tax will take time to develop. However, many early benefits that DLT affords are already becoming visible and are outlined in this report.

This report examines the state of domestic and international applications of DLT in tax administration, assesses where efforts to standardize and ensure interoperability of systems can be concentrated, and recommends how tax authorities can generate significant value, realized by governments and taxpayers alike. Many more fundamental matters that individual states and their governments should consider as the world becomes more distributed are beyond the scope of this report. You can view the full Global Taxation report here.

DIGITAL IDENTITY

Digital identity (DID) assurance is critical to fair, just, and efficient taxing systems. Costly efforts have been initiated to ensure accurate and secure identities; however, as long as confidential information is maintained in centralized repositories, future attacks and breaches are inevitable.

KEY RECOMMENDATIONS

Tax as a prime use case

Tax administrations can reuse and leverage existing Know Your Customer (KYC) approaches of private sector financial service providers. A cross-government approach is desirable, including all layers (national, sub-national, and municipal); the tax administration use-case for such a system could be an effective exemplar for this multi-layer approach. This includes a standardized digital identity framework and roadmap for implementation that supports the necessary technical development and resource management.

Additionally, this will ensure tax requirements are aligned with other governmental service delivery functions across tax, trade, social services, justice, welfare distribution, government-supported utilities, etc. This framework should be supported by the selection of sufficient technical tools to ensure data security, integrity, and availability expectations are met. Various state databases containing and collecting digital identity information can be well managed and diminish the incidence of actual data exchange using DLT. As this approach matures, DLT-based systems will help to ensure the transparency, cost-effectiveness, integrity, and high credibility of data management processes.

Interoperability

Organizations need to collaborate to ensure tax data is accurate with proper security measures in place. This will help in appropriate tax risk analytics and reporting measures. In addition, this will reduce (but never eliminate) potential fraudulent tax-related activities in which different identities are established and verification and validation can be challenged.

If an assured identity system works for the financial arrangements between government and citizen, then others (welfare, pensions, health data management, and broader governmental service access) can work in a similar interoperable fashion.

LEGAL AND REGULATORY

Most tax legislation predates the sort of distributed systems enabled by DLT. If the full benefits of the technology are to be realized, not just in tax but with respect to any government program or process, there needs to be a thorough analysis of existing legal and regulatory barriers. Any successful project depends not only on mapping the issues but also on addressing the barriers. Governments and businesses must work together to ensure the legal and regulatory regime is fair and relevant. Applying blockchain in an international context introduces a further layer of complexity in this realm.

KEY RECOMMENDATIONS

Address the challenges stemming from the legal/ regulatory framework

- Review the existing legal framework, and group rules by the following classifications, execute the designated actions

- Rules that are redundant in the context of blockchain (e.g., physically certifying documents). Redundant rules should be repealed and substituted with new rules relevant to blockchain infrastructure (see below).

- Rules that impose barriers but are necessary (e.g., protection of fundamental individual rights, such as privacy). Appropriate actions may include leveraging innovative technology like Zero-Knowledge Proofs (ZKP), which can protect privacy within transactional tax regimes, such as VAT and withholding taxes.

- Rules that include a significant element of subjectivity or ambiguity (e.g., anti-avoidance rules) and therefore prevent binary outcomes based on quantifiable objective factors. See below for appropriate actions.

EXPLORE OPTIONS FOR ADDRESSING LEGAL AMBIGUITY

Technological Solution

Determine whether the current state of natural language processing (Artificial Intelligence) capabilities can adequately analyze legal provisions and case-law with sufficient precision.

Legal Solution
Consider introducing binary objective criteria that trigger rebuttable legal presumptions, the outcomes of which can be revisited at the request of the authorities or the taxpayer.

Review Outcomes
Provide for a possibility to review outcomes in case of dispute resolution and embed such possibility in the blockchain system (e.g., by having a trusted party that can implement changes).

IDENTIFY THE CHALLENGES THAT ARISE IN CROSS-BORDER SITUATIONS

Divergent legal frameworks across jurisdictions leading to different legal qualifications of similar fact patterns.

Technological Solution
Explore the technical feasibility of smart contracts accounting for different legal frameworks across jurisdictions, depending on a protocol that attributes jurisdiction to tax to a given country or countries.

Legal Solution
Coordination of the legal framework, thus ensuring greater consistency (especially feasible within regional integrated blocks such as the European Union).

International Exchange of Information under Article 26 of the Organization for Economic Co-operation and Development (OECD) Model Tax Convention[199] or the Directive on Administrative Cooperation (DAC) relies on communication only between tax authorities, excluding the possibility for direct exchange between private parties and foreign authorities.

Legal Solution
Amend the Exchange of Information rules, allowing for direct data sharing between private parties and foreign authorities. This may be achieved on a bilateral or multilateral basis.

Technological Solution
Automatic exchange of information in real-time between tax authorities, based on a blockchain solution.

ESTABLISH THE QUALITY OF DATA AND ITS IMPACT ON LEGAL RESPONSIBILITY;

the quality of the output of the blockchain system is entirely dependent on the quality of the data input

Importance of standardized data, especially for cross-border data exchange; consider alignment to a global standards organization, such as the National Institute of Standards and Technology (NIST) or the Organization for the Advancement of Structured Information Standards (Oasis).

Importance of intermediaries (e.g., banks, telecommunication providers, other digital platforms) with robust KYC programs, for providing the necessary data.

Determination of legal responsibility when the data provided is dependent on a due-diligence standard (e.g., due diligence commensurate with the activity in banking or financing activities).

ENSURE THAT ANY TAX-DLT SYSTEM IS COMPLIANT WITH GENERAL DATA PROTECTION REGULATION (GDPR) OR SIMILAR GOVERNMENT DATA ACT

Prohibition of decision-making by automatic means (e.g., Article 22 of the GDPR); there needs to be a possibility for human review and adjudication.

‘Right to be Forgotten’
Possibility of erasure; determine whether such principles may undermine the immutability of the blockchain.

Private Data

Explore the possibilities afforded by Zero-Knowledge Proof advanced cryptographic capabilities.[200]

ALIGN WITH COMPETITION LAW

Although this point is beyond the strict taxation scope of this report, there is a need to monitor industry-commercialized blockchain-based taxing systems for the incidence of competition amongst DLT systems. It will be important to analyze the different means of validating transactions and the possibility of systems containing commercially sensitive data, which could be used for illegal price setting and anti-competitive behavior.

DATA MODEL FOR TAX

A decentralized solution may decrease the amount of continuous effort currently needed to monitor, administer, and police compliance with tax obligations. A blockchain solution necessitates an upfront fixed investment with variable, but controllable, future maintenance costs. A decentralized data model is also conducive to preventing information from altering. Therefore, it could assist in addressing tax avoidance incidents and equip policymakers with enhanced data transparency and traceability. Improved transparency will also support better policy design decisions. Decentralized data infrastructure brings clarity and simplicity to a confusing and challenging process.

A decentralized data model does not translate into higher taxes, but rather offers a more efficient means of taxation that, in turn, yields advantages for tax authorities and taxpayers alike.

KEY RECOMMENDATIONS

Data Framework

Consensus Protocol

The two most prominent consensus protocols are: Proof-of-Work (PoW) and Proof-of-Stake (PoS); they have their own benefits and costs. When designing a data infrastructure, the decision on which mechanism to deploy should involve a robust cost-benefit analysis.

Coordination of Data Ingestion

Coordination is a key component while fulfilling a data model; however, blockchain, by design, is a decentralized system that brings trust-less nodes together. The technology itself facilitates many stakeholders (nodes) in coordinating and validating transactions. Pilot programs are thus advised to stress-test the developed data infrastructure and ingestion processes.

Associated Costs to Consider

Questions to address should include timing: whether onboarding of the historical data from previous years into the new form of a data model is required. If not, how would the old data model be compatible with the new data model in case there is a need to access and act upon older data? It is also important to consider the costs associated with educating taxpayers on how to use the system.

Security and Systematic Risk Management

A multi-phase process should be developed in the unfortunate scenario of data leakage, data hacking, or other form of systemic failure. The first phase should be an immediate technical response to mitigate the risk. The second phase should consist of the following actions, executed in parallel or series: communication plan; compensation program aligned to the data breach, and a legislative/regulatory framework pre-developed to protect and support those affected.

GOVERNANCE DATA MODEL

Governance of the decentralized data model could be divided into two general themes (on-chain data governance and off-chain governance) with three associated layers (off-chain community, off-chain development, and on-chain protocol).[201] To design an efficient blockchain tax data infrastructure, it is important to recognize that off-chain components do not exist in isolation from their on-chain counterparts, since both elements

are mutually dependent, and thus should be designed in unison.

INTERSECTION OF ARTIFICIAL INTELLIGENCE (AI) AND BLOCKCHAIN

AI brings sophisticated data analytics to tax to optimize compliance and effectively transform tax into an innovation hub, while generally empowering the tax function.[202] Blockchain offers transparent, validated, and structured data sources necessary for AI model building and deployment. AI systems partnered with blockchain can produce new insight to substantially improve information security, system scalability, fraud reduction, and governance.[203]

GOVERNANCE

A blockchain infrastructure for tax purposes will require special governance arrangements. The critical roles of each party should be clearly defined and built into the Information Technology (IT) infrastructure, along with appropriate incentive mechanisms that will enhance the long-term viability of the DLT system by encouraging participation by a multitude of stakeholders. The tax ecosystem encompasses a wide variety of actors. Thus, it is important at the outset to define a set of shared principles that reflect the aspirations of the members of the ecosystem and serve as guidelines in developing blockchain solutions.

KEY RECOMMENDATIONS

Delivering Mutual Tax Certainty

The overriding objective of a tax-based blockchain infrastructure should be to deliver faster tax certainty for both the taxpayer and the tax administration. This means that there should be certainty around: (i) the identity of those operating on the ledger; (ii) the fact that the taxable event has occurred as recorded in the chain; and (iii) including all relevant information to automatically assess tax implications.[204]

Protecting Taxpayer Rights

The protection of taxpayers' rights is a fundamental and critical element. This effort should be focused on a robust dispute resolution mechanism, appropriate guidance on burden-of proof, identity management, and digital inclusiveness.

Providing an Integrated Value Proposition

Distributed ledger technologies will also require clarity regarding when it is acceptable to use data for purposes other than those for which the data was initially provided. Thus, it is important to: (i) avoid establishing siloed systems when an integrated system is more effective; (ii) consider including services of value to the taxpayer, even if they are not tax related; (iii) embed information requirements from other government entities rather than establishing parallel systems; (iv) avoid replicating existing processes found in paper-based or legacy IT systems; and (v) define the integrated value proposition for both private and public stakeholders when participating together in an ecosystem.

Applying the Principle of 'Subsidiarity' When Selecting a Platform

Taxation is incidental to economic transactions. Therefore, a blockchain-based tax platform may not be the best general purpose technology option if there exist current solutions in the market where taxation can be effectively incorporated. For example, it may be more efficient to embed taxation into a digital payment, commerce, or supply chain solution rather than establishing an entirely new tax system.

Ensuring the Resilience of the Blockchain

Tax-related blockchain systems will require: (i) a very high degree of uptime; (ii) effective authentication of the actors operating on the blockchain; (iii) a robust information security arrangement, including protection of commercial secrets; (iv) predictability in change management since the system interfaces with other systems within and outside the tax administration; (v) capacity to train users and handle complaints and queries; (vi) monitoring

of the system; and (vii) a proper dispute resolution mechanism.

Promoting participation and inclusion of multiple stakeholder classes in system design and development

Longer and more intensive, participatory processes are likely needed to effectively design blockchain systems. Multi-stakeholder classes should be represented in the governance structure of the DLT system (participation) and decision-making rights should be carefully considered to ensure all relevant and material stakeholder classes are represented by a governance member with a recognized, and valued, decision-making vote. The discourse should in any case address the following seven governance dimensions: system development/maintenance roles; participation incentives; membership; communication amongst stakeholders; decision-making; initial system formation and launch; and context-specific rights and obligations of stakeholders.

Establishing a Governance Board/Framework

The aforementioned governance elements need to be included in an overarching governance framework and associated board where all relevant stakeholders are properly represented. Special governance arrangements will likely include: (i) earlier, longer, and more intensive consultations processes to understand how the blockchain systems interact with existing processes in the public and private sectors; (ii) a robust change management mechanism, as upgrades to the blockchain system are likely to have ripple effects; (iii) a process for encouraging and processing unsolicited proposals; and (iv) a program to foster a vibrant conversation across the ecosystem addressing needs of the multi-stakeholders.

While there are few tax-related DLT systems with robust and carefully constructed governance models from which to leverage, there are several technology-laden systems impacting a multitude of stakeholders with impressive governance models

Consider, for example, the Global Vaccine Alliance (GAVI)[205] for a nuanced and precise governance model, DHIS2,[206] an open-source digital health information system for a streamlined governance model uniquely tied to a university (University of Oslo), and Mojaloop,[207] an open-source software payment system employing a foundation model across an efficient mix of public and private sector actors.

PRIVACY AND TRANSPARENCY

DLT has created an opportunity to rethink the traditional balance between privacy and transparency across tax policy, law, and processes. While digital technology is enabling better tracking and reporting of economic activity, the concept of taxation and the associated administrative burden have remained largely unchanged. DLT can free institutions, the economy, and society to rethink deeply embedded paradigms outside of the traditional constraints of data collection and management.

Privacy and transparency should also be qualified by the subject (person or organization) at issue, the entity bequeathed with the authority to enforce privacy and transparency, and the scope of the tax-related data being made private or transparent (e.g., all DLT data or only cross-border transaction data). Technologies such as Zero-Knowledge Proofs (ZKP) may also play a key role here. Applying ZKP-technology, one party (the prover) can prove to another party (the verifier) that they know a value x, without conveying any other information. Privacy-preserving technologies such as this may enable compliance with required privacy standards and legislation, although further development may be needed.

KEY RECOMMENDATIONS

Put citizens in control

For a balance between privacy and transparency to evolve as technology evolves, a social license to innovate is important and should be maintained. It is recommended that safe, secure, and easy to use custodial solutions be provided so citizens can own their identity keys, building a partnership approach between responsible authorities and citizens, whereby a clear balance is considered between providing the relevant data and maintaining privacy and control from a taxpayer's perspective.

Policymakers should leverage the power of smart contracts to mirror existing legal, regulatory, and contractual restrictions on data usage and sharing

There are opportunities for public and private sector actors to launch proofs of concept and pilots with DLT systems that adhere to current legislative, regulatory, and contractual limitations.

Consider the use of Non-Fungible Tokens (NFTs)

NFTs provide the opportunity to establish that data is unique and immutable, its true ownership, and its associated permissions. The ability to locate meta-attributes around the data, and verify the data as being unique, could be a way of balancing privacy and transparency in a way that is comfortable to citizens and businesses and enables them to make decisions about the costs and benefits of sharing their data, while recipients of the data can be assured of its validity and ownership.

Policymakers should consider the introduction of an Immutable Notarization Blockchain for Taxation Data

One key challenge in the potential utilization of blockchain and DLT technology for greater transparency in the digital taxation domain concerns the data privacy of relevant entities who participate in the DLT network. Often transactions between parties are confidential to these parties, with the taxation authority, possibly being the sole third party legally permitted to further query into the transaction details. In these use cases, there is an inherent tension between the benefits of DLT technology for transacting parties and the danger of loss of privacy for the parties. Thus, blockchains and DLT technology must continue to develop to address these privacy concerns.

One potential solution is to retain only a minimal trace of the transaction, by way of capturing on the blockchain only the cryptographic hash of the transaction records. This is known as a "hash-only blockchain," a digital notarization blockchain which functions much in the same way as legal, human notaries. In this system, when two transacting parties arrive at a taxable event, both parties compute the cryptographic hash of their relevant documents and evidence of the payment. They then utilize the blockchain to store only these hash/digest values together with the appropriate record-identifier. Each party retains their complete data records in their respective private databases.

In this case, the blockchain acts as a decentralized, automated notary that keeps an immutable list of these hash values, thus preventing parties from modifying their data records. Relevant government authorities can later request these transaction data

records from the parties and recompute the cryptographic-hash values for these records and compare these hash values against those found on the blockchain. This provides assurance that none of the parties have illegally modified these data records after the taxable event has occurred.

Tokenized currency that can execute governance requirements associated with transactions could enable a broader range of taxable events or could enable a more targeted approach to taxable events

This could be accomplished by programming a tax office-approved corporate policy into the transaction or by making the amount of tax due so small as to be negligible on a per-transaction basis. The central role of a taxation authority could be reconfigured and risks associated with the implementation of new transaction and currency systems reduced.

CONCLUSION

There is no doubt that DLT will continue to have significant effects on finance, tax, trade, and other settings where many actors in a system need access to assured real-time data about a transaction. Governments have the option, of course, of stepping back and letting the market take its course. That way, if DLT is not fit for purpose and cannot be implemented at scale and in compliance with existing frameworks, it will fade away and a lot of time and trouble will have been saved.

This working group holds that stakeholders should be directed to further develop blockchain technologies, in general, across certain key use-cases, including tax. For tax specifically, we suggest all involved in tax administration, domestic and international, public and private, engage with this breakthrough technology and understand what it means for the tax systems that support the financial and societal stability of our nation-states.

SECTION IX

DERIVATIVES

CRYPTO-DERIVATIVES

The traditional derivatives market is said to be over $1 quadrillion dollars on the high end, but some analysts say the market is grossly overestimated. The higher end of the estimates includes the notional value of derivative contracts.[208]

The rise of cryptocurrency derivative products in the current financial market brought with it lots of questions and concerns. The crypto-derivatives market has now overtaken the crypto spot market by trading volume as it continuously expands with new products. Although crypto derivatives represent a new set of tradeable products, they have many of the same characteristics as traditional crypto-derivatives. You can access the full crypto-derivatives report here.

> Crypto-derivatives are "secondary contracts or financial tools that derive their value from a primary underlying asset. A primary underlying asset could be a cryptocurrency such as Bitcoin".[209]

These derivatives can be traded OTC, over centralized exchanges, and even over decentralized exchanges because of blockchain technology. There are many different types of crypto-derivative and structured products on the market. We can categorize these products into three main categories: crypto futures, crypto options, and perpetual contracts.

CRYPTO FUTURES

Crypto Futures are structured the same as traditional futures contracts but the underlying asset is a cryptocurrency. Within the crypto space, there are two different types of futures, inverse futures and non-inverse futures, also referred to as vanilla futures. Vanilla futures work in exactly the same way as we are used to in traditional finance – the P&L is linear and paid out in the quote currency, such as USD or a USD-based stablecoin when trading a pair like BTC/USD or ETH/USD.

Inverse futures were designed to eliminate the need to hold any fiat or stablecoin on a platform. For those contracts the margining and P&L are calculated in the base currency of the contract, for example in BTC when trading BTC/USD futures. As a result, the P&L calculation is non-linear.

CRYPTO OPTIONS

Crypto options share the same structure as its traditional counterpart but the underlying asset is a cryptocurrency. Crypto options are relatively nascent and simple at this stage of development. Over the coming years, exotic crypto options with more complex structures as well as embedded option structures may emerge for multiple purposes including for hedging, synthetic exposure, and speculation.

‘CRYPTO’ PERPETUAL CONTRACTS OR SWAPS

Crypto Perpetual Contracts, which are sometimes referred to as Perpetual Swaps and other times referred to as Perpetual Futures, but generally referring to the same concept, were originally invented by BitMEX. When cryptocurrencies grew in popularity and started attracting more and more retail traders, these traders kept complaining that their positions ‘disappeared’ when in reality they were trading dated futures which had expired. To solve for this, BitMEX came up with the Perpetual Contract. Unlike the other futures and options, perpetual contracts are unique to cryptocurrencies.

Perpetual contracts are the most popular derivative in the current crypto market. A perpetual contract can be thought of as a futures contract that never expires. Traders are able to keep their positions open for as long as they want under certain conditions. One of these is that the account must contain a minimum amount of BTC, or other crypto, (margin). Another distinct factor to consider is the funding rate. This is a unique mechanism that helps tether the price of the perpetual contract to that of Bitcoin, or other crypto. Because of its dated expiry, the price of a futures contract will always converge with the price of the underlying asset at expiration. Since perpetual contracts do not expire, its price can start deviating significantly from the spot price. A solution to this problem is to have one side of traders pay the opposing side.[210]

Perpetual futures are futures contracts with no maturity, as opposed to dated futures, which expire at a pre-set date and time such as every month or every quarter. Any position in a perpetual futures stays open until the trader decides to close the trade by executing an offsetting trade, or until the trade gets liquidated.[211]

As perpetual futures have no set expiry they are, in a way, akin to spot exposure. To ensure that perpetual prices are kept in line with the spot market, the contracts have an exchange of payment between buyers and sellers depending on where the future price is trading relative to the underlying spot price. The spread between spot and perpetual futures prices is commonly known as ‘basis’ in traditional finance, but in crypto is often referred to as ‘funding’. The resulting payment that is exchanged between long and short holders of the contract is mostly referred to as the funding payment.[212]

The MTM (‘mark-to-market’) of perpetual contracts is determined by the ‘Funding Rate’. The funding rate is the mechanism that ties the perpetual contracts price to the underlying spot price. Depending on how often the exchange processes the funding rate, the spread between the perpetual contracts and spot prices is generally smaller than the spread between the perpetual contracts and dated futures (exception being when approaching expiry date).

To date, perpetual contracts are the most popular product in the current crypto market.

CRYPTO ETFS

Exchange Traded Funds (ETFs) are not derivatives, rather it is synthetic exposure to an underlying asset like stock shares.

A Bitcoin ETF tracks Bitcoin’s value and trades on regular exchanges (rather than on dedicated crypto exchanges). Investments in them give investors the opportunity to get exposure to bitcoin’s price changes without having to buy the underlying asset on cryptocurrency exchanges, while also offering price leverage.

A Bitcoin ETF listed on major stock exchanges decreases the barrier to entry, allowing a larger demography of investors to participate. Bitcoin ETF proposals in the US have been circulating since 2013, and only recently, Bitcoin ETF on CME Futures have been approved. On October 19, 2021, ProShares BTC ETF (ticker: BITO) launched and within days, broke ETF records for investment inflows (over $1bn in two days at the time of publication).[213] Other cryptocurrency ETFs trade on the Toronto

Stock Exchange (TSX), on Europe's Euronext, XETRA, and B3 in Brazil. Currently, European regulated markets only offer ETNs on digital assets or digital assets proxies.

EVOLUTION OF TRADING ACTIVITY OF DERIVATIVES ON DIGITAL ASSETS

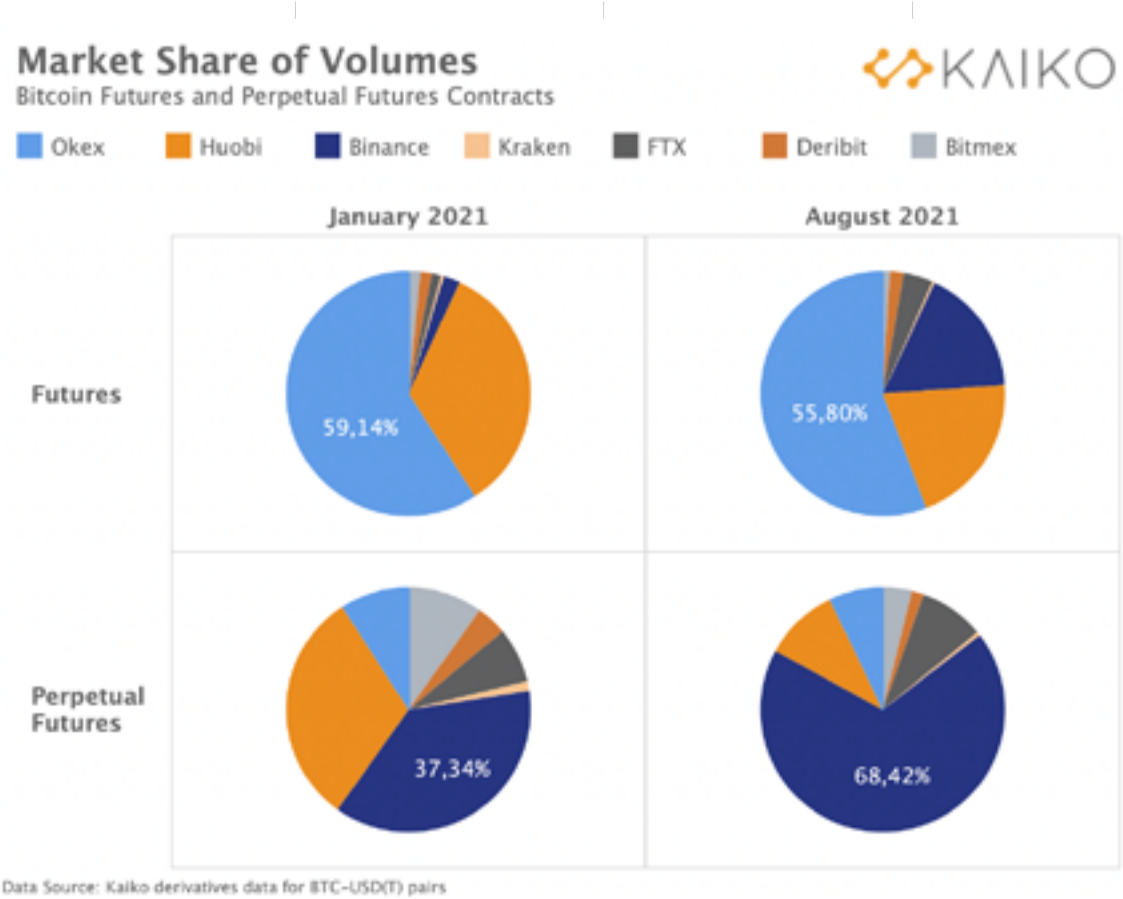
Over the past few years, the ever-growing volume, coverage, and diversity of contracts has transformed the derivatives industry into a structurally critical force in cryptocurrency markets.

EXCHANGE MARKET SHARE

The vast majority of cryptocurrency derivatives trade volume occurs on unregulated exchanges. The top unregulated exchanges are: Binance, Okex, Huobi, FTX, Bybit, Bitmex, and Deribit. Kraken, Bitfinex, and Bitflyer also offer derivatives, but their volumes are lower than top-tier unregulated markets. The Chicago Mercantile Exchange (CME) is one of the only regulated cryptocurrency exchanges that offers futures on Bitcoin and Ethereum. There are several other smaller regulated exchanges such as LedgerX, Bakkt, and ErisX, although volumes remain low.

All unregulated exchanges offer both perpetual futures and dated futures, but only a few exchanges– Deribit, Okex, and Huobi – offer options on cryptocurrencies. For options, Deribit accounts for the vast majority of market share.

TRADE VOLUME



Data Source: Kaiko derivatives data for BTC-USD(T) pairs

Since the start of 2021, exchange market share of trade volume has changed drastically for dated futures and perpetual futures. Since January, Binance went from accounting for just 2% of dated futures volume and 37% of perpetual futures volume to 16% and 68% of volume, respectively. For futures, Binance's market share grew by more than 8x and for perpetual futures Binance's market share now accounts for a majority of all volume.

Okex still accounts for the majority of dated futures volume, although its market share fell 4% since January.

FTX also slightly gained market share since the start of the year, growing from 1% to 3% of futures volumes and 7% to 8% of perpetual market share. Huobi has lost the most market share since the start of the year, losing more than half for both futures and perpetual futures.

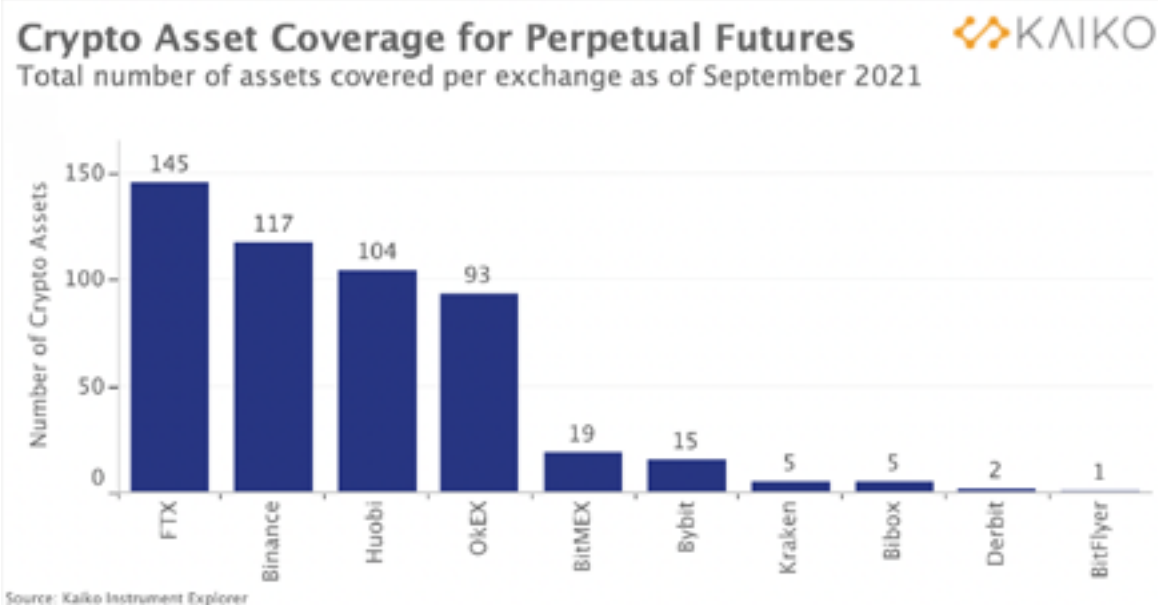
EXCHANGE COVERAGE BY CONTRACT TYPE

Cryptocurrency derivatives markets have undergone massive growth over the past couple of years, but nothing has been as impressive as the soaring popularity of perpetual futures. Almost every cryptocurrency derivatives exchange offers perpetual futures, and most offer both USD and USDT denominated contracts. Perpetual futures contracts cover the widest range of crypto assets, more so than dated futures.

Only a handful of exchanges offer options contracts, and only on Bitcoin and Ethereum.

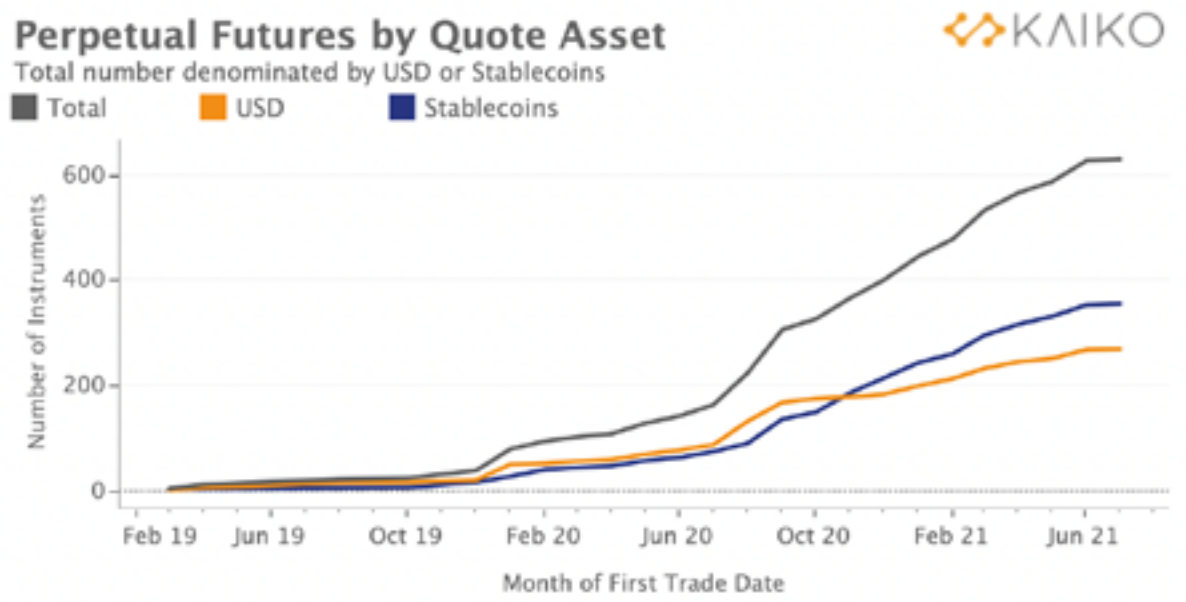
PERPETUAL FUTURES

The chart below shows the number of crypto assets covered by each exchange as of September 2021.



Today, FTX leads the market for perpetual futures with the largest number of contracts on crypto assets. FTX is known for rapidly listing contracts on new crypto assets and offers the widest variety of both blue-chip (BTC/ETH) and altcoin derivatives. FTX is a relative newcomer to the derivatives space–launching their first contract in 2019–but has rapidly gained market share and relevance due to their fast paced listing strategy.

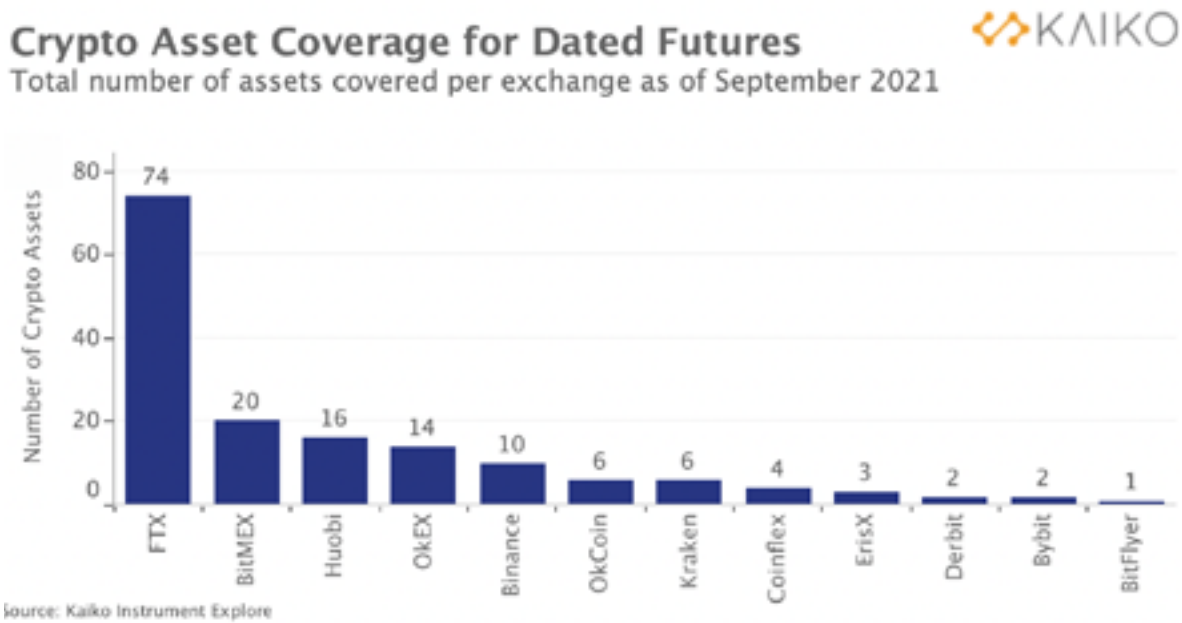
We can observe that the quantity of perpetual futures has increased sharply since 2019. Today, there are more than 600 total contracts. Around 400 are denominated in stablecoins (USDT-margined) and 200 in USD (coin-margined).



Source: Kaiko reference data

DATED FUTURES

For standard dated futures contracts, most exchanges offer only a fraction of the coverage compared with perpetual futures. Most exchanges offer futures contracts with expiries ranging from weekly to quarterly, although the quantity of dated futures varies by exchange. For example, Binance only offers a quarterly contract while FTX offers monthly, quarterly, and biannual contracts. Huobi offers weekly, bi-weekly and quarterly contracts.



Source: Kaiko Instrument Explore

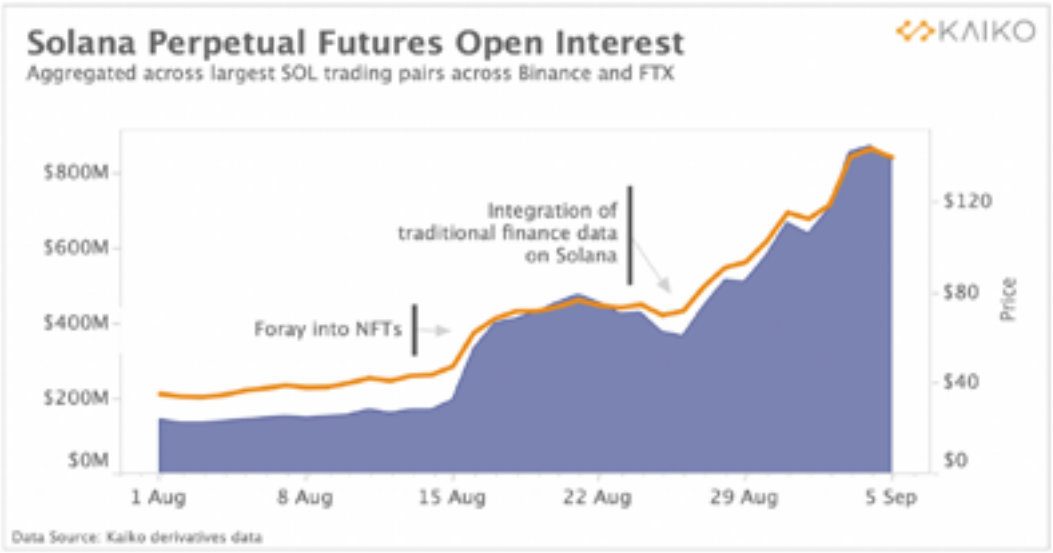
OPTIONS

Okex, Huobi and Deribit are the only unregulated exchanges to offer these contracts and all three only offer options on Bitcoin and Ethereum. Options markets are far more complex than futures which has prevented them from gaining widespread popularity, although volumes have increased over the past couple of years. Today, Deribit accounts for 90+% of total market share of options volume.

BTC VS. ALTCOINS

Derivatives are offered on 150+ altcoins, creating a highly varied trading environment. Bitcoin still dominates derivatives trading volume, but the ever-increasing range of altcoin derivatives contracts suggests growing trader interest. Bitcoin's market share of futures volume vs. Ethereum is charted below, and shows that Ethereum derivatives volume accounts for approximately 40% of total. This share has increased since March of 2021 and suggests altcoin bull runs have a direct effect on the breakdown of derivatives volumes.

Altcoin derivatives beyond Ethereum have also seen surging interest among traders. For example, open interest for the altcoin Solana recently broke all-time highs at more than $800 million, compared with just $200 million at the start of August 2021.



INITIAL CRYPTO-DERIVATIVES LEGAL & REGULATORY MAPPING

The GSMI 2.0 Derivatives Working Group also researched and mapped a subset of twelve key jurisdictions: USA, Canada, United Kingdom, European Union – Germany, France, Italy, Spain, Switzerland, Singapore, Japan, Hong Kong, South Korea which are paving the way for the development and growth of crypto-derivatives. The European Union and Singapore are highlighted here. Click here to access the full report for all twelve.

THE EUROPEAN UNION

In the European Union, regulators have framed their approach to the regulation of crypto derivatives based upon the complexity of crypto-derivative products as well as investors' lack of understanding regarding the risks that come with these products. The E.U., through several of its regulatory bodies, has issued guidelines and calls for evidence to better regulate this issue. But individual E.U. member countries have also developed their own approaches.[214]

A. ESMA & MARKET SUPERVISION IN THE EUROPEAN UNION

The European System of Financial Supervision (ESFS), the framework for financial supervision in the European Union, is made up of the European Supervisory Authorities (ESAs), the European Systemic Risk Board, the Joint Committee of the European Supervisory Authorities, and the national supervisory authorities of E.U. member states.[215]

Within the ESFS, there are three European Supervisory Authorities, who are directly responsible for supervision of the European Financial Markets: The European Banking Authority (EBA); the European Securities and Markets Authority (ESMA); and The European Insurance and Occupational Pensions Authority (EIOPA).[217] Each of the three ESAs has the power to issue non-legally binding Guidelines as tools to promote the consistent application of E.U. law across E.U. member states.[217]

ESMA is the independent market supervisory and enforcement authority within the E.U. responsible for promoting "consistent application of market rules".[218] ESMA has three objectives; to protect investors, maintain orderly markets, and uphold financial stability within the European financial markets.[219]

B. ESMA'S VIEW OF CRYPTOCURRENCY AND CRYPTO-DERIVATIVES

Most prominently as it pertains to cryptocurrency, crypto derivatives, virtual currencies and new financial instruments, EMSA has been granted specific product intervention powers to temporarily prohibit or restrict the marketing, distribution or sale of a financial instrument or a type of financial activity or practice when certain conditions are met.[220]

- **MiFID and MiFir**
  On October 20, 2011, the European Commission adopted a legislative proposal for the revision of MiFID which took the form of a revised Directive and a new Regulation.[221] After more than two years of debate, the Directive on Markets in Financial Instruments repealed Directive 2004/39/EC and the Regulation on Markets in Financial Instruments, commonly referred to as MiFID II and MiFIR, were adopted by the European Parliament and the Council of the European Union.[222]

MiFID stands for the Markets in Financial Instruments Directive; It has been applicable

across the European Union since November 2007.[223] It is a cornerstone of the E.U.'s regulation of financial markets seeking to improve their competitiveness by creating a single market for investment services and activities and to ensure a high degree of harmonized protection for investors in financial instruments.[224] MiFID II/MiFIR entered into force on January 3, 2018.[225] ESMA created this new legislative framework to strengthen investor protection and improve the functioning of financial markets, making them more efficient, resilient and transparent.

Within it, MiFID outlines the: (1) conduct of business and organizational requirements for investment firms; (2) authorization requirements for regulated markets; (4) regulatory reporting to avoid market abuse; (5) trade transparency obligation for shares; and (6) rules on the admission of financial instruments to trading.[226]

ESMA Regulation of Cryptocurrency & Crypto-derivatives

ESMA first stepped into the world of cryptocurrency when it expressed its view on token sales, also known as ICOs, in November 2017.[227] Although ESMA's proclamation was vague and did little more than acknowledge the existence of cryptocurrencies and ICO's, later, in the Call for Evidence Report issued in January 2018, the ESMA announced that crypto-derivatives, in the form of CFDs and BOs, should be subject to strict legal scrutiny. ESMA defines CFDs or "Contracts for Difference" as:[228]

> "a derivative other than an option, future, swap, or forward rate agreement, the purpose of which is to give the holder a long or short exposure to fluctuations in the price, level or value of an underlying, irrespective of whether it is traded on a trading venue, and that must be settled in cash at the option of one of the parties other than by reason of default or other terminational event."

BO's, or Binary options, are defined as:[229]

> "a derivative that meets the following conditions: (a) it must be settled in cash or may be settled in cash at the option of one of the parties other than by reason of default or other terminational event; (b) it only provides for payment at its close-out or expiry; (c) its payment is limited to: (i) a predetermined fixed amount if the underlying of the derivative meets one or more predetermined conditions; and (ii) zero or another predetermined fixed amount if the underlying of the derivative does not meet one of more predetermined conditions."

ESMA suggested that these derivatives products are speculative and volatile, exposing investors to potentially significant monetary loss.[230] As a result of its findings, ESMA called for responses from market participants regarding crypto-derivatives and adopted several restrictive product invention measures, stemming from its power under Art. 40 of MiFIR.[231]

The intervention measures included (1) a prohibition on the marketing, distribution, or sale of BOs and (2) a restriction on the marketing, distribution, or sale of CFDs to retail investors.[232] In adopting these restrictive measures, the ESMA is quoted as saying:[233]

> "CFDs are complex products. The pricing, trading terms, and settlement of such products is not standardized, impairing retail investors' ability to understand the terms of product…Retail investors find it difficult to understand and assess the expected performance of a CFD… Furthermore, the offer of CFDs to retail investors has increasingly featured aggressive marketing practices as well as misleading communications…"

Separately, it also noted that cryptocurrency is an immature asset class that poses "separate and significant concerns."[234]

SINGAPORE

Introduction

In Singapore, the relevant regulator for crypto-derivatives is the Monetary Authority of Singapore ("MAS"), which is Singapore's central bank and integrated financial regulator. The MAS is responsible for administering and supervising the securities, financial advisory services, and payments regimes in Singapore, under the Securities and Futures Act ("SFA"), Financial Advisers Act ("FAA") and Payment Services Act 2019 ("PSA"), respectively. Entities and individuals that intend to conduct activities relating to crypto-derivatives, are required to comply with the MAS' rules under the aforementioned regimes.

While crypto-derivatives are not prohibited in Singapore, the MAS has indicated that it does not consider crypto-derivative products to be suitable for most retail investors.[235]

ASSESSING WHETHER A CRYPTO-DERIVATIVE IS REGULATED

The primary factor determining the regulatory treatment of a crypto-derivative product is the nature of the token that the product references.

Depending on the nature of the token, the product will be regulated in Singapore if: (i) it falls within the definition of a "capital markets product" under the SFA; or (ii) references a payment token (a "payment token derivative"), and is offered or listed on an approved exchange.

1. CAPITAL MARKETS PRODUCTS

Under the SFA, "capital markets products" include securities, units in a collective investment scheme ("CIS"), derivatives contracts, spot foreign exchange contracts for the purposes of leveraged foreign exchange trading, as well as any other products the MAS has prescribed as a capital markets product. Of these categories, a crypto-derivative product is most likely to fall within the definition of a "derivatives contract", since the SFA defines a "derivatives contract" as a contract or arrangement under which:

- one of the parties is required to discharge all or any of its obligations at some future time; and
- the value of the contract or arrangement is determined by reference to the value or amount of one or more "underlying things".

According to the MAS' FAQs on product definitions, the following would be considered "derivatives contracts": (i) futures swaps (i.e., a swap on a futures contract), or any other swaps; and (ii) contracts for differences referencing an "underlying thing".[2346]

An "underlying thing" includes: a security, a unit in a CIS, a currency or currency index, an interest rate, a commodity, or the credit of any person. If the reference token of the product is within the definition of an "underlying thing", the product is likely to be a "derivatives contract" and thus regulated as a "capital markets product".

The next few sections summarize some of the relevant licensing requirements that could apply to a crypto-derivative product that is considered a "capital markets product" under the legislation administered by the MAS.

CMS License

An entity that carries on a business in any regulated activity under the SFA, will be required to hold a capital markets services ("CMS") license for such regulated activity. Regulated activities under the SFA include: (a) dealing in capital markets products; (b) advising on corporate finance; (c) fund management; (d) real estate investment trust management; (e) product financing; (f) providing credit rating services; and (g) providing custodial services.

Financial Advisers' License

Any person that acts as a financial adviser in Singapore in respect of any financial advisory services, is required under the FAA to either hold a financial adviser's license or be an exempt financial advisor. A financial advisory service includes advising others in respect

of any "investment products" (which includes capital markets products).

Markets where derivatives contracts are listed Entities and exchanges that provide a place or facility (whether electronic or otherwise) where, offers or invitations to exchange, sell or purchase derivatives contracts are regularly made on a centralized basis, may require approval or recognition from the MAS as either (i) an approved exchange or (ii) a recognized market operator.

2. PAYMENT TOKEN DERIVATIVES

Approved Exchanges

A crypto-derivative product will be regulated if it references a payment token and is listed on an approved exchange.
As of September 2021, there are only four approved exchanges in Singapore: Asia Pacific Exchange Pte. Ltd.; ICE Futures Singapore Pte. Ltd., Singapore Exchange Derivatives Trading Limited; and Singapore Exchange Securities Trading Limited.

Based on public media comments by the MAS, the MAS considers Bitcoin and Ether to be payment tokens. Derivatives that reference Bitcoin and Ether would therefore be payment token derivatives and would be regulated if listed on these approved exchanges.

If payment token custody services are provided in relation to payment token derivatives offered on an approved exchange, the MAS will require the approved exchange to be responsible for the appointment of the custodian. The custodian will also be subject to similar regulation that a custodian of securities or other capital markets products is subject to.

ADDITIONAL MEASURES FOR RETAIL INVESTORS

The MAS has also introduced additional measures for retail investors who trade in payment token derivatives with financial institutions regulated by the MAS. Such financial institutions are required to collect from retail investors 1.5 times the standard amount of margin required by approved exchanges for a comparable contract. This is subject to a floor of 50% and a cap of 100% of the notional value of the payment token derivatives contract. These margin requirements must be supplemented with other measures such as tailored risk warnings and restrictions on advertising.

NEXT STEPS

We are witnessing the first steps of the derivatives industry in the digital assets and we believe this product area will significantly expand and diversify its offering to adapt to the needs of the users. Firstly, the regulated market offering is at its infancy with just a few traditional regulated exchange offering products on digital assets.

Those products are mostly on single tokens but the index industry is developing tools that will offer a better representation of the overall digital asset offering. Then, as the trading activity and exposure of the actual underlying assets grow and diversify, one can expect innovation from a product standpoint. 2021 seems to be a milestone year for the entry of institutional investors in this asset class and further development will most certainly bring new needs and consequently new products to the market in the coming years.

SECTION X

COUNTRY HIGHLIGHT: SOUTH KOREA

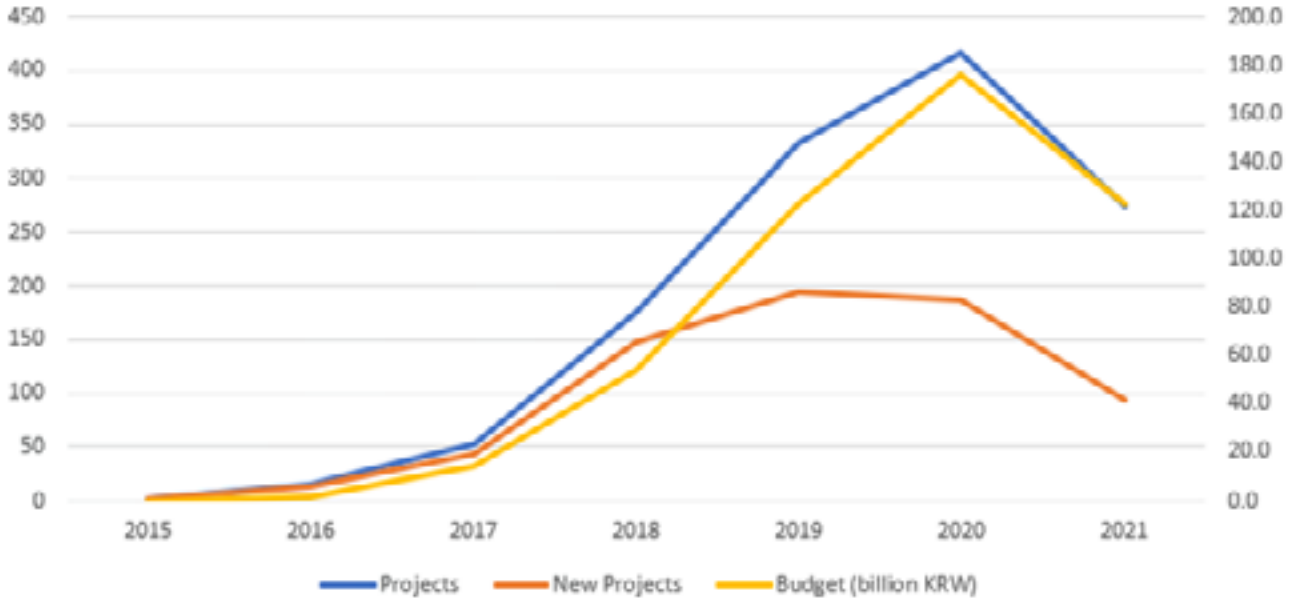
The linked report offers an overview of blockchain adoption through an analysis of policy and business cases in South Korea.

Although South Korea leveraged information and communication technologies to advance its economy in the 2000s (which has expanded its focus from manufacturing and exporting in the 1970s and 1980s), its innovation in blockchain has been stagnant since the announcement of the emergency measure and technology roadmap amid the Bitcoin shock in December 2017.

In this report, six use cases are introduced in three parts. The first part covers the policy and regulations for blockchain as virtual assets. South Korea amended the Act on Reporting and Using Specific Financial Transaction Information[237, 238] to comply with the Financial Action Task Force's recommendations revised in 2018.[239] As a result, on the enforcement due date, September 25th, 2021, out of forty-three Virtual Asset Service Providers (VASPs) registering their virtual asset businesses at the Korea Financial Intelligence Unit, only four companies provided fiat money services.[240] Furthermore, they must abide by the travel rule[241] in six months and adapt to the emerging markets of NFTs and the metaverse.[242]

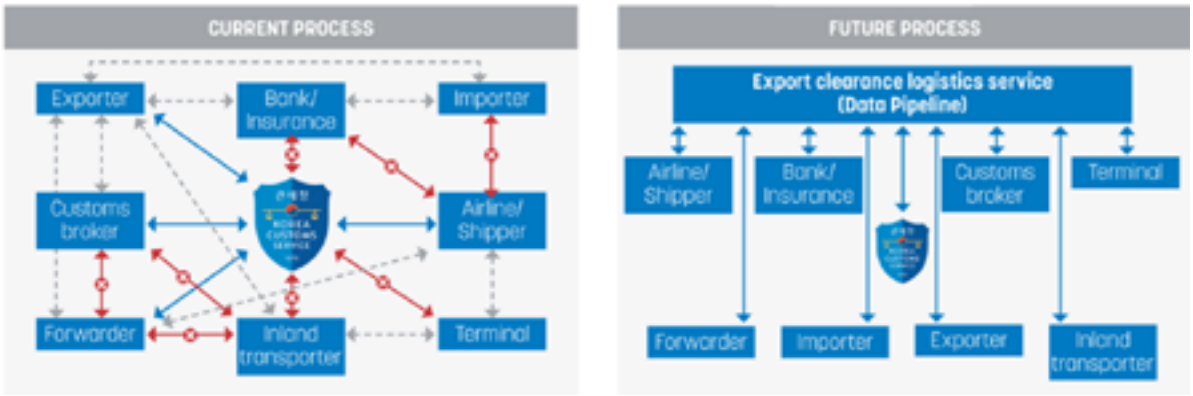
The second part looks at South Korea's blockchain R&D. Seventeen ministries have funded 417 projects to cultivate blockchain inventions since 2015.

Significantly, the Ministry of Science and ICT's Blockchain Convergence Technology Development Program supported fifty projects between 2018 and 2021.[243] Their R&D focused on virtual assets at the initial stage in 2015 and soon shifted its application to various domains, including identification and logistics. In addition, the Busan Regulation-Free Special Zone[244, 245] pilots seven blockchain projects on financial services, public security, tourism, logistics, real-estate, and MyData.[246, 247]



The last part reviews two cases of government blockchain adoption. The Korea Customs Service was

one of the first agencies in the world to introduce blockchain into customs clearance.[248]



It stopped the project before commercialization due to the burden of transforming the public data systems into blockchain-based systems and insufficient partnerships with counterpart governments. In collaboration with private sectors, the government has now also provided the world's first blockchain-based vaccination certification services[249, 250] and extended it to a globally integrated Decentralized Identity (DID) system.[251]

These South Korean cases highlight three ambiguities in blockchain policies. First, blockchain involves both financial and industrial features. As the government regulates the former[252] and promotes the latter, it needs a new regulatory framework[253, 254] embracing the two features together. Second, integrating services on a blockchain platform will bring forth seamless automation of industries across manufacturing, financial services,[254] and public services.[256] South Korea, having accumulated capacities in manufacturing, is in need of a comprehensive strategy to encompass all services on a platform. Third, the two cases of the government's adoption of blockchain suggest that innovations in blockchain can be facilitated through effective cooperation among government ministries and agencies regarding particular businesses of private sectors.

With the history and legacy of remarkable industrialization, South Korea has the technological foundation and the concrete capabilities (e.g., logistics, personal data) to advance and adopt blockchain technology. Consequently, its policy is not simply to invest in virtual assets but also to develop a virtual-physical world woven by blockchain. The new environment demands South Korea transform its policy stances on blockchain, from specialization to comprehensiveness and cooperation. These are the main lessons from South Korea for other countries adopting blockchain.

South Korea has achieved remarkable growth in the last 60 years, rising from the ashes of the war into one of the most vibrant economies in the world. The country imports natural resources such as oil and minerals to process them for export. Moreover, it exports cars, ships, semiconductor devices, and smartphones. South Korea internally has an advanced value network and innovation system, and externally made up 3.0% of world trade volume (9th largest) in 2020.

The tradition of its industrialization, accumulated through time, is its strength. Its culture is focused on advancing blockchain technologies and developing business models for various domains, rather than financial services and virtual assets. In other words, blockchain innovation in South Korea is likely to be bound to real world assets such as logistics, real estate, personal data, and identification.[255] Furthermore, it is in an excellent position to disseminate blockchain innovation through trading partnerships.

However, these strengths can also resist blockchain adoption. Most of all, South Korea has specialized its competence into a few parts (e.g., DRAM[258] , smartphone devices) in compliance with global platforms[259] such as IBM's framework and Google's Android. Specialization in worldwide value chains might be its best strategy to survive its lack of natural resources and insufficient domestic market and lead the global economy. South Korea needs a well-designed strategy from a comprehensive viewpoint and a cooperative stance to lead a specific part of the blockchain ecosystem.[260]

SECTION XI

NEXT STEPS/GSMI 3.0

Over the last decade, blockchain technology and digital assets have matured and expanded across industries and across the globe. Much has changed, but a constant has been the industry's ability to move fast. GSMI aims to catalogue global activity in the industry, in part, to help address counterproductive fragmentation. In the inaugural GSMI report, released in October 2020, areas ripe for additional attention were highlighted. A year later, some of those challenges remain at the top of our list.

COMMON REGULATORY APPROACH

The distributed nature of the technology supports agility, but the difference in regulatory approaches across jurisdictions continues to lead to widespread fragmentation – both globally and within countries. This is a perennial pain point for both regulators and innovators. A common strategy would better serve all ends. Meaningful efforts to mitigate the incidence of information silos have also increased, but there is still much room for improvement.

EDUCATION

Education remains paramount. The development of thoughtful, digestible, and nuanced educational resources and efforts aimed at informing those crafting laws and regulations that touch blockchain technology and digital assets is critical. Recent interest in NFTs and Web 3.0 has increased attention in the industry, but the quality of understanding by stakeholders remains inadequate. Decision makers must be better educated with thoughtful, accurate, digestible information.

MULTI-STAKEHOLDER ENGAGEMENT

Important things happen when stakeholders from myriad backgrounds communicate. Regulatory frameworks based on input from actors in the public sector, private sector, and civil society have a better chance of effectively addressing concerns while encouraging thoughtful innovation. In their efforts to identify a rational path forward, regulators should prioritize engaging stakeholders from varied backgrounds and jurisdictions. Cross-industry, multi-stakeholder, multi-jurisdiction engagement is the way to build the robust frameworks needed for the future.

NIMBLE, PRINCIPLES-BASED GUIDANCE

Much existing regulation and standardization related to blockchain focuses on digital assets, as opposed to the underlying technology. This is positive. The future benefits and risks of blockchain cannot be completely or correctly anticipated at this juncture. As new uses for blockchain technology emerge, nimble, platform-agnostic, principles-based regulation will continue to be more sustainable and relevant.

TAX COMPLIANCE

Blockchain is an exceptional tool for compliance – particularly in tax. By integrating blockchain into tax systems, governments can ensure the benefits of this technology reach an expansive swath of society. Focusing on blockchain for tax will result in solutions with built-in smart regulations that manage risks. Tax solutions should result in on-chain transactions recorded on a publicly viewable blockchain ledger that are auditable by anyone at any time. This is a feature FinCEN and law enforcement have already embraced, and something tax authorities should consider seriously.

TAXONOMY

When carefully conceived, shared language can create an invaluable foundation for understanding and progress. Over the last decade, numerous blockchain taxonomies have emerged, but so far none have been universally accepted or adopted, making consistent regulations across (or within) jurisdictions difficult. Confused language remains a pain point within the industry. The taxonomy presented by this working group spans industries – including terms related to digital ID and the environment, which are often left out of blockchain taxonomies; it is a dynamic document and recommendations are welcome.

ADDITIONAL MAPPING

Moving forward, as the digital and crypto assets markets continue to grow, additional areas of research and mapping could include Web 3.0, specifically NFTs, DAOs, community tokens, virtual reality, gamification, DeFi protocols, and the metaverse. As these areas become more developed and complex, new legal and regulatory issues will arise. It is critical that stakeholders maintain an understanding of new developments; additional mapping should continue.

GSMI is an ongoing effort to connect the constellation of satellites that make up the blockchain technology and digital assets solar system. The proliferation of activity in this space is stimulating a generation of solutions fit to meet the challenges of our time. As global actors build novel solutions to address society's most intractable challenges, shared standards are needed to facilitate responsible, sustainable innovation. We welcome your support and participation in our crowdsourced efforts to bring additional resource tools and understanding of our great and burgeoning industry.

Thank you to every volunteer author, editor, and supporter. We appreciate all of you. See you in 2023 for GSMI 3.0.

SECTION XII

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GBBC
Global Blockchain
Business Council

SECTION XIII

APPENDIX

CONTENTS

APPENDIX A

TAXONOMY

TECHNOLOGY TERMS

Term	Definition	Category	Source
Airdrop	An airdrop is the distribution of tokens without compensation (i.e. for free), generally undertaken with a view to increasing awareness of a new token.	Financial	OECD - Taxing Virtual Currencies
Application Programming Interface (API)	An API is a particular set of rules and specifications that software programs can follow to communicate with each other.	Technical	LiMSwiki
Banking Industry Architecture Network	Banking Industry Architecture network (BIAN) is a common architectural framework for enabling banking interoperability. It helps create standardized capabilities in banking to lower costs and increase innovation.	Financial	Red Hat - Modernizing Retail Banking with Blockchain
Block	Structured data composed of block data and a block header.	Technical	ISO 22739:2020 - Blockchain Vocabulary
Block data	Structured data composed of zero or more transaction records or references to transaction records.	Technical	ISO 22739:2020 - Blockchain Vocabulary
Block header	Structured data that includes a cryptographic link to the previous block unless there is no previous block.	Technical	ISO 22739:2020 - Blockchain Vocabulary
Block reward	The reward given to miners or validators after a block is confirmed in a blockchain system	Technical	ISO 22739:2020 - Blockchain Vocabulary
Blockchain	A database that places records of transactions in blocks on a DLT network. Each block is linked (or "chained") to the previous block, using cryptographic signatures that make the transactions they contain immutable.	Technical	GBBC - GSMI 1.0
Burning	Burning is the act of sending cryptocurrency tokens to a wallet that has no access key.	Technical	Economic Times
CeFi	Centralized finance (CeFi) allows people to earn interest or get loans on their cryptocurrency by lending or borrowing it through a centralized corporation.	Technical	CryptoBriefing
Cloud Computing	The on-demand availability of computer system resources, especially data storage and computing power through the internet, typically made available by third-party service providers.	Technical	IMF - Digital Money Across Borders
Confirmed	Accepted by consensus for inclusion in a distributed ledger.	Technical	ISO 22739:2020 - Blockchain Vocabulary
Confirmed block	Block that has been confirmed	Technical	ISO 22739:2020 - Blockchain Vocabulary
Confirmed transaction	A transaction that has been confirmed.	Technical	ISO 22739:2020 - Blockchain Vocabulary
Consensus	An agreement between Distributed Ledger Technology (DLT) nodes that a transaction is validated, and that the ledger contains a consistent set and ordering of validated transactions. Different DLTs use different consensus mechanisms.	Technical	ISO 22739:2020 - Blockchain Vocabulary
Consensus mechanism	Rules and procedures by which consensus is reached.	Technical	ISO 22739:2020 - Blockchain Vocabulary

Cryptographic link	A link used in the block header to reference the previous block in order to create the append-only, sequential chain that forms a blockchain.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Cryptographic Trust	Trust bestowed in a set of machines that are operating a set of cryptographic algorithms to behave as expected. This form of trust is based on mathematics and computer hardware/software engineering.	**Regulatory**	Sovrin Glossary V3
Custody	Holding, directly or indirectly, client funds or securities, or having any authority to obtain possession of them. As it relates to cryptocurrency, custody commonly refers to holding a client's private keys.	**Financial**	SEC - Investor Bulletin: Custody of Your Investment Assets
Cryptography	Discipline that embodies the principles, means and methods for the transformation of data in order to hide their semantic content, prevent their unauthorized use, or prevent their undetected modification.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Decentralized application	An application that runs on a decentralized system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Decentralized Autonomous Organization (DAO)	A Decentralized Autonomous Organization (DAO) is an organization where the rules of operation and organizational logic are encoded as a smart contract on a blockchain.	**Financial**	Static1
Decentralized system	Distributed system wherein control of the system is distributed among the participating entities.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
DeFi	Decentralized finance ("DeFi") is a broad term for financial services that build on top of the decentralized foundations of blockchain technology.	**Financial**	WEF
Digital Signature	Data which, when appended to a digital object, enables the user of the digital object to authenticate its origin and integrity.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Distributed Ledger Technology (DLT)	A system of electronic records that enables independent entities to establish a consensus around a shared ledger without relying on a central authority to provide or authenticate the authoritative version of the records. The consensus is established by the authoritative ordering of cryptographically validated ("signed") transactions made persistent by replicating the data across multiple nodes and tamper-free by linking them via cryptographic hashes. The shared result of the consensus process serves as the authoritative version of the records.	**Technical**	GBBC - GSMI 1.0
Distributed Ledger Technology Account	Representation of an entity participating in a transaction. Smart contracts, digital assets, and private keys can be associated with Distributed Ledger Technology Accounts.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Distributed Ledger Technology Address	Value that identifies a DLT account participating in a transaction.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Distributed Ledger Technology Network	Network of DLT nodes that make up a DLT system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Distributed Ledger Technology Node	Distributed ledger technology device or process that participates in a network and stores a complete or partial replica of the ledger records.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Distributed Ledger Technology Oracle	A service that provides a distributed ledger with external information. DLT Oracles are primarily used to provide smart contracts with information that is not available on the DLT system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Distributed System	System in which components located on networked computers communicate and coordinate their actions by interacting with each other.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Double spending	Failure of a DLT platform where the control of a token or crypto-asset is incorrectly transferred more than once, creating a situation of ambiguous ownership of the asset.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary

Electronic Health Record	An electronic health record (EHR) is a digital version of a patient's paper chart. EHRs are real-time, patient-centered records that make information available instantly and securely to authorized users.	**Healthcare**	HealthIT
Encryption	Encoding message or data in such a way that only authorized parties can access it.	**Technical**	-1
End-to-end visibility	Having data available across the supply chain in real time to enable better decisions on risk management and performance improvement	**Supply Chain**	EY
Entity	Item inside or outside an information and communication technology system, such as a person, an organization, a device, a subsystem, or a group of such items that has recognizably distinct existence.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
ERC-20	The standard allows for the implementation of a standard API for tokens within smart contracts. This standard provides basic functionality to transfer tokens, as well as allowing tokens to be approved so they can be spent by another on-chain third party.	**Technical**	GBBC - GSMI 1.0
ERC-721	The standard allows for the implementation of a standard application programming interface (API) for non-fungible tokens (NFT) within smart contracts. This standard provides basic functionality to track and transfer NFTs.	**Technical**	GBBC - GSMI 1.0
Ethereum	Ethereum is an open-ended, decentralized, blockchain-based, public software platform that facilitates peer-to-peer contracts, known as Smart Contracts, as well as Decentralized Applications, known as DApps.	**Technical**	CME
Fault Tolerance	Ability of a functional unit to continue to perform required function in the presence of faults or errors.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Forging	This is often called staking and refers to the process through which transactions are verified when a DLT uses a 'proof of stake' mechanism	**Financial**	OECD - Taxing Virtual Currencies
Fungible Token	A token that is interchangeable with an identical token and divisible into smaller units.	**Technical**	ISSA Global Corporate Action Principles
Genesis Block	A genesis block has no previous block and serves to initialize the blockchain.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Governance	Governance refers to how a blockchain is initiated and managed. It defines the rules and procedures about network membership, management of permissions, transaction validity, issuance of new assets and their tokenization, dispute resolution, software updates, regulatory reporting, and protection against cyber risks.	**Technical**	OECD Ilibrary - The Potential for Blockchain Technology in Corporate Governance
Hard Fork	A hard fork is a software change to a DLT protocol that introduces a permanent split between the new protocol and the old protocol, making them incompatible ("backward incompatible").	**Technical**	ISSA - Crypto Assets: Moving from Theory to Practice
Hash Time-Locked Contract	A smart contract that enables the implementation of time-bound transactions.	**Technical**	World Bank Group - Blockchain Interoperability
Hash Value	String of bits which is the output of a cryptographic hash function.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Health record	The health record is the principal repository for data and information about healthcare services provided to an individual patient.	**Healthcare**	American Health Information Management Association
Healthtech	Healthtech is the application of organized knowledge and skills in the form of medicines, medical devices, vaccines, procedures and systems developed to solve a health problem and improve quality of life.	**Healthcare**	WHO - Health Technologies and Medicines
Hyperledger Fabric	Hyperledger Fabric, an open-source project from the Linux Foundation, is a modular blockchain framework, which is used as a foundation for developing enterprise-grade applications and industry solutions.	**Technical**	Circulor

Hyperledger Sawtooth	Hyperledger Sawtooth is an enterprise solution for building, deploying, and running distributed ledgers. It provides a modular and flexible platform for implementing transaction-based updates to shared state between untrusted parties coordinated by consensus algorithms.	**Technical**	Hyperledger Sawtooth
Immutability	A property wherein ledger records cannot be modified or removed once added to a distributed ledger.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Initial Coin Offering (ICO)	The cryptocurrency industry's equivalent to an initial public offering (IPO). A company looking to raise money to create a new coin, app, or service launches an ICO as a way to raise funds.	**Financial**	Investopedia - What is an ICO?
Internet of Things (IoT)	The Internet of things refers to a type of network to connect anything with the Internet based on stipulated protocols through information sensing equipment to conduct information exchange and communications in order to achieve smart recognitions, positioning, tracing, monitoring, and administration.	**Technical**	IJESC - Volume 6 Issue No. 5
Interoperability	Ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Invoice Automation	A method of using automation software to extract invoice data, populate the information in an accounts payable system, and process invoice data for the accounts payable.	**Supply Chain**	Tipalti
Layer 1	Layer 1 is the underlying main architecture of a blockchain such as the already existing and functioning Bitcoin or Ethereum network.	**Technical**	Cryptoeq
Layer 2	Layer 2 refers to an overlaying network that is built on top of the underlying blockchain.	**Technical**	Cryptoeq
Ledger	Information store that keeps records of transactions that are intended to be final, definitive, and immutable.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Ledger record	Containing transaction records, hash values of transaction records, or references to transaction records recorded on a distributed ledger.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Liquidity Mining	Liquidity mining is a DeFi mechanism in which participants supply cryptocurrencies into liquidity pools, and are rewarded with fees and tokens based on their share of the total pool liquidity.	**Financial**	Defichain
Local payment	Local payment refers to a payment denominated in a single, specific currency exchanged by two banks/Payment Service Providers located within the same country.	**Financial**	UNECE - Blockchain in Trade Facilitation V2
Mainnet	Independent blockchain running its own network with its own technology and protocol.	**Technical**	Coinmarketcap
Master Patient Index	The Master Patient Index identifies patients across separate clinical, financial and administrative systems and is needed for information exchange to consolidate the patient list from the various RPMS databases.	**Healthcare**	Indian Health Service
Medicalchain	Medicalchain is a decentralized platform that enables secure, fast and transparent exchange and usage of medical data.	**Healthcare**	Medicalchain - Whitepaper
Miner	Miners are nodes in the network that ensure the transactions in the block are valid.	**Technical**	OECD - Blockchain Primer
Mining	Activity, in some consensus mechanisms, that creates and validates blocks or validates ledger records. Participation in mining is often incentivized by block rewards and transaction fees	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Off-chain	Related to a blockchain system but located, performed, or run outside the blockchain system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Off-ledger	Related to a DLT system, but located, performed or run outside the DLT system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary

On-chain	Located, performed, or run inside a blockchain system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
On-chain Governance	On-chain governance is a mechanism that enables a decentralized community to update a blockchain by voting directly on-chain.	**Technical**	Gemini - An Overview of Blockchain Governance
On-ledger	Located, performed, or run inside a DLT system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Open-source	Having the source code freely available for possible modification and redistribution.	**Technical**	Merriam-Webster
Orphan Blocks	Valid and verified blocks which have not been accepted into the blockchain network due to a time delay in the acceptance of the orphan block as opposed to another qualifying block.	**Technical**	Cryptoeq
Paper Wallet	A method of storing cryptocurrency where one writes or prints their wallet's private key and address on paper, which is its final security backup method.	**Financial**	Cryptoeq
Payment transaction	Payment transaction means an act of placing, transferring or withdrawing funds, initiated by the payer, or on his/ her behalf, or by the payee, irrespective of any underlying obligations between the payer and the payee.	**Financial**	UNECE - Blockchain in Trade Facilitation V2
Permissioned	Requiring authorization to perform a particular activity or activities.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Permissionless	Not requiring authorization to perform any particular activity.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Pooled mining	Pooled mining pools all the resources of the clients to generate the solution to a given block. Therefore, rewards generated by that block's solution are split and distributed between the pool participants.	**Financial**	IMF
Private Distributed Ledger System	DLT system that is accessible for use only to a limited group of DLT users.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Private key	Part of an entity's asymmetric key pair, used for public key cryptography. A private key is used to generate a public key as well as sign off on blockchain transactions. Private keys are used in order to allow an entity to access their crypto assets, and should not be shared.	**Technical**	Original
Proof-of-Authority (PoA)	A type of consensus mechanism that gives certain nodes the exclusive right to create new blocks and secure the blockchain. The Proof-of-Authority mechanism is most commonly used for private blockchains.	**Technical**	Taxonomy of Blockchain Technologies
Proof-of-Burn (PoB)	A type of consensus mechanism in which miners must prove that they have 'burned' a digital asset through sending it to a verifiable and unspendable address. The Proof-of-Burn mechanism is commonly used to bootstrap a network.	**Technical**	Taxonomy of Blockchain Technologies
Proof-of-Capacity (PoC)	A consensus mechanism that focuses on the amount of memory the prover can employ to compute the proof. Miners who dedicate more disk space have a proportionally higher likelihood of mining a block and gaining the reward.	**Technical**	Taxonomy of Blockchain Technologies
Proof-of-Stake (PoS)	A consensus mechanism that selects 'provers' based on the amount of tokens that they own. The more tokens a 'prover' owns, the more likely they are to be chosen to verify the next block. Proof of stake assumes that users with a large share of the system wealth are more likely to provide accurate information.	**Technical**	Taxonomy of Blockchain Technologies
Proof-of-Work (PoW)	A consensus mechanism in which miners validate transactions through solving the inversion of a cryptographic function. The likelihood that a miner mines a new block is proportional to their contribution of computing power to that of the system's total computing power.	**Technical**	Taxonomy of Blockchain Technologies
Public key	Key of an entity's asymmetric key pair which can be made public.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary

Public-key Cryptography	Cryptography in which a public key and a corresponding private key are used for encryption and decryption, or are used for verifying digital signatures and digitally signing, respectively.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Record	Information created, received, and maintained as evidence and as an asset by an organization or person, in pursuit of legal obligations or in the transaction of business.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Regional payment	Regional payment is a payment denominated in a single, specific currency exchanged by two banks/Payment Service Providers located within a specific geographical area which includes different countries	**Financial**	UNECE - Blockchain in Trade Facilitation V2
RegTech	The use of technology to manage regulatory processes within the financial industry through technology. The main functions include regulatory monitoring, reporting, and compliance.	**Regulatory**	IMF - Digital Money Across Borders
Reward System (Incentive Mechanism)	Method of offering reward for some activities concerned with the operation of a DLT system. An example of a reward is a block reward.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Scalability	Scalability in regards to a blockchain protocol refers to its ability to support high transactional throughput and future growth.	**Financial**	Gemini - The Blockchain Trilemma
Segregated Witnesses (SeqWit)	The process to increase Bitcoin blockchain block size limit by removing signature date from transactions.	**Technical**	Cryptoeq
Settlement Finality	Settlement finality is defined as the point when the irrevocable and unconditional transfer of an asset occurs. Final settlement is a legally defined moment.	**Financial**	BIS - Payments without Borders
Sharding	A technique in distributed systems that horizontally partitions databases into rows, called shards. This is done to reduce the load on the blockchain network's participating nodes by eliminating the need for nodes to store every state or transaction, and instead only store a subset of every transaction.	**Technical**	Cryptoeq
Sidechain	Blockchain system that interoperates with a separate associated blockchain system to perform a specific function in relation to the associated blockchain system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Smart Contract	A computer program that is stored on a DLT) system, used to define and enforce a set of conditions. Smart contracts are typically used to execute agreements between two parties, without the involvement of an intermediary. Smart contracts sometimes use Oracles to utilize off-chain information.	**Technical**	ISSA - Crypto Assets: Moving from Theory to Practice
Soft Fork	A soft fork can be defined as a change to the DLT software that is backward compatible, which means that, unlike hard forks, there is no splitting or branching out of the blockchain	**Technical**	ISSA Global Corporate Action Principles
Solo Mining	Solo mining is when a miner performs the mining operations individually. All mined blocks are generated to the miner's credit.	**Financial**	IMF - Treatment of Crypto Assets in Macroeconomic Statistics
Staking	Crypto staking is the process of locking up crypto holdings in order to obtain rewards or earn interest.	**Technical**	Sofi
Subchain	Logically separate chain that can form part of a blockchain system.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
SupTech	Supervisory technology (suptech) is the use of innovative technology by supervisory agencies to support supervision. It helps supervisory agencies to digitize reporting and regulatory processes, resulting in more efficient and proactive monitoring of risk and compliance at financial institutions.	**Financial**	BIS - FIS Insights onPolicy Implementation No. 9
Telehealth	Telehealth is the use of telecommunications and information technology to provide access to health assessment, diagnosis, intervention, consultation, supervision and information across distance.	**Healthcare**	Medicaid.gov - Telemedicine

Testnet	Value-less networks used by protocol and smart contract developers to test their code in a production-like environment before deployment to the mainnet. Most testnets use a proof-of-authority consensus mechanism due to difficulty in incentivizing proof-of-work miners.	**Technical**	Ethereum.org - Docs
Timestamp	Time variant parameter which denotes a point in time with respect to a common time reference.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Validation	Function by which a transaction, ledger record or block is validated.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary
Validator	Validators are the participants on the network who run nodes (called validator nodes) to propose and attest blocks on a PoS blockchain.	**Technical**	Consensys - What is Proof of Stake?
Virtual file System	The virtual file system is the software layer in the kernel that provides the filesystem interface to userspace programs.	**Technical**	Kernel - Overview of the Linux Virtual File System
Virtual Nodes	A virtual node represents access to an object within a virtual file system.	**Technical**	IBM - Understanding Virtual Nodes
Wallet	Application used to generate, manage, store or use private and public keys.	**Technical**	ISO 22739:2020 - Blockchain Vocabulary

TYPES OF ASSETS/FINANCIAL TERMS

Term	Definition	Category	Source
Account-based CBDC	A type of CBDC tied to an identification scheme, such that all users need to identify themselves to access it.	**Financial**	BIS Annual Economic Report 2021 III. CBDCs
Algorithmic Crypto Asset	A crypto asset that can be pegged to a price level or a unit maintained through buying, selling, or exchange among assets, or some other predetermined mechanism.	**Financial**	GFMA - Designing a Prudential Treatment for Crypto-Assets
Asset-backed tokens	Assets represented digitally on a distributed ledger	**Technical**	ISSA Global Corporate Action Principles
Bitcoin Futures	A contract or an agreement between two parties to purchase and sell BTC at a given price at a specific future date.	**Financial**	Phemex Academy
Bitcoin Options	Bitcoin options are the right, but not the obligation, to buy bitcoin at a future date at a predetermined price.	**Financial**	GBBC - GSMI 2.0
Bitcoin perpetual contracts	Bitcoin perpetual contracts are derivatives that, unlike futures or options, do not have an expiration or settlement date. It is a swap contract that is closely pegged to the underlying instrument and is marked-to-market via a "funding rate mechanism" (the relationship between the swap price, the underlying price, and funding rate is generally between -0.025% and 0.025%)	**Financial**	Phemex Academy
Central Bank Digital Currency (CBDC)	A digital payment instrument and store of value issued by and as a liability of a jurisdiction's central bank or other monetary authority, and denominated in that jurisdiction's national unit of account.	**Financial**	r3 - CBDC Taxonomy and Design Choices
Convertible (or open) virtual currency	A currency that has an equivalent value in real currency and can be exchanged back-and-forth for real currency (ex: Bitcoin).	**Financial**	FATF- Virtual Currencies
Crypto Asset	Crypto assets are a type of private asset that depend primarily on cryptography and distributed ledger technology as part of their perceived or inherent value.	**Financial**	European Banking Authority

Cryptocurrencies	A crypto asset that is a digital representation of value with no redeeming rights against a central party. Cryptocurrencies may function within the community (enabled through peer-to-peer networks) of its users as a medium of exchange, unit of account or store of value. Cryptocurrencies may also act as an incentive mechanism and/or facilitate functions performed on the network they are created in; their value is driven by market supply/ demand therein.	**Financial**	GBBC - GSMI 1.0
Cryptocurrency derivatives	A derivative for which the underlying asset or reference is a cryptocurrency.	**Financial**	GBBC - GSMI 2.0
Digital Asset	An asset in binary form that comes with a right to use, that has clearly defined notions of issuance, termination, ownership, and transfer of ownership, a definable monetary value, which may be between specific counterparties, and which may be based on a right to use, or may be based on the principle of limited supply. A digital asset is not necessarily analogous to a security.	**Financial**	GBBC - GSMI 1.0
Digital Financial Asset	A term used to distinguish financial assets in digital form from other assets, such as images, videos and texts that are also rendered in digital form.	**Financial**	ISSA Global Corporate Action Principles
Digital Native Tokens	A digital asset that is generated and governed by the protocol of a DLT system.	**Technical**	World Bank Document
Know Your Customer (KYC)	KYC is the practice carried out by companies to verify the identity of their clients in compliance with legal requirements and current laws and regulations.	**Financial**	Electronic Identification - What is KYC
Margin Trading	Borrowing money from a broker to buy a stock/crypto and using your investment as collateral. Investors generally use margin to increase their purchasing power so that they can own more stock/crypto without fully paying for it.	**Financial**	SEC - Margin: Borrowing Money to Pay for Stocks
Non-convertible (or closed) virtual currency	A currency that is intended to be specific to a particular virtual domain or world, such as a Massively Multiplayer Online Role-Playing Game (MMORPG) or Amazon.com, and under the rules governing its use, cannot be exchanged for fiat currency.	**Financial**	FATF- Virtual Currencies
Non-fungible Token (NFT)	A cryptographic asset on a blockchain with unique identification codes and metadata that distinguish it from others. Unlike cryptocurrencies, NFTs cannot be traded or exchanged at equivalency. NFTs are commonly used to record original work and ownership rights.	**Technical**	Investopedia
Privacy Coin	A token predicated on protecting user anonymity and limiting traceability of transactions.	**Technical**	Cryptoeq
Satoshi	A "satoshi" or " sat" refers to a single monetary unit of account on the Bitcoin blockchain (100,000, 000 satoshi =1 Bitcoin)	**Financial**	Cryptoeq
Security Token	Token issued solely on DLT that satisfies the applicable regulatory definition of a security or financial instrument under local law (e.g., World Bank's "Blockchain Bond").	**Technical**	GFMA - Designing a Prudential Treatment for Crypto-Assets
Settlement Token	Representation on DLT of underlying traditional securities/ financial instruments issued on a different platform (e.g., a traditional CSD, registrar, etc.) where such representation itself does not satisfy the definition of a security or financial instrument under local law and is used solely to transfer or record ownership or perform other mid/back-office functions (e.g. collateral transfer, recording of ownership)	**Financial**	GFMA - Designing a Prudential Treatment for Crypto-Assets
Stablecoins	A crypto asset that aims to maintain a stable value relative to a specified asset, or a pool or basket of assets.	**Financial**	BCBS - Prudential treatment of cryptoasset exposures
Store of value	An asset, commodity, or currency that maintains its value.	**Financial**	Investopedia

Tokenized Commercial Bank Money	A digital form of money that represents a single fiat currency and is issued by/structured as a claim on a bank, credit institution or other similarly highly regulated depository institution.	**Financial**	GFMA - Designing a Prudential Treatment for Crypto-Assets
Utility Token	A means of accessing aDLT platform and/or a medium of exchange which participants on that platform may use for the provision of goods and services provided on that platform (e.g. loyalty rewards programs/systems, gift card rewards, credit points that are only usable within the DLT platform, memory and network server space, and other utilities based value)	**Financial**	GFMA - Designing a Prudential Treatment for Crypto-Assets
Virtual Currencies	Virtual currencies are "a digital representation of value that functions as a medium of exchange, a unit of account, and/or a store of value."	**Financial**	GBBC - GSMI 1.0
Wholesale CBDC	A CBDC for use by financial institutions (wholesale transactions) that is different from balances in traditional bank reserves or settlement accounts.	**Financial**	BIS Annual Economic Report 2021 III. CBDCs

ENVIRONMENTAL TERMS

Term	Definition	Category	Source
Carbon Border Adjustment Taxes	A carbon tax implemented on imported products in order to prevent "carbon leakage" as a result of climate action in the host country.	**Supply Chain**	European Commission - Carbon Border Adjustment Mechanism
Carbon Credit	One credit is equal to one ton of carbon emissions. The goal of carbon credits is to decrease carbon emissions from companies, by granting them a tradable credit. This incentivizes companies to cut down on emissions because they can gain monetary value from the credits they receive.	**Sustainability**	Investopedia
Carbon Emissions Token (CET)	A token representing a specified volume of metric tons of greenhouse gas emissions; distinguishes between the scope and category of emissions being reported.	**Sustainability**	VEM - Interwork Alliance
Carbon Offsetting	A quantifiable amount of carbon that can be traded, bought, or sold in order to reduce carbon emissions in the atmosphere.	**Regulatory**	Carbon Offset Guide - Understanding Carbon Offsets
Carbon Removal Unit Token	A non-fungible Token representing 1 mtCO2e removed from the atmosphere and stored. Shares the same Core Carbon Principles with attributes focusing on additionality, durability and reversal/replacements.	**Sustainability**	VEM - Interwork Alliance
Carbon Token	A carbon token is an asset-backed stable token with underlying carbon assets that have low price volatility and can be independently verified on international registries.	**Supply Chain**	Veridium - Unlocking the World's Environmental Asset Markets
Carbon Tracking	Enables organizations to dynamically track and calculate the GHG emissions footprint of their operations (scope 1 and scope 2) and supply chains (scope 3), providing accurate emissions insights based on the actual flow of materials.	**Sustainability**	Circulor
Conflict Minerals	Minerals trade used to finance armed groups, fuel forced labor and other human rights abuses, and support corruption and money laundering.	**Sustainability**	European Commission
Core Carbon Principles	A blueprint published by the Institute of International Finance that outlines criteria for utilizing and scaling voluntary carbon markets.	**Regulatory**	IIF - TSCVM Phase 2 Report, Page 13
Core Carbon Principles Token	A fungible token representing a specified volume of metric tons of greenhouse gas emissions reduced or removed by a project with standard data elements aligning with the TSVCM's Core Carbon Principles.	**Sustainability**	VEM - Interwork Alliance
Credit Buyer	As relates to ecological markets, an individual or organization that purchases verified credits issued by a Standard Registry.	**Regulatory**	VEM - Interwork Alliance

Ecological Claim Token	A token issued by a Modular Benefit Project containing co-benefits of the project (e.g. water conservation) and checkpoints, representing potions of a claim that build over time.	**Regulatory**	VEM - Interwork Alliance
Ecological Project/ Program (EP)	A single source of truth to all participants regarding the identity of a project or program and its ecological benefit claims; contains key details that are important for the supplier, validation and verification body, standard registry, and buyer in the market. An EP can contain multiple Modular Benefit Projects.	**Sustainability**	VEM - Interwork Alliance
Environmental, Social, Governance (ESG) Scorecard	A simple scorecard for a participant to record their established pledge (net zero, net negative, etc.) and track progress (goals, forecast, actuals, effective). Commonly a report issued through an external auditor.	**Sustainability**	VEM - Interwork Alliance
ESG Certification	Performance evaluation based on ESG criteria and certifications under environmental, social and governance categories, leading to the issuance of an ESG certificate.	**Sustainability**	SGS ESG Certification
ESG Token	Enables a supplier to provide their customers with Environmental, Social and Corporate Governance data regarding individual products	**Sustainability**	SGS ESG Certification
Green Washing	The process of conveying a false impression or providing misleading information about how a company's products or operations are more environmentally sound.	**Sustainability**	Investopedia
Modular Benefit Project (MBP)	A data element contained in an Ecological Project/Program (EP); an EP can have multiple MBPs depending on what type of claim the project will be making (e.g. carbon removal, carbon reduction, etc.); used to issue specific types of Claim Tokens.	**Sustainability**	VEM - Interwork Alliance
Processed Claim Control	Once validated and verified it is a credible claim that has an associate credit and is returned or burned, requires Processed Id. Mint, Roles and Credible behaviors.	**Regulatory**	VEM - Interwork Alliance
Standard Registry	An organization that establishes science-based standards for measuring, reporting, and verifying (MRV) ecological benefit claims and issues value in the form of credit for claims that meet the standard set. A standard registry also certifies verifiers to collect and process claims based on the established standard.	**Regulatory**	VEM - Interwork Alliance
Supplier	A supplier performs the actions, in either an Ecological Project or Program (EP), for creating the asset value for use in the voluntary market and becomes the initial owner of the ecological benefit value generated. Includes owners, sponsors, and developers.	**Supply Chain**	VEM - Interwork Alliance
Taskforce on Scaling Voluntary Carbon Markets	An initiative that is focused on creating a voluntary carbon market that is consistent with the Paris Agreement.	**Regulatory**	TSVCM
Validation and Verification Body (VVB)	An organization that is certified by a Standard Registry to verify MRV claims issued by an EP.	**Regulatory**	VEM - Interwork Alliance
Verification Contract	A multi-party contract between an Ecological Project (EP) and a Validation and Verification Body specifying the type of benefit being created; each Modular Benefit Project within an EP would have a separate Verification Contract.		VEM - Interwork Alliance

DIGITAL ID TERMS

Term	Definition	Category	Source
Accreditation Credential	A Credential issued by an Auditor Accreditor or Governance Authority asserting that a Trust Community Member conforms to the Accreditation requirements of a Governance Framework.	**Regulatory**	Sovrin Glossary V3

Cloud Agent	An Agent that is hosted in the cloud. It typically operates on a computing device over which the Identity Owner does not have direct physical control or access. Mutually exclusive with Edge Agent. A Cloud Agent requires a Wallet and typically has a Service Endpoint. Cloud agents may be hosted by an Agency.	**Regulatory**	Sovrin Glossary V3
Credential Registry	An Entity that serves as a Holder of Credentials issued by Trust Community Members in order to provide a cryptographically verifiable directory service to the Trust Community or to the public. The term also refers to the actual repository of Credentials maintained by this Entity. An informal Credential Registry may accept Credentials from participants whose purpose is to cross-certify each other's roles in the Trust Community.	**Regulatory**	Sovrin Glossary V3
Credential Registry Credential	A Credential issued by a Governance Authority asserting that a Credential Registry is authorized under a particular Governance Framework	**Regulatory**	Sovrin Glossary V3
Decentralized Identifier (DID)	A globally unique identifier developed specifically for decentralized systems as defined by the W3C DID specification. DIDs enable interoperable decentralized Self-Sovereign Identity management. A DID is associated with exactly one DID Document.	**Regulatory**	Sovrin Glossary V3
Edge Agent	An Agent that operates at the edge of the network on a local device, such as a smartphone, tablet, laptop, automotive computer, etc. The device owner usually has local access to the device and can exert control over its use and authorization. Mutually exclusive with Cloud Agent.	**Regulatory**	Sovrin Glossary V3
Edge-to-Edge Connection	A Connection that forms and/or communicates directly between two Edge Agents	**Regulatory**	Sovrin Glossary V3
Governance Authority (GA)	The Entity (typically an Organization) governing a particular Governance Framework.	**Regulatory**	Sovrin Glossary V3
Governance Authority Credential	A Credential issued by one Governance Authority asserting the recognition of another Governance Authority.	**Regulatory**	Sovrin Glossary V3
Identity	Information that enables a specific Entity to be distinguished from all others in a specific context. Identity may apply to any type of Entity, including Individuals, Organizations, and Things.	**Regulatory**	Sovrin Glossary V3
Identity Data	The set of data associated with an Identity that permits identification of the underlying Entity.	**Regulatory**	Sovrin Glossary V3
Legal Identity	A set of Attributes sufficient to identify an Identity Owner for the purpose of legal accountability in at least one Jurisdiction. A Legal Identity may be established by one or more valid Credentials from Issuers that are trusted to provide the necessary Attributes.	**Regulatory**	Sovrin Glossary V3
Level of Assurance (LOA)	A measure—usually numeric—of the Trust Assurance that one Entity has in another Entity based on a defined set of criteria that establish the amount of reliance the first Entity may accept from the second Entity in the performance of the criteria. LOAs are often defined in or referenced by Governance Frameworks.	**Regulatory**	Sovrin Glossary V3
Microledger	A cryptographic data structure maintained over a single Connection that enables two or more Agents to securely share Pairwise Digital IDs, Public Keys, Service Endpoints, and other Identity Data.	**Supply Chain**	Sovrin Glossary V3
Prover	A role played by an Entity when it generates a Zero Knowledge Proof from a Credential. The Prover is also the Holder of the Credential.	**Regulatory**	Sovrin Glossary V3
Self-sovereign Identity	An identity system architecture based on the core principle that identify owners have the right to permanently control one or more identifiers together with the usage of the associated identity data.	**Healthcare**	Sovrin Glossary V3

Trust Community	A set of Entities cooperating to achieve their mutual trust objectives. An informal Trust Community may not have an official structure or a Governance Framework. A formal Trust Community consists of the set of all Entities participating in a Governance Framework	**Regulatory**	Sovrin Glossary V3

SUPPLY CHAIN TERMS

Term	Definition	Category	Source
Anomalies	A discrepancy highlighted in the supply chain that could potentially highlight an issue (e.g. an event that has happened in an unknown location, a mass balance ratio discrepancy between points in a supply chain).	**Supply Chain**	Circulor
Asset	An asset is a physical item that is being tracked through the chain of custody. An asset is identified by a QR Code, barcode, NFC tag, etc.	**Supply Chain**	Circulor
Chain-of-custody	A process that tracks the movement of evidence through its collection, safeguarding, and analysis lifecycle by documenting each person who handled the evidence, the date/time it was collected or transferred, the GPS location the action occurred, and the purpose for the transfer.	**Supply Chain**	NIST - Computer Security Resource Center
Circulor Lockbox™	Used in the Circulor platform, with permission, to allow Organisations access to records within their supply chain that they do not own.	**Supply Chain**	Circulor
Circulor Protocol™	The proprietary Circulor Protocol, embedded within the Circulor platform, verifies data entered onto the system and enforces common rules on all ecosystem participants.	**Supply Chain**	Circulor
Events	An event is an action that occurs on an Asset being tracked in the supply chain, and forms the chain of custody of a given Asset.	**Supply Chain**	Circulor
First Mile	The starting point in a supply chain	**Supply Chain**	Circulor
Inherited Emissions	The amount of emissions that are inherited by downstream suppliers in the supply chain.	**Supply Chain**	Circulor
Privacy Protection Policy	A statement or legal document that discloses some or all of the ways a party gathers, uses, discloses, and manages a customer or client's data.	**Supply Chain**	Circulor
Traceability	The proof of traceability and provenance of an Asset that is being tracked through a Supply Chain.	**Supply Chain**	Circulor

APPENDIX B

SUPRANATIONALS CHART

The GSMI subteam focused on a subset of supranational organizations with the following highlights. Access the full suprationals chart here.

10
Supranationals

187
Jurisdictions

APPENDIX C

BLOCKCHAIN UNIVERSITIES

The GBBC team mapped universities across the globe actively training the next generation of blockchain professionals. Read the results here.

389
courses and degrees mapped

68
Jurisdictions

APPENDIX D

INDUSTRY CONSORTIA LIST

We are grateful to our research partners for this portion of the report, who include Accenture, ESG Intelligence, and GDF. Access the full consortia list here.

479
industry consortia mapped

GLOBAL BLOCKCHAIN BUSINESS COUNCIL

DC Location:
1629 K St. NW, Suite 300
Washington, DC 20006

Geneva Location:
20 Rue de-Candolle
1205 Geneva