A Research Vignette by Keith Bear & Michel Rauchs for GDF

Financial Services Leads The Development Of Enterprise Blockchain

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Foreword

It has been some time since the hype of Enterprise Blockchain we experienced in 2015. Then, large corporates enthusiastically grappled with the technology and not the cryptocurrency, there were few viable use cases, and the market was awash with great intentions. Since then the hype has largely dissipated and the community has rolled up its sleeves and got working.

At Global Digital Finance, we're fortunate to span the crypto ecosystem and the distributed ledger technology (DLT) Enterprise Blockchain ecosystem. From this vantage point, we see markets heading towards greater productivity and utility, as more use cases come online at an increasingly impressive rate.

From the IBM Food Trust which provides near real time traceability of food, now live with hundreds of corporates and thousands of farmers, to the Monetary Authority of Singapore (MAS) completing the fifth and final phase of testing their multi-currency platform "Project Ubin", DLT has come a long way in the past half-decade.

At GDF, we believe these scale enterprise projects will meaningfully impact the efficiency, transparency and fairness of global trade and financial markets. Truly global, truly digital finance is here.

This is all built on a narrowing the selection of enterprise ready technologies. Precisely because the market has come so far in such a short space of time, we asked our colleagues Keith and Michel to take a good look at Enterprise Blockchain to provide insights to the community.

The last five years show technology stacks that can solve real problems, like supply chain traceability, real time global cross-border payments, and improved capital efficiency have arrived. The advent of Libra and the arrival of Central Bank Digital Currencies (CBDC) have moved DLT up the agenda of global policy makers, regulators, and financial services executives.

The big question for the financial services sector, and in fact for all sectors, is where to look in the enterprise blockchain landscape to deliver solutions to help solve some of the "wicked problems" we face in industry over the next business cycle.

Simon Taylor
Co-Chair, GDF

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Introduction

From cryptocurrencies to Enterprise Blockchain

With the advent of Bitcoin in 2009, the genie of cryptocurrencies was let out of the bottle; resulting in the launch – and often subsequent fall into irrelevance – of tens of thousands of digital tokens on public blockchains. These systems are characterised by open access policies and permissionless usage, but also controvertible game-theoretical foundations, pseudonymous network operators and contributors, the lack of settlement finality and legal recourse, and unpredictable network behaviour. Originating in early 2015, Enterprise Blockchain has been the institutional response to public blockchains, inspired by early aspirations to reduce cost and to embrace technology innovation, thus aiming to bring some of the acclaimed benefits to the corporate world within well-defined organisational and regulatory boundaries.

Shared IT for B2B multi-party collaboration

Today, Enterprise Blockchain – also often referred to as enterprise Distributed Ledger Technology (DLT)[1] – generally refers to a set of technologies, tools, and methods to build, deploy, and maintain shared business networks that are jointly operated by identifiable participants. Going beyond purely technical merits, Enterprise Blockchain can be thought of as Shared IT, a versatile component within traditional enterprise IT which consists typically of multi-owner systems with shared governance and operation to facilitate multi-party collaboration across organisational boundaries. By sharing an agreed-upon and consistent single version of the "truth", duplicative processes, technology, and reconciliation costs can be removed leading to reduced errors, greater efficiency, and consequently lower costs. The distributed network architecture adds greater resilience to these systems whereas the extensive use of cryptographic techniques provides additional assurances that lead to greater accountability and transparency.

A vibrant ecosystem of diverse participants

Over the years, the potential of shared B2B infrastructure to automate business processes across distinct entities has appealed to many start-ups, corporations, and other organisations who have entered what has gradually evolved into a large and vibrant ecosystem at a global scale. Hundreds – if not thousands – of vendors provide a range of specialised services, whereas many more organisations ranging from SMEs to large corporates and public-sector institutions have been exploring how to best leverage this new paradigm of shared IT for their operations.

Going live: the financial services sector is taking the lead

Over the last two years, a growing number of business networks have made the transition from proof-of-concept (PoC) or pilot into production, going live with multi-party systems that have often been silently in the making for several years (the median enterprise blockchain project takes about 25 months from PoC to production).[2] Not all sectors across the economy have been equally involved: besides healthcare and food/agriculture, networks built around financial services appear to particularly stand out.[3] This may be due to financial services as an industry carrying an excessive burden of reconciliation costs due to the nature of value chains with multiple participants, extensive regulatory obligations, and historical market conventions. All these factors can add up to effective business cases focused on mutualised cost reduction in the first instance, often followed by incremental revenue generation through new business models in a second instance.

1 The lengthy debate about potential differences between these umbrella terms remains unresolved to this date: this article will consequently use both terms interchangeably.
2 *Cambridge Centre for Alternative Finance* (2019) 2nd Global Enterprise Blockchain Benchmarking Study (p.31).
3 See *Cambridge Centre for Alternative Finance* (2019) 2nd Global Enterprise Blockchain Benchmarking Study (p.33) and LeadBlock Partners (2020) Enterprise Blockchain 2020 (p.21).

Why are we doing this research vignette now?

A new uptick in interest and activity has been registered in the industry since the advent of the COVID-19 pandemic. PoCs seem to have fallen out of favour as enterprises are eyeing the deployment of real production systems. Existing projects are accelerated, in particular when contributing to the overall digitisation strategy. The ecosystem is moving to a greater stage of usage and adoption by institutions and governments alike. The purpose of this article is thus to reflect on the evolution of the Enterprise Blockchain ecosystem, assess the current state of the industry, and explore the key trends that will shape its future trajectory. Findings are based on research conducted in June and July 2020, which involved desktop research and semi-structured interviews with key decision-makers from the ecosystem's leading companies.

Navigating The Ecosystem

Approaching the Entreprise Blockchain ecosystem can be a daunting task given the proliferation of different projects, products, and services. We therefore propose a simple framework that divides the ecosystem into four interconnected layers that feed off each other in various ways:

1. **Protocols**
2. **Platforms**
3. **Business networks**
4. **Applications**

This mental model provides a practical way to quickly categorise projects and activities within their respective area of application in order to better understand their value proposition. It should be noted that in practice, some of the layers tend to overlap and the lines can be somewhat blurred.[4]

1. Protocols: the generic codebase frameworks serving as technical foundation

DLT protocols are the technical foundation of any business network and comprise the codebase that defines a generic software framework for building enterprise blockchain networks. In most cases, these frameworks are open source and maintained by open developer communities, but can be commercialised by companies via proprietary enterprise versions.[5] There are several dozen protocols available on the market today, but a small number of protocols have managed to establish a dominant position (see *the Big Three* on page 8).

4 While this approach brings some order to a dynamic and fast-evolving landscape, it has its limitations, too. There are many technical, operational, and organisational middleware layers in between that we have ignored for the sake of simplicity. Furthermore, the lines between some of the layers can sometimes be rather blurred, and companies and projects may operate across several layers at once. The framework should thus be considered as a stylised introductory lens to approach the ecosystem.

5 Some DLT protocols are proprietary and exclusively licensed and distributed by the developing company.

2. Platforms: the infrastructure backbone of business networks

DLT platforms constitute the infrastructure backbone of many **business networks** by enabling customers to easily build, deploy, manage, and maintain networks and interact with **applications** all within a single, unified environment. Platforms may support one or more **protocols**, provide multi-cloud options for network deployment and infrastructure hosting, and offer a wide range of supporting services (e.g. data insights, monitoring, integrations, operational consoles). Many platforms have integrated toolkits and middleware solutions that provide additional functionality and facilitate the integration with existing enterprise systems and applications. Both start-ups and established cloud service providers are offering DLT platform services to the market.

3. Business networks: shared multi-party enterprise systems

DLT business networks refer to shared peer-to-peer (P2P) networks that have been deployed in production. Each network is composed of several participant types (e.g. operators, nodes, validators, oracles) that are transmitting messages between each other and jointly producing a shared record of events – the distributed ledger. A business network is based on a selected **protocol** and can be deployed, managed, and operated through one or several DLT **platforms**.[6] Business networks vary in size: they can range from less than five participants to several hundred or more, depending on the technical and operational implementation.

4. Applications: implementing use cases that create business value

DLT applications are programmes, processes, or operations that connect to **business networks** to implement or support a given use case. It is at the application level where (most) users interact with the underlying blockchain system and where the actual business value is being created. Applications can be network-specific (i.e. linked to a particular business network) or network-agnostic (i.e. operate across multiple business networks), and contribute to either cost savings or new revenue streams.

PROTOCOLS AS TECHNOLOGY ECOSYSTEMS

The long tail of protocols

An astonishing number of Enterprise Blockchain protocols have emerged over the years, creating a vibrant landscape signalling promising long-term potential. Based on different design premises, each protocol offers distinct features that are often tailored to the needs of specific use cases or industry segments. Despite the wide range of options, three protocols have established a dominant position and relegated competing protocols to the long tail of the market.

The "Big Three" as open technology ecosystems

All available metrics confirm the undisputable market dominance of *Corda*, *Enterprise Ethereum*, and *Hyperledger Fabric*, which collectively account for the vast majority of developer activity and deployed business networks. At the heart of each lies an open-source codebase which invites developers and businesses to contribute: as a result, these protocols have evolved into veritable technology ecosystems that feature diverse communities of contributing developers, financial supporters, and dedicated advocates. The stability of the codebases listed can be seen as an additional sign of the growing maturity of the ecosystem. For example, *Corda* is now at version 4, and *Hyperledger Fabric* is now at version 2.

6 Network participants may also deploy and operate their node instances on-premises without having to use a third-party platform.

1) Corda

Corda is an Enterprise Blockchain protocol maintained and distributed by R3, a commercial software company originating from a member consortium composed of dozens of international banks. Since November 2016, *Corda* features a vibrant developer community that supports the development and maintenance of the open-source codebase, whereas R3 also provides a commercial enterprise version that offers additional features and benefits. As the main steward of the protocol, R3 has undertaken significant efforts to attract a number of global IT firms (e.g. Accenture, Cognizant, Infosys, Wipro) as partners for system integration and other services.

2) Enterprise Ethereum

Enterprise Ethereum refers to a set of projects that use modified versions of the *public Ethereum* codebase as the foundation for building permissioned Enterprise Blockchain networks. Unlike *Corda* and *Hyperledger Fabric*, *Enterprise Ethereum* encompasses multiple implementations that are maintained and made available to the public by different projects and companies, some of which are proprietary (e.g. Clearmatics's *Autonity* or Axoni's *Axcore*). In contrast, Hyperledger's *Besu* and ConsenSys's *Quorum* — initially developed by global bank J.P. Morgan — figure among the most popular open-source implementations.[7] The Enterprise Ethereum Alliance, a non-profit organisation featuring more than 200 members from all industries, acts as a semi-formal standards body that coordinates the technical specifications to ensure compatibility between the different enterprise versions.

3) Hyperledger Fabric

Based on a codebase originating from the IBM Open Blockchain Initiative, *Hyperledger Fabric* officially launched in July 2017 and quickly became the most popular project operating under the Hyperledger umbrella. The open ecosystem of developers and integrators is coordinated by the non-profit Hyperledger organisation under the auspices of the Linux Foundation, which manages and distributes the open-source codebase. *Hyperledger Fabric* is supported by all major **DLT platforms** and constitutes the cornerstone of IBM's popular *Blockchain Platform*, which remains one of the core contributors to the codebase and ecosystem.

Different monetisation strategies

Proprietary protocols are directly monetised via licensing agreements (e.g. Axoni's *Axcore*, Clearmatics' *Autonity*, Symbiont's *Assembly*), whereas open-source protocols can be commercially distributed via extended, more feature-rich enterprise versions (e.g. *PegaSysPlus* based on Hyperledger *Besu*, R3's *Corda Enterprise*). In most cases, however, vendors and system integrators commercialise open-source protocols at the **platform** layer by providing deployment and maintenance services.

Coopetition between ecosystems

Despite competitive pressures, there is a shared incentive among protocol ecosystems to collectively promote and grow the Enterprise Blockchain industry. Cooperation can take different forms, ranging from cross-industry interoperability initiatives and technical working groups to organisational partnerships: for instance, the Hyperledger Foundation and the Enterprise Ethereum Alliance are members in each other's organisation and the Hyperledger project suite contains Enterprise Ethereum implementations and tools (e.g. Hyperledger's *Besu* and *Burrow*).

7 On August 25th 2020, ConsenSys officially announced the acquisition of the Quorum IP and an undisclosed strategic investment by J.P. Morgan into the blockchain software firm.

PLATFORMS AS EFFECTIVE LAUNCHPADS

Platforms play a crucial role in launching and expanding business networks

DLT platforms significantly reduce the time to market and associated costs for **business networks** and **applications**. Abstracting away much of the technical complexity of the underlying infrastructure, they allow network participants to focus on the business case and provide valuable flexibility through a range of deployment and management options. Platforms also facilitate the onboarding of new members and ensure a smooth expansion of the **business network**. An example is the *Komgo* business network, which selected *Kaleido* as the enabling platform, managing to grow the network from initially 15 consortium members to now 17 banking entities and more than 120 other corporations through seamless onboarding.[8]

A maturing ecosystem of trusted enterprise providers

The entrance of large cloud providers (e.g. AWS, IBM, Microsoft, Oracle) has brought additional choice and options to the market while also creating the necessary trust and confidence in the ecosystem – an essential prerequisite for attracting large enterprises.

Towards a multi-cloud and multi-protocol future

Platforms pursue different strategies: some focus on a single **protocol** (e.g. IBM's *Blockchain Platform* exclusively building on Hyperledger Fabric), whereas others take a more agnostic approach and support multiple **protocols** (e.g. *Chainstack, Kaleido*). Until recently mainly a feature of ambitious start-ups, there is a growing trend among the platforms of established cloud providers to offer customers various deployment options that include cloud environments of competitors.

Protocol proximity as a competitive advantage

Platforms with less influence or control over the underlying open-source **protocol** codebase may have difficulties offering the strict service level agreements (SLAs) required by large financial services institutions. In contrast, platforms that are deeply involved in the development and governance processes of the **protocols** they support have a competitive advantage that customers are willing to pay for, beyond the mere computing environment.

From "Blockchain-as-a-Service" (BaaS) to "Blockchain Managed Services" (BMS)

Since 2019, a significant shift away from BaaS – centrally managed and hosted **networks** – has taken place. While an essential facilitator of early network deployments, increasing demand of network participants for greater flexibility and individual choice have given rise to a more diversified range of managed services that increasingly substitute the old model of "one provider manages all". In addition to accelerating the distribution of control over **networks**, this development also facilitates the onboarding of new participants to existing **networks**.

The constraints of strict enterprise requirements

Large financial institutions have strict internal and regulatory requirements for mission-critical IT systems that only few platforms can satisfy (e.g. ISO standards, key management, business continuity plans), posing a challenge for smaller providers to serve as the platform of choice beyond PoCs and trials. The management and hosting of network nodes only constitutes a small share of the full solution; production systems need a whole range of additional services that go beyond the initial plumbing.

8 Based on the Quorum variant of the Enterprise Ethereum protocol suite, Komgo is a blockchain network that focuses on commodity trade and finance. It was developed by a consortium of initially 15 core members including *Citi, ING, Koch Supply & Trading, MUFG Bank, ABN Amro and Société Générale*.

BUSINESS NETWORKS ARE ABOUT NETWORK EFFECTS

Increasing maturity of the business network layer

While non-technical considerations such as governance arrangements, incentive alignments, as well as legal and regulatory issues have caused significant delays, hundreds of shared business networks across various industries and regions have been deployed in production over the last two years.[9] This development marks an important transition from experimentation to actual business usage that is critical to the deployment of **applications** on these networks. An example of this increasing maturity is the Corda-based *Spunta* blockchain network, a distributed infrastructure for the Italian banking sector which has grown from an initial 32 banks at launch to a total of 55 by May 2020. The project expects to reach a total of 200 participating banking institutions in the coming months, becoming a major foundation for subsequent application development.[10]

Network effects dictate vertical and horizontal expansion

Following a small-scale launch, many networks are now entering a growth stage where new participants are actively onboarded. Depending on the business scope, networks pursue a strategy of vertical integration (onboarding downstream and upstream partners to create a holistic cross-industry structure) or *horizontal expansion* (integrating potential competitors from the same industry). An example is the expansion of *Tradelens* – a network launched by Maersk and IBM for container-based supply chain digitisation – into financial services, with Standard Chartered joining the network in order to leverage *Tradelens's* electronic bill of lading to help supply chain finance.

Monolithic networks are still predominant

The majority of large business networks are orchestrated around a narrow use case where the governance, infrastructure, and network operation is often concentrated in one entity. While this arrangement tends to offer both a quicker time-to-market and shorter time-to-value[11], it can also limit a network's flexibility to further expand and attract new **applications**.

Staged roll-out phases enable gradual modularity

To avoid the re-creation of siloed business systems operating in isolation – a potential risk of monolithic networks, some networks adopt a phased roll-out approach. Starting with logical and infrastructural centralisation, more modularity is gradually introduced that offers old and new participants greater flexibility and choice while opening the network up to potential new **applications** and use cases.

Can there be too many business networks?

Although the launch of new networks is rightfully cherished as an essential factor to advance the ecosystem, there is a risk that enterprises may be compelled to join a considerable number of networks tangentially overlapping with their business operations (e.g. see the recent proliferation of networks addressing trade finance). Active participation in multiple networks requires substantial resources and may create unnecessary friction and costs, potentially deterring involvement in the first place. Recent developments at the **platform** layer and the emergence of "super networks" (see next page) represent a potential solution for alleviating some of these concerns.

9 The IBM Blockchain Platform alone is home to some 150 live business networks, of which more than a dozen have already evolved into vibrant ecosystems comprising a wide variety of participants.

10 Based on the Corda protocol, the Spunta network both streamlines and automates transaction reconciliation, moving from lengthy and error-prone settlements to the real-time management of reconciliations. With SIA as one of the consortium partners who already support some 40% of SEPA payments across Europe, Spunta is also positioned to expand across borders.

11 Time-to-value refers to the period of time between the first conceptualisation of the project and the business network ultimately starting to generate tangible economic value for participants. Often underestimated, it is gradually replacing time-to-market as a leading KPI for evaluating enterprise blockchain projects.

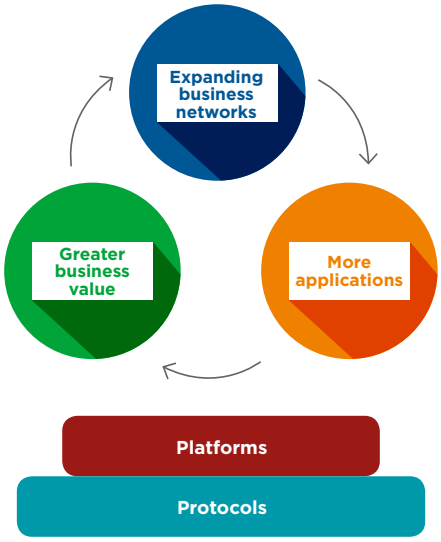
Looking Ahead: Key Trends To Watch

Business networks becoming more decentralised, one step at a time

A growing number of **network** participants are moving node management in-house, following increased demand of **platform** clients since 2019 for the option of hosting instances in private company clouds. This development adds to the overall robustness of **networks** by providing a more distributed topology based on diverse deployment options. We expect this trend to continue and pave the way for the gradual distribution of control among members at the governance level as well – a further step towards the ultimate Enterprise Blockchain promise of jointly-owned and collectively-operated market infrastructure.

Increased focus on the application layer

As with any institutional technology, the core foundation first needs to be laid before end user **applications** can be deployed. With a fully-developed **protocol** layer and an increasingly mature **business network** layer (further expansion and growth towards critical mass), the focus in the Enterprise Blockchain ecosystem is now ready to shift to the **application** layer, which is home to the actual front-end solutions that create real business value to end users.



Monolithic networks gradually giving way to modular arrangements

As a result of the above, we foresee that application-agnostic **business networks** will increasingly replace or supersede monolithic networks whose initial focus was limited to a narrow **application**. Opening up the **network** to multiple use cases – possibly beyond industry boundaries – provides an attractive venue for application developers and operators to deploy their solutions, creating incentives for additional **applications** to emerge on the same **network** that participants and end users can choose to run in a modular fashion. In a similar vein, network-agnostic **applications** that can be deployed across multiple business **networks** will proliferate: in a first stage, these will likely be made available via generic marketplaces for specific DLT **protocols** (e.g. see the *R3's CordApp marketplace*). A key value driver, as already demonstrated by public and permissionless cryptoasset **networks** such as Ethereum, is composability, i.e. the ability to combine different building blocks (modular applications) in various ways with little friction.

The rise of semi-public "super networks"

The emergence and growth of large industry-agnostic **business networks** with open access policies is a trend that will accelerate over the coming quarters. These **networks** are permissioned yet enable any organisation to join if eligibility criteria are met (hence "semi-public"), with the aim of creating a bottom connectivity layer between enterprises that reduces the need to join multiple **networks** at once. Examples include private-sector initiatives such as The Corda Network, a "network of networks" governed by an independent foundation that dissolves the boundaries between smaller Corda-based sub-networks. Similar initiatives also exist at the country level (e.g. Alastria in Spain, BSN in China) and the regional level (e.g. EBSI in the European Union) with the aim of building a (supra)national Enterprise Blockchain infrastructure that prevails over a fragmented landscape of many closed, siloed systems.

Increasing connectivity between networks via middleware tools and the application layer

Middleware tools such as Digital Asset's network-agnostic smart contract language *DAML* enable developers to abstract away the underlying **networks** – and even **protocols** – and focus on business **applications**. Similarly, identity and token standards are becoming an increasingly important driver facilitating the flow of data between different **networks** and **applications**. Standardisation at the **application** layer will allow enterprises to transcend the natural boundaries of **networks** by enabling near-frictionless value exchange across the entire ecosystem. Among many others, the Token Taxonomy Initiative spearheaded by the member-driven non-profit InterWork Alliance is a prominent example of cross-industry collaboration to promote the development of standards.

Ignore developments in Asia at your own peril

Somewhat overshadowed by events in the Western world, Enterprise Blockchain developments in Asia are advancing at breathtaking speed. In particular China is leading the way in terms of **network** deployments and ecosystem growth, receiving an additional boost after the official endorsement by the government pursuing a strategy that establishes blockchain as a national priority. While projects in the East and West currently mainly develop in parallel, we expect a rapprochement and growing interaction between projects in the future.

Private and public networks are approaching

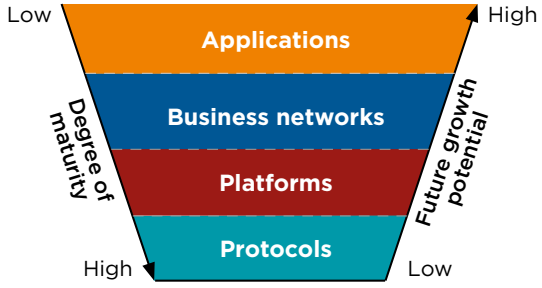
This article has so far mainly dealt with permissioned **business networks** operating within well-defined enterprise boundaries, largely ignoring the parallel ecosystem of public and permissionless **networks** powered by cryptoasset-driven incentives. However, there is a growing trend of convergence between these systems as enterprises come to realise the benefits of open, readily-available infrastructure. For instance, new tools such as *Baseline* use public **networks** (e.g. *Ethereum main net*) as a common frame of reference to orchestrate the synchronisation and reconciliation between disparate enterprise systems and **applications**. Other enterprise projects use public **networks** altogether as the technical foundation for issuing, managing, and transferring digital securities, as illustrated by recent bond issuances by international banks *Société Générale*, *Santander*, and *BBVA*, as well as tokenisation platforms such as *Tokeny* or *Stokr*.

Advances in research enabling new paradigms

The excitement around blockchain as a technology has brought renewed interest into academic sub-disciplines such as distributed systems and cryptography. For example, advances in distributed systems research have led to the design of more scalable and performant systems that face fewer decentralisation trade-offs than older implementations. In particular, significant breakthroughs in cryptographic techniques such as zero-knowledge proofs enable the development of verifiable computation, opening up a whole new avenue of promising privacy-preserving applications whose use extends way beyond the — admittedly still limited — universe of Enterprise Blockchain. The practical implementation of these otherwise mostly theoretical concepts into production systems will offer new paradigms for global cross-entity collaboration in full confidentiality with high degrees of individual control.

Inverse relationship between degree of maturity and future growth potential of layers

The further up you move the Enterprise Blockchain stack, the less mature the layers are: protocols and platforms have evolved over years into robust and stable offerings, whereas business networks – and applications in particular – are in a more nascent stage. Conversely, the future growth potential for a layer is increasing up the stack: hundreds, if not thousands, of new business networks are scheduled to see the light, potentially attracting tens of thousands of applications that are yet to be conceived.



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