CTT
Centre for
Trustworthy
Technology

Augmenting the Global Digital Economy through Open Transaction Networks

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Foreword

The trajectory of technological evolution is marked by transformative milestones that have fundamentally reshaped society. In the 1960s, the inception of The U.S. Advanced Research Projects Agency Network (ARPANET), laid the groundwork for the internet, revolutionizing communication, and information sharing. The 1980s saw the personal computer enter homes and offices worldwide, democratizing access to digital technology and altering the landscape of work and leisure. The early 2000s witnessed a leap in biotechnology, with CRISPR gene-editing heralding a new era in medicine, agriculture, and environmental science, promising solutions to some of humanity's most pressing challenges. Now, in the 2020s, the advent of generative AI stands to redefine creativity, problem-solving, and interaction, propelling us into a future where the potential for innovation is limitless. These are not just milestones of technological achievement but beacons that illuminate a path towards potential and promise.

Within this landscape, the concept of Open Transaction Networks (OTNs) shines brightly as a pivotal breakthrough. With its deceptively simple design, steadfast objectives, and boundless possibilities, OTN represents a paradigm shift in how we conceive our global digital economy across all paradigms- the 'high', 'middle' and 'low' income stratas. This paper adeptly introduces the necessity, concept, and vast potential of OTNs, painting a vivid picture of a future where transactional ecosystems are not just efficient but inherently equitable and inclusive.

The analysis of pilot initiatives, across continents, presented in this paper, highlights the surging excitement around the transformative capabilities of OTNs. This envisioned shift is built on the pillars of equity, empowerment, and shared progress, signaling a future where progress is defined by the universal democratization of opportunities for growth and prosperity. OTNs are poised to power economies as they undertake critical priorities of today, such as the transition to green energy, inculcating climate resilience practices in agriculture, restoring forests & biodiversity, while continuing to drive holistic societal progress towards improving livelihoods, better urbanization, greater industrial participation and formalization of service sectors, among others.

For OTNs to truly reach their potential, establishing deep-rooted trust is indispensable. This pivotal trust emerges not only through a steadfast commitment to transparency and accountability but also by engaging a global chorus of experts to discuss, debate, and even dissent on the nuances of OTNs. It is through this vibrant exchange of ideas and rigorous scrutiny that OTNs can be refined, their principles strengthened, and their applications made more robust. This paper births this chorus.

As we navigate the pioneering path of OTNs we are starkly reminded that the essence of technological evolution transcends mere technical prowess. Rather, the most profound gauge of progress rests in its capacity to instill trust across communities, to champion the cause of inclusivity, and to seamlessly bridge the divides that fragment our society. OTNs will forge a future where innovation drives a more connected, equitable, and unified world.

We are on the brink of a exciting era where both individuals and organizations can reshape their roles, transitioning to act as both consumers and producers within an OTN. The moment has arrived to unlock a market potential to embark on a path towards a more equitable, sustainable and regenerative global economy.

Hassan Gaye
DPS, Ministry of Communication and Digital Economy, The Gambia

Damir Medved
Director, University of Rijeka

Introduction

"Instead of a single, large, centralized network, imagine a world of smaller, distributed, interconnected networks. This is the future of the internet."

- Tim Berners-Lee, inventor of the World Wide Web

An open network is a system where nodes or entities interlink freely, operating without the confines of centralized control. This structure encourages unhindered participation and interaction, a trait that has significantly influenced various aspects of the modern world. At the forefront of this technological revolution is the World Wide Web which has transformed how information is accessed, shared, and disseminated, redefining the very fabric of human interaction. In the natural world, the neural networks in human brains showcase the sophistication inherent in these systems. They manage a complex array of thoughts and emotions, culminating in our consciousness. Networks are the conduits through which data, ideas, interactions, and knowledge flow to foster innovation.

The explosive growth in the field of network theory is exemplified by two landmark papers.[i] In 1959, Paul Erdős and Alfréd Rényi published a paper that is now recognized as the foundational work in the study of random networks within graph theory.[ii] This pioneering research laid down the mathematical underpinnings for analyzing complex network structures and behaviors. Equally influential is Mark Granovetter's 1973 paper, which has achieved the distinction of being the most cited in the field of social network analysis.[iii] Granovetter's work provided profound insights into the intricate webs of relationships and interactions within social systems.

At its core, a network is a structured representation of a system's components, known as nodes, and the intricate connections that exist between them. The size and complexity of a real-world network can vary immensely, from a few nodes and connections to billions or even trillions. For instance, the neural network of the C. elegans nematode, unique for its completely mapped nervous system, comprises 302 neurons (nodes) for the male. [iv] Contrast this with the human brain, a vastly more elaborate network, believed to contain around one hundred billion neurons.[v] On a broader and 'open' scale, the social network of the global human population consists of approximately eight billion individuals, while the digital expanse of the World Wide Web is estimated to include over 4.6 billion webpages as of January, 2024.[vi] These exhibits of networks span a remarkable spectrum, from the microscopic precision of a single organism's neural network to the open, growing and expansive magnitude of the world wide web.

The ubiquity and significance of networks in science, technology, business, and nature stand testament to its indispensability for modern society. They are much more than simple connections. They continuously adapt and evolve, exerting a profound influence on society. Their inherent open nature is a bedrock for innovation, a platform for collaboration, and a driver for growth.

Open networks offer a unique blend of methodologies and perspectives that enable seamless interaction across various disciplines[vii] [viii] Its central features can be outlined as:

- **Universality:** It serves as a common language, facilitating dialogue and collaboration among different fields. This characteristic allows for the integration of diverse methodologies and approaches.
- **Empirical Focus:** It is grounded in an empirical approach, emphasizing data, functionality, and practical utility. This focus ensures that theoretical models and concepts are constantly tested and refined against real-world data.
- **Theoretical Foundations:** Originally, networks adopted its formalism from graph theory. It has also integrated conceptual frameworks from statistical physics, particularly in handling randomness and identifying universal organizing principles.
- **Cross-Disciplinary Synergy:** Recently networks have demonstrated incorporation of ideas from various fields. Engineering concepts, particularly control and information theory, have been incorporated to deepen the comprehension of network control systems. Simultaneously, statistical approaches have been employed to extract valuable information from incomplete and noisy datasets. Moreover, the field has embraced a robust computational dimension, utilizing advanced algorithms, database management, and data mining techniques to enhance its analytical capabilities.

» **Finite & Scalable:** Networks can either be finite or scalable. Finite Networks limit the number of links a node can establish. Scale-free networks, the focus of this paper, are characterized by their lack of limitations on the number of links a node can have.

This Point of View paper explores the fundamental role of open networks in creating an interoperable transaction ecosystem - effectively **'Open Transaction Networks' (OTNs).** The structure of the document is as follows: It begins with an overview of open networks, charting their development and defining features. The next section examines the motivations behind the global emergence of 'OTNs' in various settings, providing a detailed analysis of the digital economy and arguing for its potential to promote access, equity, innovation, and fairness. Building on this foundation, the next segment presents real-world applications of OTNs, illustrated through case studies from across the world. Subsequently, the paper discusses the foundational design principles of open networks which are aligned with the World Economic Forum's Digital Trust Initiative. This is followed by a discussion on the evolving principles necessary for the sustenance of OTNs and its benefits to society. Concluding the paper, the 'A Glimpse Ahead' section offers foresight into future developments in this field, aiming to provide valuable insights into emerging trends and the evolving landscape of OTNs.

Open Networks

Foundation and Evolution

"The power of the internet lies in its openness. Open networks fuel innovation by allowing anyone, anywhere, to connect and share ideas."

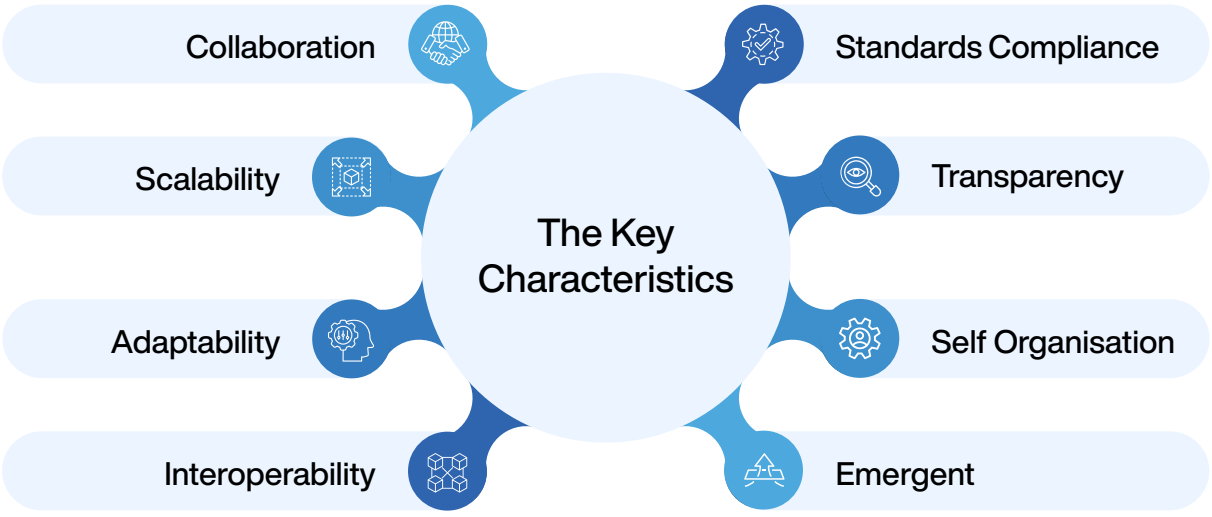
- Vint Cerf, Co-inventor of the Internet Protocl

An open network, refers to a network system where the nodes - which can be computers, individuals, or organizations - are free to join and interact without a centralized controlling authority. This decentralized approach allows for a dynamic exchange of information and resources. Open networks are characterized by their horizontal connectivity, which facilitates unrestricted and non-hierarchical interactions among nodes.[ix] This feature distinguishes open networks where equal and open communication are prevalent, devoid of centralized control mechanisms.

Tracing its evolution

The evolution of open networks is a tale of progressive advancement, deeply intertwined with the development of modern technology. The genesis of open networks can be dated back to the inception of the internet, particularly with the creation of ARPANET in the late 1960s.[x] This early network framework laid the groundwork for what would become a pivotal movement towards open, decentralized networking systems. ARPANET's design, characterized by its decentralized control and open access introduced a new paradigm in network architecture. Its design principles and architecture not only facilitated robust and flexible communication but also fostered a spirit of collaboration and information sharing that was previously unattainable. The introduction and subsequent rise of personal computing in the 1980s and the ensuing proliferation of the world wide web served as catalysts for its expansion. These developments brought the principles of open networking to a wider audience, demonstrating the practical benefits of such systems.[xi] Its evolution underscores a consistent trend towards more open, collaborative, and decentralized networking models, a trend that continues to shape the technological fabric of contemporary society.

Characteristics of an Open Network



Open networks are characterized by a set of distinct features that collectively foster an environment conducive to collaboration, efficiency, and inclusivity. At their core, these networks are composed of nodes and connections (links), which are governed by protocols and supported by an underlying architecture which outlines its design and functionality. Together, these elements enable seamless and open sharing of data and resources.

The central defining characteristic of an open network lies in its facilitation of enhanced collaboration.[xii] This is achieved through a decentralized structure, where each node, or participant, can contribute, collaborate, and even secede without the need for a central controlling authority. Such a setup inherently supports a more participatory approach, allowing for a diverse range of contributions and interactions.

Furthermore, open networks are marked by their scalability and adaptability. They are designed to efficiently handle an increasing number of nodes and links without a significant loss in performance.[xiii] This scalability ensures that open networks can accommodate a wide range of applications, from small-scale projects to large, complex systems.

Another critical aspect of open networks is their emphasis on interoperability and standards compliance.[xiv] These networks often employ widely accepted protocols and standards, which ensures that different nodes can communicate and work together seamlessly.[xv] This interoperability is vital to the collaborative potential of open networks.

Transparency is the central pillar permeating through open networks. Transparency in operations and protocols foster trust among users and stakeholders, which is essential for the effective functioning of an open network.[xvi]

Lastly, open networks often exhibit a certain degree of self-organization and emergent behavior. It can adapt and reconfigure itself in response to changes in its environment or in the behavior of its nodes, leading to innovative solutions and organic growth.

The Rise of Open Transaction Networks

Catalysts and Contexts

"There is an imminent need to redirect our rapid technological progress from prioritizing profit to fostering purpose. Open Transaction Networks brings this opportunity as a global public good. It cultivates agency for communities, initiates novel social exchanges, sparks innovation in economies, and challenges entrenched notions of who 'controls' and 'benefits' from technological advancement. This idea deserves the shared engagement of governments, private sector, civil society and philanthropies to secure a humane technological future."

- Vilas Dhar, Chairperson, Centre For Trustworthy Technology

Over the past two decades, the innovation and value generation landscape has been profoundly transformed by the rise of technology-based platform companies, significantly influencing the socio-economic framework. The platform economy has fundamentally altered key societal functionalities, streamlining processes for remote work, digital commerce, online education, telehealth consultations, business management, social networking, and the broad dissemination of information. However, this shift also introduced significant challenges, including concerns around the concentration of power, the undermining of competitive dynamics, and the creation of disparities in the pursuit of economic prosperity.

The primary reason for these challenges are the substantial 'switching costs' confronted by consumers endeavoring to discontinue their engagement with a particular platform.[xvii] Consumers often encounter formidable obstacles when attempting to sever ties due to the accumulated connections and data with their use of a particular service. As platforms grow, both consumers and service providers face the risk of centralized and sometimes arbitrary control processes imposed by these platforms. Additionally, this control poses a substantial challenge regarding the transferability of trust. Platforms enable both providers and consumers to build valuable reputations through their transaction histories within the platform. However, if a user desires to transfer their hard-earned reputation and trustworthiness to another platform or independent applications, they are hindered from doing so, even though this information pertains to their own data and credentials. As a result, if any user wishes to switch from their current platform due to misaligned incentives, they are compelled to relinquish the accumulated value they have built within the platform. This value cannot be carried over or migrated elsewhere. Consequently, this model disrupts the natural and unimpeded 'flow of value' that an equitable and efficient market should facilitate.

In response to these challenges, initiatives such as the European Union's Digital Markets Act (DMA) and the United Kingdom's Digital Markets, Competition and Consumers Bill have been introduced for promoting interoperability. This entails enabling users to seamlessly transition from one service to another while preserving their earned reputation and trust. If the European Union and the United Kingdom successfully enforce interoperability mandates, users will benefit from reduced costs of switching services and increased competition in the digital marketplace. These transformative changes could potentially culminate in legal requirements compelling major technology platforms to facilitate portability of users with their associated data across platforms, thereby simplifying the process of transitioning between digital platforms.

Over the last decade, efforts to develop effective Digital Public Infrastructure (DPI)[xviii xix xx] have underscored the importance of strategic investments in three foundational infrastructure layers: *Identity, Assets, and Transactions.* Implementing these core layers in population-scale digital transformation programs and enabling a seamless interoperability framework for data (e.g. messages, documents) and transactions (e.g. economic/commercial bilateral or multilateral interactions for a goods, services, and information-assets) are critical for unlocking the full potential of a country's economic future. Each of these layers holds significant value on its own:

Identity Layer: The *Identity* layer is a foundational digital infrastructure for enabling access to public services and ensuring that transactions can be securely attributed to the correct entities with a unique and verifiable identity. Examples of successful implementations include India's Aadhaar system, Estonia's e-Residency, and Singapore's SingPass, which have facilitated access to public and private services by providing a secure, digital means of identity verification.

Assets Layer: The *Assets* layer encompasses digital systems and open specifications that enable the recording, tracking, and management of data-assets. This includes residents' registries of health, employment, financial records as well as business related data including certificate of incorporation, tax identification number, intangible assets such as patents. The evolution and widespread adoption of interoperable networks in the asset domain, which allow for seamless exchange of electronic 'messages' and 'documents' has seen some exemplary successes. A globally popular example can be seen in Fast Healthcare Interoperability Resources 'FHIR' standards, which facilitates a seamless exchange of healthcare records basis an open standard.[xxi] Such systems have laid the foundation for an interconnected digital ecosystem in which information flows freely and securely.

Transactions Layer: The *Transactions* layer involves the economic interactions that facilitate the exchange of goods, services, and information assets between two or more transacting parties. While there has been significant progress in the Identity and Assets layers over the past two decades, the transaction layer has not seen analogous progress. The emergence of OTNs offers a promising solution to overcome this hurdle.

A transaction economy revolves around the multitude of exchanges that occur within the market, involving goods, services, and information between various parties. Optimally, this economy would operate on an *open and interoperable digital rail,* allowing for seamless interactions and transactions across several platforms and stakeholders. This is crucial for fostering innovation, competition, and access, ensuring that no single entity holds disproportionate influence or control over the market dynamics. This requires advancing the argument for interoperability viz. the ability of different systems and organizations to work together, share data, and transact seamlessly. An effective approach to addressing this lack of interoperability in the transactions layer, is through the establishment of an ecosystem-driven, unified protocol-based **Open Transaction Network (OTN).** Such a network would operate on agreed standards and protocols, ensuring that systems can interoperate without the need for direct integration or the same underlying technology.

"Open Transaction Networks can facilitate a paradigm shift in the global economy, by fostering a competitive rather than monopolistic landscape. By lowering barriers to entry, it can democratize technological access and stimulate generative collaboration and creativity. It can make our tech platforms more equitable, ensure more inclusive economic participation, and pave the way for new markets and business models"

- Bruce Schneier, Security Technologist and Professor in Public Policy, Harvard Kennedy School.

OTNs offer a multitude of advantages over the status quo:

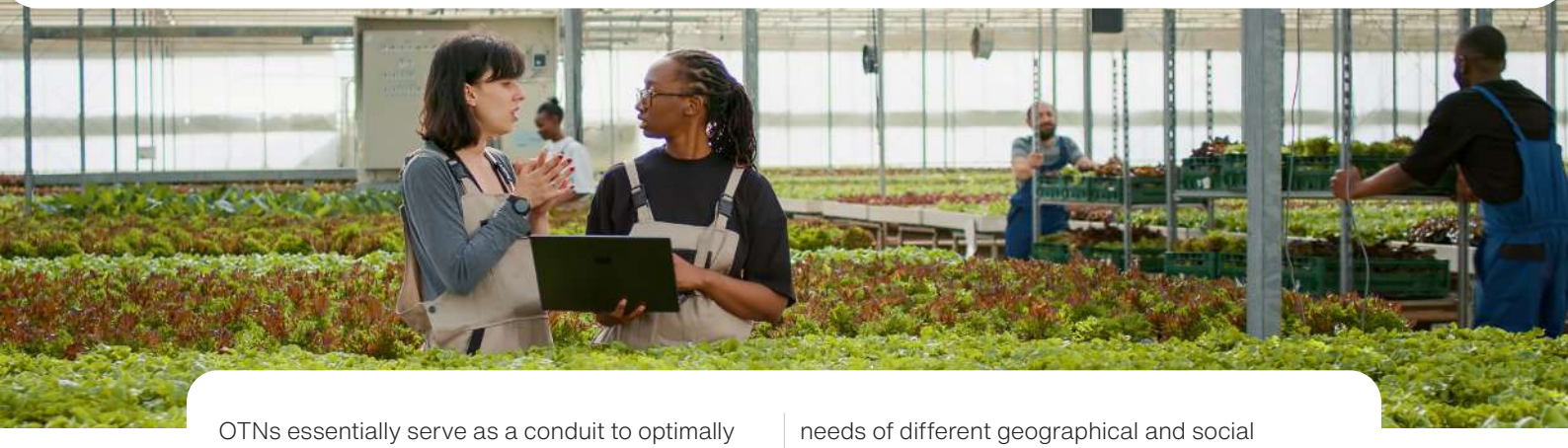
Increased Market Competition: OTNs lower barriers to entry for new players and reduce monopolistic tendencies in the economy. By enabling easier access for both service providers and consumers, OTNs encourage a more vibrant marketplace where competition thrives on innovation and quality, rather than on network dominance or consumer lock-in

Stimulated Innovation: An open, interoperable network fosters an environment ripe for innovation. Developers and entrepreneurs can build on a shared infrastructure, creating novel services and solutions that address unmet needs or improve existing offerings. This collaborative innovation can lead to breakthroughs in efficiency, security, and user experience.

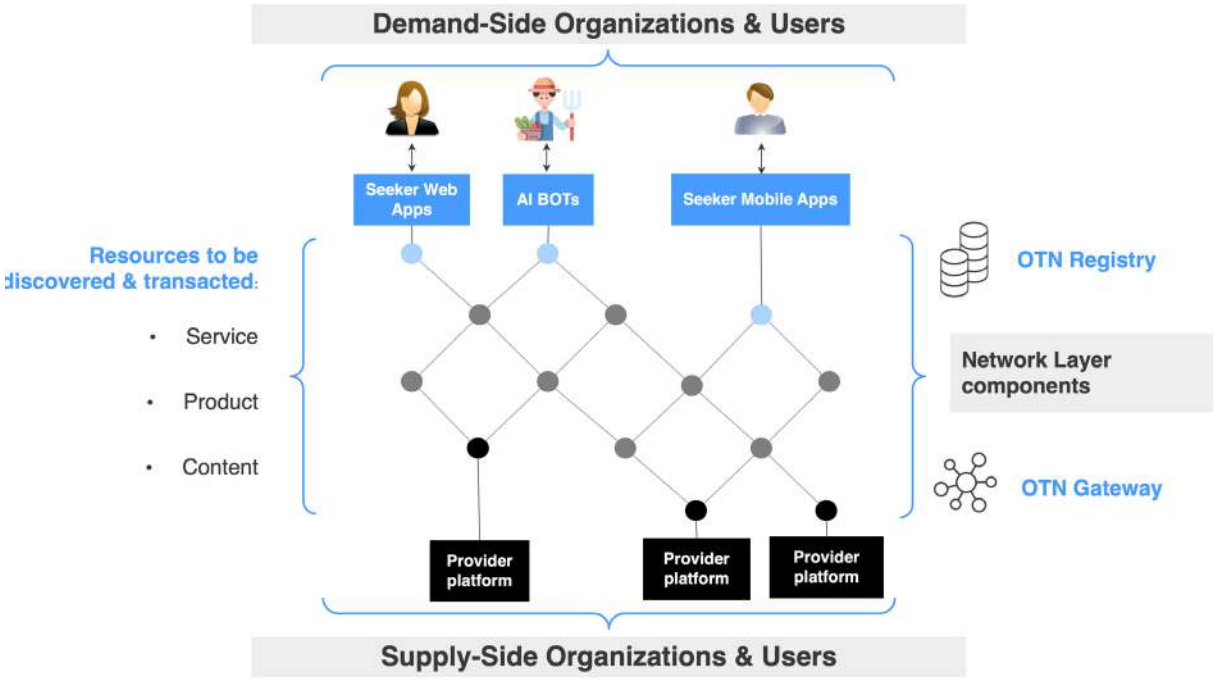
Enhanced Collaboration: OTNs facilitate collaboration among businesses, financial institutions, and service providers by providing a common platform for transactional exchanges. This shared infrastructure enables companies to partner more easily, combine their strengths, and create value-added services for their customers, fostering a more interconnected and supportive digital economy.

Equity and Inclusion: By democratizing access to the transaction economy, OTNs can play a crucial role in promoting equity and inclusion. This inclusivity can benefits individual entities but also enriches the market with a diversity of participants and perspectives.

Creation of New Markets: The interoperability and openness of OTNs pave the way for the creation of new markets and business models. Just as the internet enabled the rise of e-commerce, OTNs could unlock new transactional paradigms, driving growth in sectors yet to be imagined and providing consumers with more choices and innovative services.



OTNs essentially serve as a conduit to optimally coordinate economic interactions between the supply and demand side ecosystems. It offers the capability to streamline this exchange across a wide range of sectors, adapting to the specific needs of different geographical and social contexts. The extensive scope of their utility and influence is highlighted through emerging case studies from a range of regions and industries in the next section.



Envisioning an OTN design, it can be viewed as a composite architecture, which is composed of three distinct segments, as illustrated above:

Seeker-platforms: This includes all platforms that onboard the end-consumers (e.g. 'buyers' of retail goods, or 'seekers' of educational content), managing their operative needs - such as, acquisition, search, discovery, and enabling consumers - to transact on an OTN. Essentially, this implies any software application that interacts with the demand side of an OTN ecosystem, and thus is where a transaction on an OTN, commences. End-consumers (such as, farmers, students, patients etc) can use diverse & multimodal seeker platforms, such as mobile-apps, IVR systems, AI chatbots, web-portals etc., and so forth; to search for goods, services and products offered by the OTN's 'provider' ecosystem and transact with them.

Provider-platforms: This represents all platforms that onboard the 'supply-side' of an OTN (or the 'Providers' such as merchants of retail goods, content-creators & distributors, farm-equipment suppliers, medical professionals and so forth). Via such 'provider' platforms, these supply-side players can accept requests from end-consumers (through their seeker-platforms) and offer their catalog of goods, services, and products in response, and ultimately fulfill the consumer's needs.

Central infrastructure: This layer functions as a thin intermediary layer to facilitate all the interactions between the seeker and provider side platforms, as stated above.

The core components of this layer include:

» The 'Registry' manages a list of Organizations/ Platforms that have completed their registration processes needed by the OTN and are authorized to operate on the OTN. This registration process ensures accountability of their actions to the OTN governance processes and the alignment of operations with the core design principles of OTNs.

» The "gateway" facilitates the discoverability (or search) of all supply-side players (and their respective product or service catalogs) by broadcasting search requests from seeker-side platforms to all provider-side platforms, based on factors like location, availability, and other preferences of the seeker.

Additionally, an OTN can choose to add more capabilities, such as:

» 'Observability' to monitor and improve network health,

» 'Reconciliation and Settlement frameworks' to manage transaction settlements,

» 'Rating & scoring services' to review and rate transacting organizations,

» 'Fraud management services' to counteract malicious actors.

A more detailed deep dive of an OTN's technical architecture, its several components, and feature extensions, will be addressed in upcoming CTT papers on this subject.

Turning Ideas into Impact

The Ascent of OTN Use Cases

OTNs are poised to unbundle and unlock the transaction layer of national economies, cutting across various sectors, as illustrated below. At the forefront of this transformation is the 'Beckn Protocol, a globally recognized open source digital public good, which facilitates transaction-level interoperability by keeping a sector-agnostic approach. By embracing an interoperability architecture in these use-cases, policymakers and OTN practitioners can further bridge the supply-demand ecosystems, streamline economic interactions between the transacting parties and thereby spur combinatorial value creation for all stakeholders. Its versatility has ignited the launch of myriad OTN projects across high-income countries (HICs), low- and middle income countries (LMICs), and low-income countries (LICs)

"Many complex problems, be it of social or economic inclusion, climate action or scaling new markets for sustainable livelihoods and solutions (e.g. scaling EV charging ecosystem) deal with exponential costs when solving at population scale. Instead of each of such efforts trying to solve by themselves a multitude of costs like cost of discovery & fulfillment, of transaction and trust, we could raise all efforts to a new common ground. Open transaction networks, using the Beckn protocol, as a common and horizontal shared infrastructure distributes and reduces the cost and risks across the ecosystem."

- Sujith Nair, CEO and Co-Founder, FIDE, Co-Author, Beckn Protocol

In HICs, as nations traverse through a journey of societal transformations - induced by several internal & external circumstances, ranging from demographic changes, to climate action & sustainability efforts to industrial changes influenced by exponential technologies like AI - OTNs are being closely looked at as a means to establish a universal transaction ecosystem through collaborative public-private engagements.

There are several parallel OTN efforts being planned in Europe & USA currently, as illustrated below:

Mobility
Discovery of mobility services, EV mobility, ticket booking and more

Hyperlocal Commerce
Discovery & ordering from local restaurants, supermarkets and other retail stores

Circular Economy
Discovery of reverse logistics, recycling, product rentals, etc

Energy
Discovery of EV charging stations, Virtual Energy Warehouses & Community Microgrids

Culture/Tourism
Discovery of local attractions, accommodations & travel experiences

Industry 4.0
Discovery of smart, interconnected manufacturing systems that can optimise operations, enhance efficiency, and enable more flexible and responsive production

"In the mobility space in Europe the majority of integrations are based on 1-on-1 connections between transport operators and mobility providers. This is time consuming and limits innovation as only those integrations with a clear short term business potential are established. Open Transaction Networks will support the public transport operators who are now obliged by EU law to make available data and tickets to alternative ticketing platforms. Once OTNs are more widely known other mobility solutions will take advantage of the flexibility and cost efficiency to integrate Transport Operators and Mobility Providers. The current steps we take in preparing the Open Amsterdam Network for hyperlocal commerce and hyperlocal delivery would not be possible in the absence of an OTN. Amsterdam entrepreneurs and cargo-bike couriers will be some of the first in Europe to demonstrate the capabilities of OTNs."

- Jef Heyse, Co-Founder, Automicle

"The RBA Open Transaction Network is opening new avenues for private, public sector and academia collaboration here in Belém. These are exciting times for us and the private industry to innovate and develop contextually significant solutions around key segments like Climate, Health, Jobs & Education, Bio Economy, Urban mobility, among others with a focus on human capital development. Coupled with the Belém Innovation District, it is the much needed catalyst for technology driven socio-economic progress, beginning with unlocking upskilling and employment opportunities and I am confident this effort could set the foundation for more such societal interventions in other cities of Brazil and Latin America at large."

- Marcelo Sa, Founder and CEO - Jambu Tecnologia

SHOWCASE | LMIC COUNTRIES | Brazil

Rede Belem Aberta (RBA)

https://belemaberta.com.br/

The Open Belem Mission, is the **first city-wide open transaction network in Brazil** and in South America. The ambition is to position Bélem as a digital hub in the Amazon basin with the objective of linking producers to local and global markets through a DPI & OTN effort; with climate resilience & bio-sustainability as the overarching guiding principles for the Mission. To begin, RBA has prioritized efforts to **unlock transactions in upskilling and employment opportunities** in the City and the Pilot was officially announced in November, 2023; with a skilling-content discovery transaction executed over the RBA network.

What will RBA-Skills mission enable?

- Discover and access trainings and educational content
- Discover and access financial aid, scholarships, grants
- Foster mentorship connections between experts and learners
- Discover jobs, internships and employment opportunities
- Enable digitally verifiable credentials & open digital wallets
- Customised learning & employment paths

Opportunity for a Skills OTN

- Mismatch between exsisting skills jobs
- Demand for accessible and personalized learning & skilling efforts
- Limited edu-tech & jobs platforms
- Limited access to financial aid opportunities

Planned ahead for RBA

- Bioeconomy and Regenerative Agriculture
- Open Healthcare Services
- Open Mobility Services

... in plans for '24- 25

Partners Driving RBA

A leading tech-venture in the region: The 1st network-participant on RBA.

Universidade Federal do Pará (UFPA), as Academic & Research partner

City Council of Belém, as the Government partner for policy advisory

ParaTIC - Association of ICT Companies, Para, as the Network Infra partner

India has adapted an OTN through the establishment of the Open Network for Digital Commerce (ONDC). Launched in early 2022, ONDC's mission is to construct an interoperable network for e-commerce. Already, it has achieved remarkable success in enabling transaction-level interoperability across various sectors, including retail, mobility, and financial services. Several platforms and sellers have already joined the network, and user adoption is gradually increasing. The Government of India is actively supporting ONDC through various initiatives and policies.

"ONDC, as a pioneering example of a population scale OTN for several sectors in India, is built upon the key principles of transaction interoperability, unbundling of the building blocks of digital commerce, and ecosystem participation. This initiative, at its core a solid force multiplier to accelerate the digital transformation of MSMEs, augment 'choice' for consumers, while broadening the business potential for incumbent and new market players. ONDC will foster the development of new business and operational models, generating value throughout the entire value chain. And in its ambition, ONDC will touch upon all socio-economic segments of the society, thereby opening up a democratic space for all ecosystem participants to collaborate and thrive, as well as channeling a new wave of innovation for India's digital journey."

- T Koshy, MD & CEO, ONDC

SHOWCASE | LMIC COUNTRIES | India

Open Network for Digital Commerce

https://ondc.org

ONDC is a first-of-its-kind initiative to build an inclusive and interoperable digital commerce ecosystem. The pilot of ONDC was launched in April 2022 with key categories like hyperlocal grocery and online food delivery and is currently operational in more than 543 cities and towns across India [https://ondc.org/] across a number of categories and sectors.

What will ONDC enable?

- Expand digital commerce as a channel for transactions between consumers and providers
- Include providers of products and services for both B2C and B2B commerce
- Elimination of intermediaries, more autonomy for micro, small and medium businesses
- Unlock innovations across the ecosystem by making it inclusive
- Build multiple rails to the buyer (through different buyer apps) to connect supply and demand

ONDC is live on

Retail

Mobility

Credit

Logistics

Agri Services

Planned Ahead for ONDC

Investment

Insurance

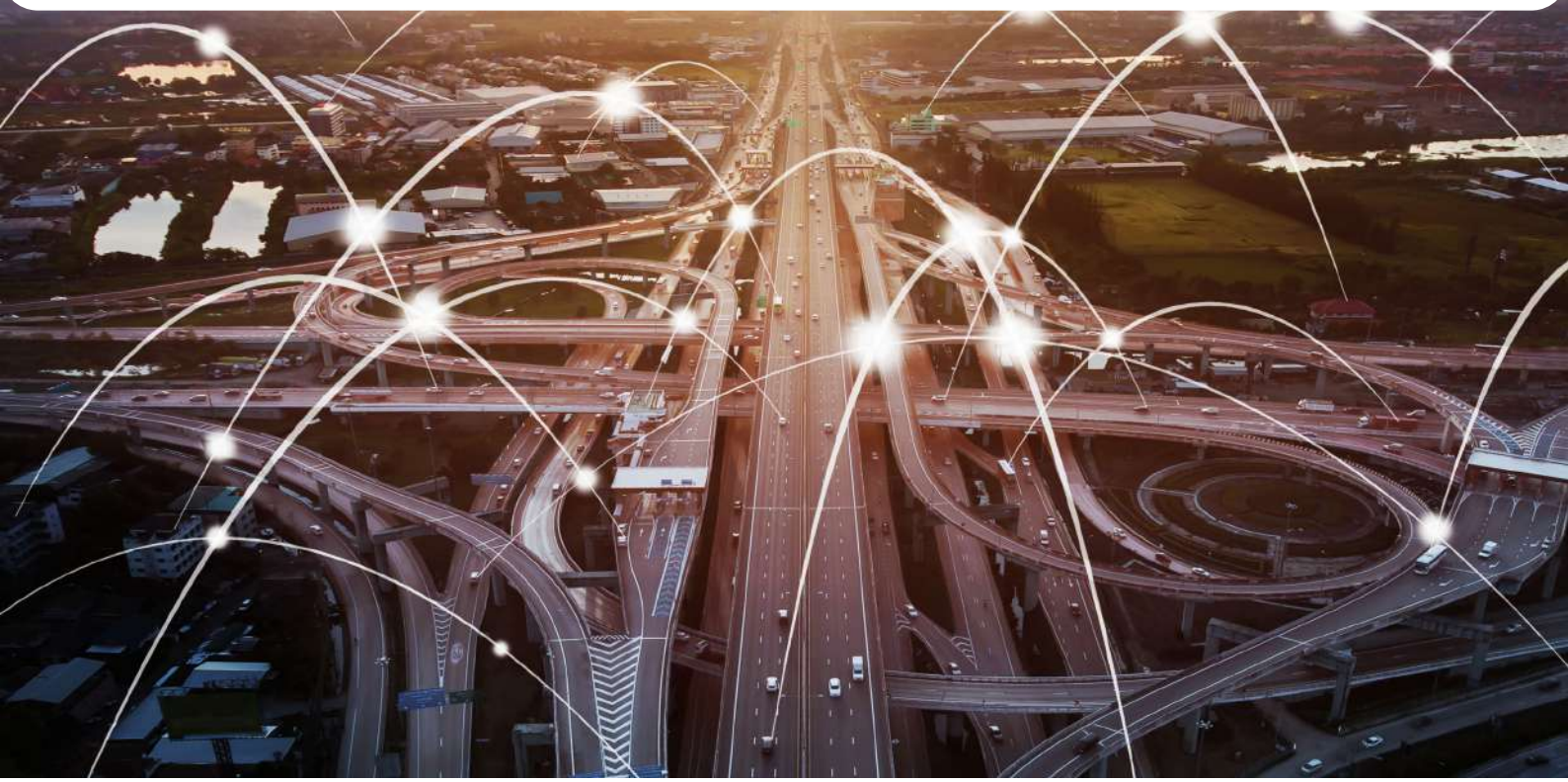
Services

Open Skilling and Employment

Partners driving ONDC

Advisory Council: Representatives from varied organizations including DPIIT, Ministry of Commerce & Industry, Quality Council of India, Digital India foundation, National Payments Corporation of India, Capacity Building Commission

The snapshot below depicts the entities that have joined the ONDC network to transact.



For LICs, OTNs offer vital benefits for socio-economic development and digital inclusion in resource-scarce settings. They increase access to digital services, stimulate economic growth by providing platforms for digital commerce, and enable small businesses to reach wider markets. OTNs in LICs are instrumental in addressing socio-economic challenges by promoting digital inclusion, economic growth, innovation, and social inclusion, thereby serving as a powerful development tool.

"Open, interoperable, and inclusive transaction networks are critical for unlocking the full potential of the digital economy in developing countries. OGa initiative in the Gambia is a pioneering example, paving the way for others to follow in the region and beyond."

- Joseph Jassey, Acting Country Executive Director, FoDE-Africa

A brief synopsis of an emerging OTN-effort in Gambia is outlined below

SHOWCASE | LMIC COUNTRIES | Brazil

Open Gambia Mission (OGa)

https://oga.gm/

Open Gambia (OGa) is a pilot mission led by an Africa-based not-for-profit foundation (FoDE). It is a **market-driven national OTN effort**, with support from Government, Academia and Civil society. Through this OTN, the mission aims to open up digital commerce opportunities across various sectors, unlocking local entrepreneurship in the Gambia. The pilot of OGa was launched in December, 2023, with proof of concept roundtrip transactions over the OGa network with an eCommerce market partner.

What will OGa enable?

- Seamless unified retail & logistics experience for consumers
- Access to more retail providers across the order to fulfillment value chain
- Elimination of intermediaries, more autonomy for micro, small and medium businesses
- OGa innovation hubs in leading universities to spur new academic-research cohorts
- Augment local entrepreneurship and Intellectual Property creation. (Gambia as a rising tech-hub in W.Africa)

OGa-Pilot with

Retail

Discovery of fresh produce, groceries and food in The Gambia

Planned ahead for OGa

- Open Skilling and Employment
- Open Tourism & Mobility
- Smart-Agriculture

Partners driving OGa

Advisory & Knowledge Partners: Ministry of Communications and Digital Economy, Foundation for digital economy

Academic Partners: Management Development Institute (MDI), University Of The Gambia (UTG)

A leading tech-venture, operating in the eCommerce segment in the region: The 1st network-participant on OGa.

Design Principles of OTNs

The principles governing OTNs are rooted in inclusivity, transparency, interoperability, and decentralization. These foundational principles are designed to foster a more accessible, equitable, and efficient environment for innovation and collaboration. The following key design principles are essential for the establishment of robust OTNs:

Decentralization: OTNs distribute decision-making authority and control across their participants, mitigating the concentration of power in a single entity or authority. This decentralization promotes resilience, reduces the risk of censorship, and enhances participant autonomy. OTNs consistently strive to decentralize their operations, technology, and governance to ensure that decision-making is collectively driven by ecosystem participants. This approach prevents any single platform or node from monopolizing the value generated by participants.

Openness and Transparency: OTNs typically permit anyone to join and engage without requiring approval or permission from a central authority. It relies on open standards and specifications that are non-exclusive and non-proprietary to facilitate interoperability. These standards and specifications are technology-agnostic, open to extensions, adaptations, and contributions by adopters, promoting innovation and reducing entry barriers. High transparency levels ensure that information, rules, and processes are readily available to all participants, fostering trust and informed decision-making.

Unbundling and Interoperability: Unbundling involves breaking down complex systems into granular components that can be independently operated, allowing different actors to perform various individual activities. OTNs prioritize the interoperability of these unbundled components, enabling different systems, devices, or platforms to seamlessly communicate and collaborate. Interoperability drives innovation by facilitating the integration of diverse technologies and services.

Inclusivity: OTNs are accessible to all participants, without discrimination or exclusion based on factors such as location, economic status, or identity. Inclusivity encourages diversity and ensures that a wide range of voices and ideas can participate in the network. Inclusivity is brought about not just in terms of the use of the services/goods/benefits from the network but also in its proponents that includes government, market, and end users - all of whom have a role to play, contributing and enriching the growth of the network.

Security and Privacy: OTNs place a strong emphasis on protecting the security and privacy of a consumer's personal data and the participant organization's transactions. It implements robust security measures to safeguard against unauthorized access and ensures confidentiality. Data minimization, protection of personally identifiable information and comprehensive consent frameworks are integral aspects of an OTN's design and architecture.

Community Governance: Governance within OTNs is community-driven, involving participants in decision-making processes. This approach guarantees that network rules and policies reflect the interests of the community. Access to the network is nondiscriminatory, inclusive, and empowers all participants with choice and agency. OTN communities establish mechanisms for continuous network and policy evolution, emphasizing participation and responsiveness. To strengthen the network, it encourages the formation of communities to develop and refine policies.

Evolvability: OTNs are nimble in its core design and embody agility, enabling it to adapt and evolve in response to market dynamics, policy shifts, technological advancements, and consumer preferences. It represents a dynamic ecosystem, continually shaped by the active engagement, collaboration, and coordination of all participants within the ecosystem. To enable its ongoing evolution and scalability, the establishment of community support frameworks and ecosystem facilitators are essential, ensuring the network remains responsive and sustainable.

Unlocking Value

Benefits of Open Transaction Networks

Unbundling the existing two-sided platform ecosystem model, that predominantly exist in several domains, to an OTN-ecosystem that accommodates multiple single-sided platforms (as outlined in the illustration on Page ..), helps reorient the market economy towards more efficiency and thus open up exponential value for all key constituents involved.

As the deployment of OTNs intensifies, a broad spectrum of stakeholders— including markets, communities, academia and governments— stand on the brink of transformative benefits. The section below outlines the specific advantages that each of these pivotal contributors within the network ecosystem can anticipate

"Throughout history – from the agricultural to the digital age –infrastructures have shaped society's defining activities, impacting social, economic, and environmental conditions of the times. As we transition into the Regenerative Era—a period that seeks to restore, renew, and revitalize our natural resources while fostering economic wellbeing – the need for a new type of infrastructure is evident. Open Transaction Networks (OTN) represent a kind of "digital mycelium" for the Regenerative Era, steering the developments and practices of this new period in human history. OTNs promise to enhance transparency and interactions within complex ecosystems, supporting transactions that align with the Regenerative Era's goals, e.g. promoting soil health, biodiversity, and carbon stewardship in agriculture, or adapting transactions in urban environments to meet the challenges of climate change and supply chain vulnerabilities. OTNs will enable practices that ensure the resilience of our communities, while fostering balance between humanity's interests and those of the natural world."

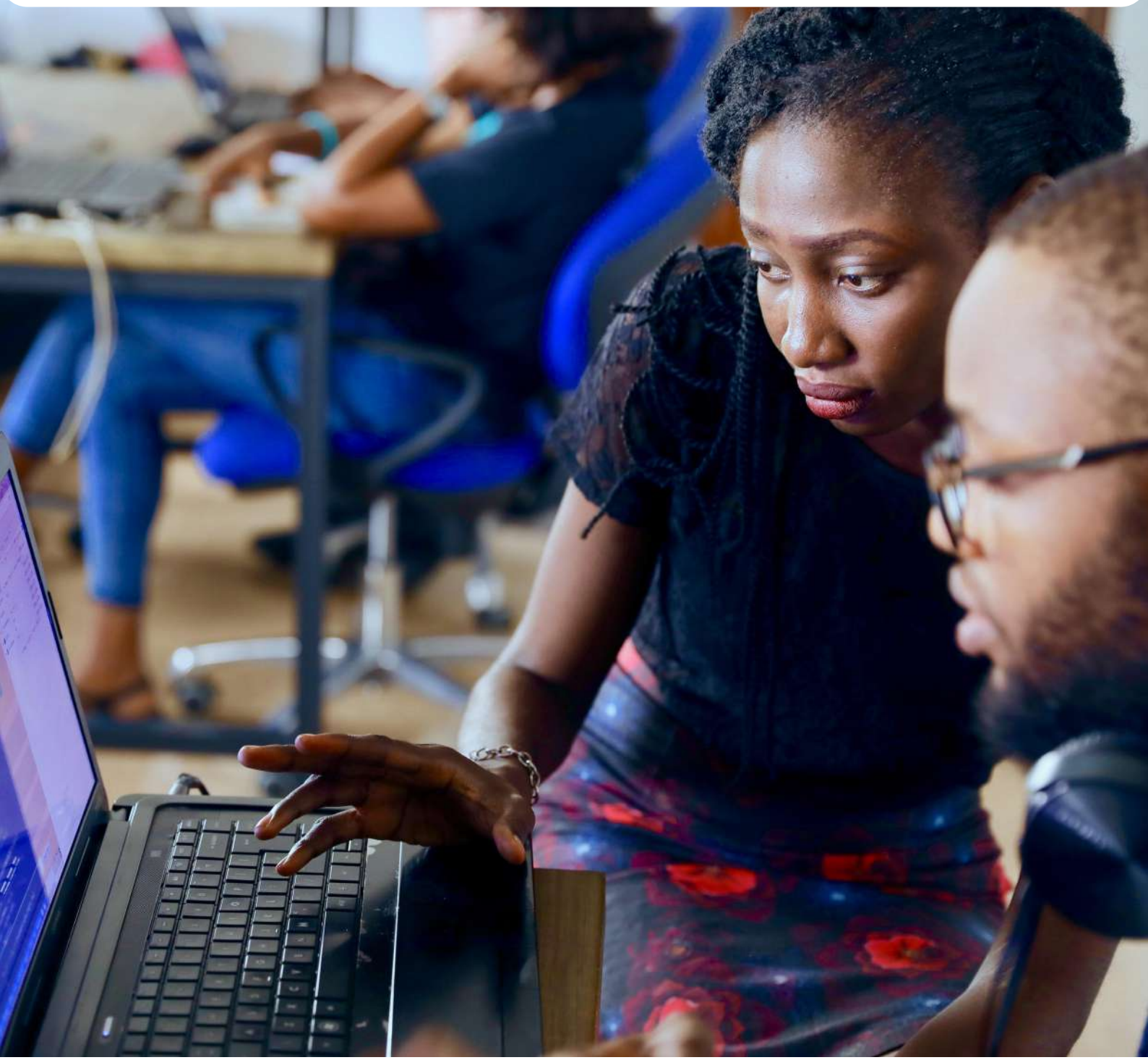
- Herman Gyr, Founding Partner - Enterprise Development Group

Market: OTNs can enhance market efficiency, innovation, and competition by offering interoperability and accessibility. They can provide businesses with expanded market access, reduced entry barriers, and opportunities for innovation, while decreasing operational costs and improving data-driven decisions. Consumers can benefit from increased product choices, improved transparency, and enhanced market interaction efficiency. Collectively, such networks can optimize resource allocation, accelerate economic development, and foster innovation, contributing to a more dynamic, equitable, and sustainable market ecosystem.

Communities: OTNs can offer a multitude of benefits to communities where it is institutionalized. It can empower them with agency and control to contextualize their participation in the network, fostering an ecosystem where economic opportunities are expanded equitably. Moreover, by upholding the principles of public scrutiny and accountability through unwavering transparency in its operations it fosters civic engagement in the economy. Further, OTNs adaptability provides the potential to optimize varied facets of a society for communities. It can augment access to educational and skilling opportunities, incentivize entrepreneurship, and promote financial inclusion.

Governments: OTNs can enhance government operations by promoting transparency and enabling better service delivery across varied sectors of the economy. It can facilitate informed policy discussions, reduce corruption, and support data-driven governance. OTNs can encourage economic development by fostering innovation, empowering entrepreneurs, and attracting investments. Additionally, it can contribute to inclusive development by ensuring that various community voices can participate in the economy and decision-making processes.

Academia: Today, academic institutions encounter significant challenges in accessing relevant data to develop economic models and validate hypotheses. Via the availability of OTNs - which can provide open, anonymised and aggregated data - researchers can explore different facets of user interactions to generate and validate diverse hypotheses over comprehensive data sets. This process can spur the creation of innovative economic, business, and operating models. OTNs can also offer a digital rail for researchers to showcase their proof-of-concepts over new & emerging ideas and establish meaningful research linkages with the Industry. Academia can strengthen their position in advising government and industry players on ongoing policy development, by utilizing insights drawn from such research and data analysis efforts. These insights can be reintegrated into OTN operations to enhance network operation and foster elevated trust amongst all stakeholders.



Considerations For Sustenance of OTNs

The effectiveness of an OTN is fundamentally linked to the enthusiastic participation of its network members and the creation of robust, transparent governance. Central to this endeavor is cultivating trust among participants for transactions that involve multiple stakeholders. Just as critical is the consensus on a cohesive technical infrastructure that facilitates interoperability for multi-party transactions. Furthermore, those leading OTN projects must adeptly tackle the intricacies of legal, contractual, and grievance handling mechanisms to guarantee seamless network functionality and sustain its future success.

"The key to network thinking is fostering "trust" in the multi-party interactions between the various network participants, facilitated by the symbiosis of technology and clear governance for seamless transaction interoperability. While technical interoperability can be readily attainable through unified protocols, addressing the legal, contractual, and process-level interoperability needs in a network can be complex. Thus, this critical aspect needs to be carefully designed, coupled with broader consensus amongst the network participants. With trust being established, Open Transaction Networks, similar to the Internet and powered by various protocols and standards, will trigger unprecedented exponential innovation cycles."

- Dr Pramod Varma Co-founder of FIDE.org and Co-author of Beckn protocol

A snapshot of insights drawn from established and emerging OTNs that were designed with these critical considerations, is outlined below:

Community Contribution: An OTN thrives on decentralization and maximizing stakeholder benefits. Thus, it's crucial for an OTN to cultivate an engaged stakeholder community that ensures accountability of its operations and growth. The development and adoption of the network rely heavily on community contribution, necessitating the establishment of robust mechanisms for such participation to solicit feedback.

Technology: The technology choices adopted in OTNs rely on core principles around inclusion, innovation, security, and transparency measures. Adopting open transaction interoperability protocol specifications are essential for widespread adoption and interoperability. OTNs should facilitate a collaborative space for the ecosystem participants to aid the joint development of protocol specifications, embrace minimal and privacy-preserving data collection methods, continuously monitor technological performance, and establish open communication channels for trust-based collaboration within the network.

Governance: Network governance in OTNs should be participative and encourage strong stakeholder engagement methods through feedback mechanisms, advisory panels, user councils and clear onboarding guidelines. Open distribution of network policies and establishment of clear and friction-less grievance mechanisms ensures that network activities are transparent to all stakeholders.

A Glimpse Ahead

As OTNs evolve and practitioners around the world get to learn and adapt from multiple OTN proof-points, policymakers and industry-leaders must also stay cognizant of other emergent technological head-winds - such as the fast-changing AI landscape - and the geo-economic policy opportunities that OTNs could open up for nations to generate more value for their constituents. A snapshot view of how an overlap of OTNs and AI could lead to unlocking inclusive economic value, as well as reimagining new forms of digital-trade cooperation using OTNs, is articulated below.

OTN interfaces with AI

"Amidst the drive to embed generative AI into every aspect of our lives, needed or not- in combination with the power of OTN, is a bridge for an inclusive and open world for everybody. Imagine a world where language barriers vanish, where AI listens and translates, enabling immediate digital access for the illiterate and speakers of non-mainstream languages alike. This isn't just technology; it's a gateway to equitable services in commerce, health, agriculture and education, where your voice alone opens up a universe of multimodal possibilities - this is what I would call a solution the world really needs."

- Jan Kuenne, Vice President, EU and India Pacific, Enterprise Development Group

The advent of AI technologies can significantly amplify the efficacy of OTNs by simplifying its complexity and enhancing its inclusiveness and reach. The adoption of multilingual, conversational AI tools and models are key to engaging the current and next generation of internet users. In a fast-changing global AI landscape, significant investments are being made in R&D by Researchers, Governments, and Industry players to develop contextually relevant AI-based language models. These conversational interfaces aim to be universally accessible, thereby bridging the digital divide. These investments will facilitate Automatic Speech Recognition (ASR), Speech to Text (STT), and Text to Speech (TTS) technologies, leading to the development of intelligent cataloging and the creation of advanced user interfaces, which in turn, will extend the technology's accessibility.

Progress in this domain is expected to enable mass production of content in local languages - using video formats and conversational, generative AI technologies - all of which promises to enhance the online experience for end-consumers in OTN environments. AI Bots can be deployed to deliver personalized content in users' native languages, increasing engagement and acceptance. These transformative changes in the AI industry can thus augment and accelerate the adoption of OTNs in varied geographies and contexts.

The Global Potential of OTN

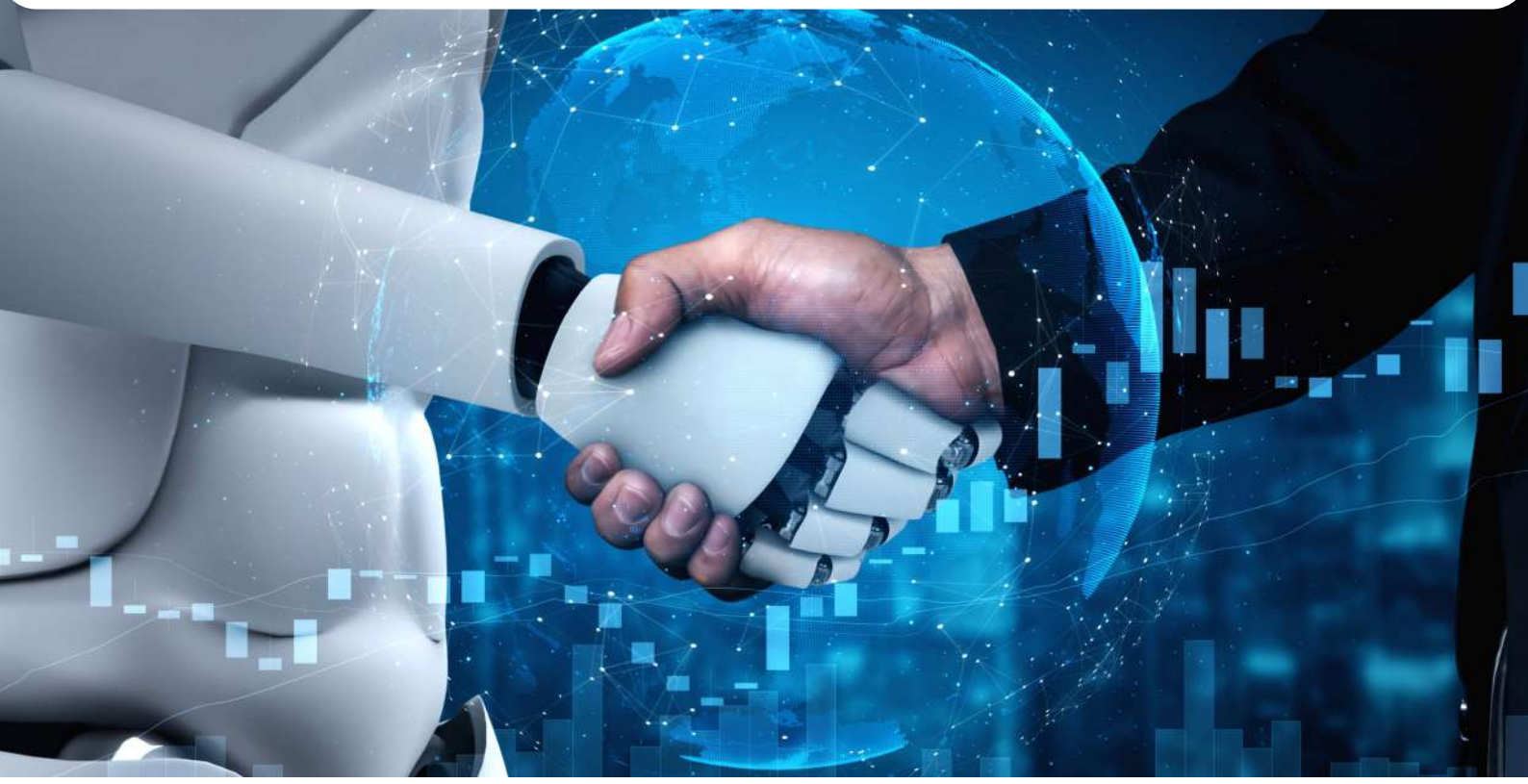
"Ongoing OTN efforts in Brazil and the Gambia illustrate examples that can be adapted to and adopted by other countries. While the sectoral focus may be different between them, the approach is similar: empowering and enabling people to participate in the digital economy through protocol-based open networks at population scale."

- Dr. Anit Mukherjee, Senior Fellow, ORF America

Technology stands as a dynamic catalyst, propelling the expansion of the global economy and transforming the contours of globalization. This surge has ushered in unparalleled economic opportunities and driven socio-economic development across the globe. Yet, the path to fully meeting the varied socio-economic demands of different regions is still unfolding. The creation of innovative modalities that facilitate diverse economic transformations and bolster sustainability is essential. Such innovations will empower countries at every economic level to attain self-reliance and energetically advance their policy objectives and global pledges, including those outlined in the United Nations' Sustainable Development Goals (SDGs). OTNs offer a vision of a future where every nation can flourish in a tightly knit global community, utilizing technology to foster enduring progress. As catalysts for digital-driven economic modernization, they serve as a crucial impetus for advancing this future-facing agenda.

OTNs strive to equalize economic transactions by linking market actors through a standardized, unified protocol-driven framework. The growing adoption of such networks is setting a precedent for inclusive growth, as is now being witnessed through several OTN initiatives like Brazil's Rede Belem Aberta, India's Open Network for Digital Commerce (ONDC), Gambia's national open network (OGa), and several others in the making. These endeavors are strategically designed with a broad vision, targeting key socio-economic needs of regions such as enhancing skills and generating jobs for improved quality of life, boosting digital commerce, and supporting national pursuits in energy sustainability and regenerative agriculture. This multifaceted approach underscores a commitment to nurturing diverse aspects of socio-economic development.

OTNs have the potential to new frontiers of bilateral and multilateral trade between nations, through regional and global digital trade corridors. This emerging paradigm has the potential to serve as a catalyst for a refreshed globalization 2.0 agenda, wherein nations worldwide engage in the frictionless exchange of goods, services, capital, and human expertise. This movement of economic and financial resources through OTNs can represents a significant evolution in global trade dynamics. These new digital trade corridors have the potential to augment competetive potential of each nation, simultaneously enhancing avenues of collaboration with both regional and global partners. This could facilitate a unified stride towards global objectives, including poverty alleviation, the improvement of living standards, the transition to green energy, and the reconfiguration of global supply chains to promote international trade. Realizing this exciting future will necessitate collaborative efforts and strategic alliances among governments, industry, civil society, and community working towards a unified goal of fostering a global economy that is inclusive, innovative, and thriving.



Conclusion

As we mark the eighth decade since the inception of ARPANET, the precursor to the modern internet, it's awe-inspiring to contemplate the vast array of applications that have flourished over the past 80 years. From reshaping business paradigms to fostering global connectivity, empowering democratic movements, and propelling scientific advancements, the internet has indelibly reshaped our world. At its core, the internet embodies a minimalist architectural design focused on facilitating connectivity. This elegant yet robust framework, guided by principles aimed at fostering global connectivity, ushered in a new era of human interaction and innovation. Now, we stand at a similar juncture with the emergence of Open Transaction Networks.

OTNs represent a paradigm shift, emphasizing design principles aimed at enhancing interoperability across a wide spectrum of domain-agnostic economic transactions. This paper serves as a foundational exploration of the necessity and conceptual framework of OTNs, marking the beginning of a global discourse on this idea. We, the authors, believe this to be the first global discussion on this transformative concept.

As OTNs evolve, their adaptations, achievements, and challenges will revolve around this core principle of interoperability. Its potential lies in the boundless realm of human creativity and necessity. Through various pilot initiatives underway worldwide, we will witness the development of specific utility and sustainability models tailored to each unique application.

While the practical applications and deployment tactics will differ across countries, the foundational principles driving their goals will be consistent.

In the coming months, the Centre for Trustworthy Technology will delve deeper into the compelling use cases emerging from these OTN pilots. Together, we will uncover the groundbreaking potential of this idea and its profound impact on shaping the future of transactions and connectivity in the years ahead.

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Vilas Dhar
Chairperson, Centre For Trustworthy Technology

Dr Pramod Varma
Co-founder, FIDE, Co-Author, Beckn Protocol

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CEO and Co-Founder, FIDE, Co-Author, Beckn Protocol

Joseph Jassey
Country Executive Director, FoDE-Africa

Sulayman Gibba
Chief Mentor, FoDE-Africa

Marcelo Sa
Founder and CEO - Jambu Tecnologia

T Koshy
MD & CEO, ONDC

Nitin Mishra
CTO, ONDC

Bruce Schneier
Security Technologist and Professor in Public Policy, Harvard Kennedy School

Herman Gyr
Founding Partner, Enterprise Development Group

Jan Kuenne
Vice President, EU and India Pacific, Enterprise Development Group

Dr. Anit Mukherjee
Senior Fellow, ORF America

Jef Heyse
Co-Founder and CBDO, Automicle B.V.

Damir Medved
Director, University of Rijeka

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Hassan Gaye
DPS, Ministry of Communication and Digital Economy, The Gambia

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Authors:

Satwik Mishra
Acting Executive Director,
Centre for Trustworthy Technology

Neeraj Jain
Vice President,
Network Expansion, ONDC

Rajeesh Menon
Head, Growth & Strategy, Foundation for Interoperability in Digital Economy

Research Assistance:

Helen Huang
Senior Research Associate,
Centre for Trustworthy Technology

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