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Advancing Digital Public Infrastructure for the Agriculture Sector

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Contents

Introduction	3
Background	3
Role of DPI in agriculture	3
1 Agri.DPI	3
2 Components of Agri.DPI	3
2.1 Data enablement	3
2.2 Data exchange platform	3
2.3 Data governance	3
2.4 Data exchange and governance value proposition	3
3 Telangana: Agri data exchange and governance	3
4 Next steps	3
5 Contributors	3

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Introduction

Background

Digital public infrastructure (DPI) refers to the foundational digital framework that nations build for effective governance and citizen services.

The most common and generic types of DPI relate to digital identity, digital payment and data exchange. While there are multiple examples of the first two types globally, DPIs of the data exchange type are just emerging.

Many countries throughout the world are already investing in DPI. Examples include Estonia's digital ID and e-residency programmes, China's social credit system, Singapore's Smart Nation initiative, and Aadhaar, India's digital ID programme and unified payments interface (UPI).

India's DPI is a transformative initiative, aligning with the nation's push towards a digital economy. These innovations streamline governance, enhance financial inclusion and provide a strong foundation for emerging technologies. Its UPI has revolutionized financial transactions, fostering a cashless society. Despite the successes, challenges such as data security and privacy concerns require continual attention. Overall, India's DPI exemplifies a concerted effort towards inclusive, tech-driven development.

While each nation's DPI varies, the global landscape showcases a trend toward digital innovation in public services, emphasizing efficiency, accessibility and data-driven governance. The common thread is leveraging technology for public welfare.

Role of DPI in agriculture

Agriculture, as a cornerstone of human civilization, has entered a new era, where data-driven decision-making, precision farming and efficient resource allocation are paramount. In the pursuit of global food security, sustainable agriculture and rural economic development, harnessing the potential of digital public infrastructure is

an imperative. While efforts are being made to enhance agriculture production, productivity, quality, sustainability, equity and profitability, a common underlying theme is to leverage digital and emerging technologies to achieve efficiencies across the agriculture value chain.



The government has announced the development of a DPI for agriculture as an open source, open standard and interoperable public good to enable inclusive farmer-centric solutions through relevant information services for crop planning and health, improved access to farm inputs, credit and insurance, help for crop estimation and market intelligence.

Narendra Singh Tomar, Minister of Agriculture and Farmers' Welfare of India (2019-2023)

Digital public infrastructure for the agriculture sector has the potential to create immense social and economic value for all stakeholders in the agricultural value chain, enabling digital transformation at scale, the potential for which currently remains untapped.

Data is the foundation for DPIs. According to [the World Bank](#), the average farm globally generated in 2014 approximately 190,000 data points daily. This figure will skyrocket to about 4.1 million data points per farm per day by 2050. As data becomes ubiquitous, the need for verified, quality, interoperable data ecosystems will increase.

- **Availability:** Does the data exist? Can it be accessed? Are external data sources available?
- **Quality:** Is the data complete? Is the data granular enough? Is the data accurate?
- **Usability:** Is the data in a usable format? Can the data be linked to other data? Are there any sensitivities around data use/sharing?

As per a [report published by McKinsey](#), in partnership with the Ministry of Electronics and Information Technology of India, artificial intelligence-driven digital solutions – fuelled by data

and enabled by digital public infrastructure – have the potential to add over \$65 billion of value to the Indian agriculture sector.

TABLE 1 **Digital agriculture economic potential for India**

National goal	Digital theme	Potential economic impact in \$ billion	Potential scope and scale of impact	Potential productivity efficiency gains
Doubling farmer income	Digital financing and insurance	~15	Potential for 40%-60% of farmers to institutional credit organized finance	10% point of interest savings as credit moves from non-institutional to organized sources
	Precision agriculture	~25	Potential adoption up to 20% of small holding farmers and 60% of large farm owners	15% increase in productivity using precision agriculture and digital advisory services
	Digital marketplace for agriculture	~25	Potential for 60% of agricultural surplus to be transacted through digital market place	10% improvement in farmer price realization through digital channels

Source: Ministry of Electronics and Information Technology of India

The World Economic Forum’s Centre for the Fourth Industrial Revolution India has collaborated with the Indian State Government of Telangana to develop a [framework](#) for establishing responsible data ecosystems.

This briefing paper captures the challenges, learnings and innovative solutions for building a potential agriculture DPI, and the methodology followed in developing and operationalizing an [Agricultural Data Exchange \(ADeX\)](#) and [Agricultural](#)

Agritech driving agriculture transformation

A recent [study](#) by the World Economic Forum’s Artificial Intelligence for Agriculture Innovation (AI4AI) initiative, in collaboration with the State Government of Telangana and Digital Green, shows that 7,000 chili farmers who were provided access to agritech services during the pilot,

[Data Management Framework \(ADMF\)](#). The paper serves as a guide for governments, policy-makers, industries and agritech start-ups dealing with similar challenges in building digital public goods in the agriculture ecosystem. It also aspires to help address some key questions around the importance of consent management, the role of data in agriculture innovation and data governance in the agriculture ecosystem, as well as calls upon all stakeholders to work in synergy towards the widespread adoption of DPI for agriculture.

saw an increase of about \$2,000 to their net income per hectare. The digital services related to crop advisories, soil testing, quality testing and e-commerce-based market connect. The pilot demonstrated the transformative power of digital agriculture, though on a small scale.

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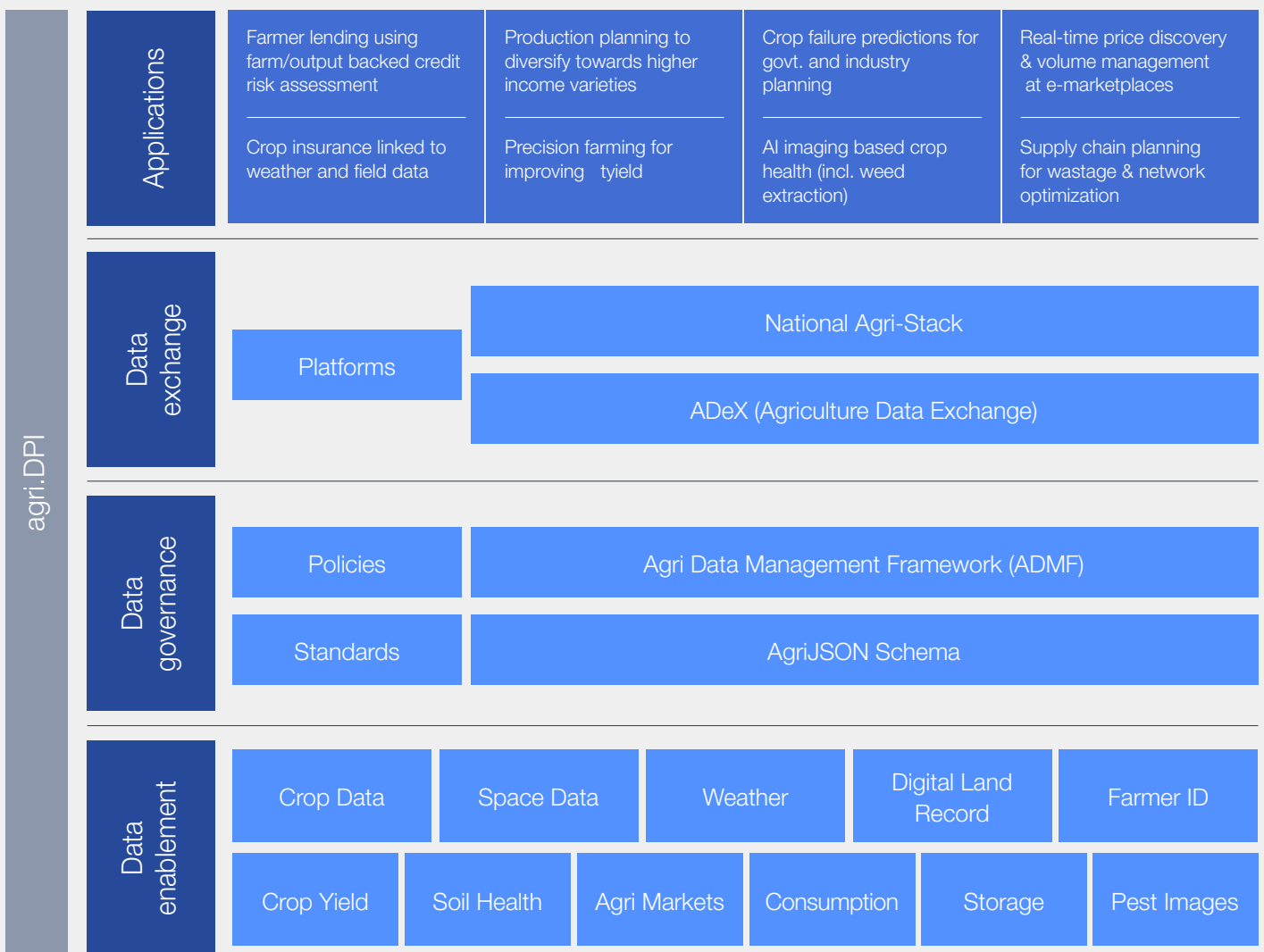
Agri.DPI

Agriculture DPI, or agri.DPI, is visualized to be a DPI that enables seamless exchange of data across the agriculture ecosystem to support digital agriculture and innovation. It is a digital platform supported by a set of policies and protocols with three foundation layers:

- **Data enablement:** ensuring availability and accessibility of quality datasets enabled by the DPI.

- **Data governance:** policy measures to promote responsible access and utilization of agricultural data.
- **Data exchange platform:** the technology platform to facilitate consent-based data sharing between data providers and data users.

FIGURE 1 Agriculture DPI framework



Source: World Economic Forum

2

Components of Agri.DPI

This section discusses the critical enablers of establishing an agriculture DPI and methodology followed for developing and operationalizing it.

2.1 Data enablement

The agriculture value chain is highly complex and comprises of multitude of actors. Datasets are quite diverse (weather, soil, markets, etc.) each with numerous sources, in varied formats and with multiple stakeholders (farmers, governments, retailers, etc.). Ensuring that right data is available to the right users at the right time is essential to foster innovation. This critical requirement is termed “data enablement”.

Agriculture datasets are available with various government departments, academic institutions, farmer organizations (including individual farmers) and private sector stakeholders. To increase the accessibility of available data, datasets have been identified based on their availability, quality and, most importantly, utility in operationalizing the prioritized use cases, such as access to finance, access to advisories and access to markets.



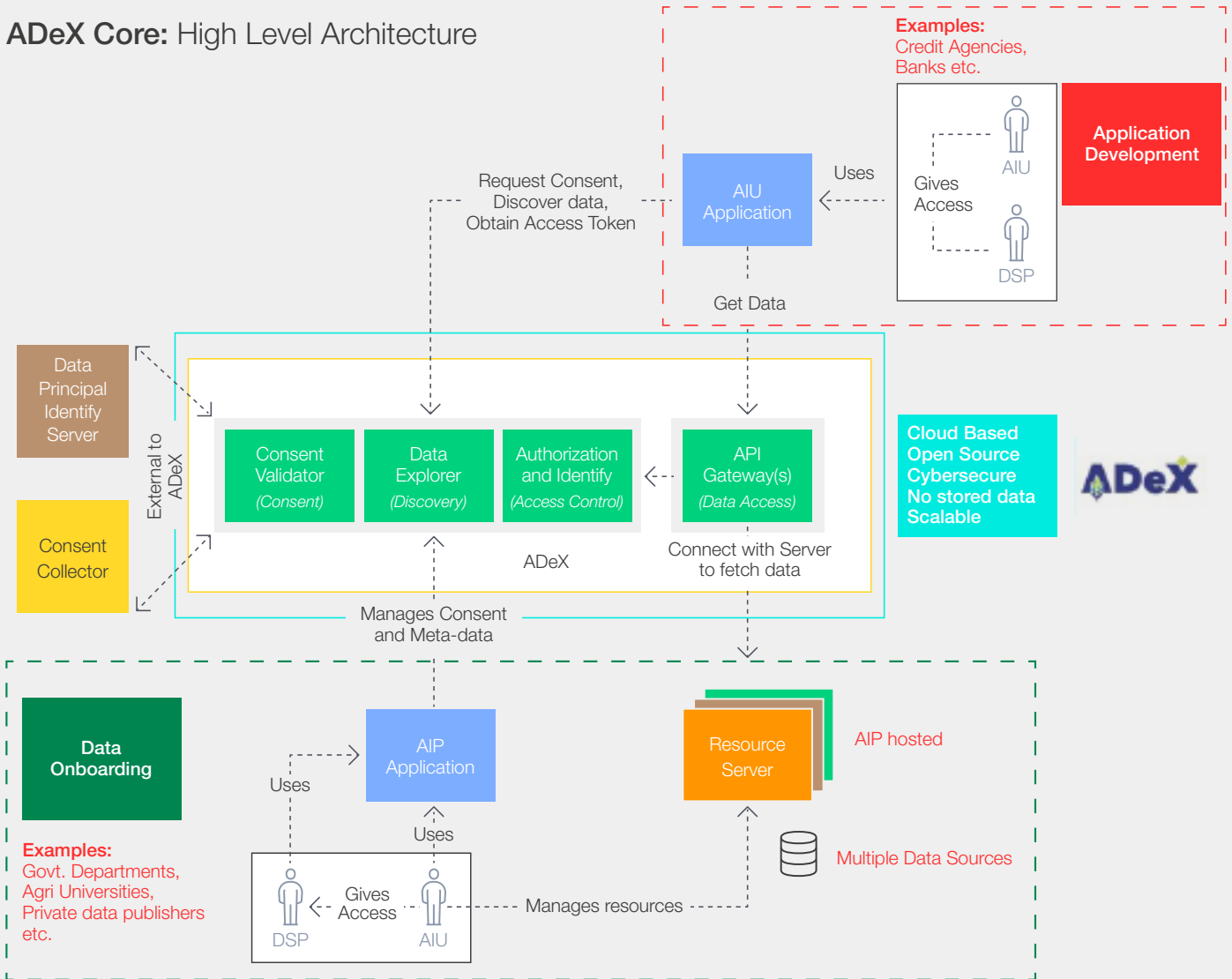
2.2 Data exchange platform

The data exchange platform, referred to as the Agriculture Data Exchange (ADeX), has been developed and deployed as the core component of

the agri.DPI to enable data sharing between data providers and users in a rights-protecting way.

FIGURE 2 High-level architecture of ADeX

ADeX Core: High Level Architecture



Source: World Economic Forum

The ADeX platform is modular in nature with five modules deployed initially in phase I:

- **Identity and access management:** used for identification, registration, authentication and authorization of various stakeholders as they interact with the platform.
- **Data explorer:** used for the discovery and management of meta-data of the data available with the data exchange; the service can be used by a data provider or user to onboard or discover datasets on the ADeX.

- **API gateway:** enables data providers to offer data and data users to access data in a secure manner; it also hosts all APIs for consumption or use by stakeholders.
- **Consent manager:** this module ensures that access to relevant data is preceded by consent of the data principal for a specific purpose as required under ADMF (or any other applicable laws/regulations).
- **Transaction engine:** operational module that supports contracts (explicit or implicit) between the parties, metering and billing, and audit trail.

2.3 Data governance

A World Economic Forum [white paper](#) has identified three key requirements for responsible sharing of data: protecting individuals, preventing harm and promoting innovation. Based on the paper's recommendations, the State Government of Telangana has introduced a comprehensive data

management framework for the agriculture sector in association with industry experts and after conducting public consultation. The key actors and their roles, rights and obligations are specified in the Agriculture Data Management Framework (ADMF).

TABLE 2 Data governance definitions

Role	Definition
Data principal	Relevant person to whom the personal data relates.
Agriculture information provider (AIP)	Means a person, business entity, or public and private organization that provides, creates, updates, secures and maintains agricultural data in accordance with this framework.
Agriculture information user (AIU)	Means a person, business entity, or public and private organization that receives agricultural data from the AIP under a data sharing agreement with the AIP in accordance with this framework.
Data service provider (DSP)	Refers to entities, who act on behalf of AIPs and AIUs to carry out the function of enriching, formatting, or transforming datasets or databases so that such enriched, formatted and transformed data can be used for the purposes specified in the framework's annex.

2.4 Data exchange and governance value proposition

The value proposition of data exchange and governance lies in its ability to facilitate efficient and effective sharing of agriculture data among stakeholders and creates value by:

- Enabling **discovery** of data required for innovation and research.
- Creating **network effects** by replacing bilateral data transfer to N-N data sharing in a responsible and transparent manner.

- Accelerating the evolution of the **country's digital agriculture ecosystem** through open standards, protocols and APIs in data management, thus enabling public and private sector to use the data to develop digital products and services for farmers.
- Providing for effective **security and protection of personal and non-personal data** by specifying the terms and conditions for sharing of data and the purpose and period for which such data can be used.

3

Telangana: Agri data exchange and governance

Agriculture is a high-priority sector for the State of Telangana, given that 5 million farmers depend on it and that the sector contributes about 15% of the state's GDP. The government has been adopting a multipronged approach

to elevate the status of the agriculture sector through such interventions as enhancing irrigation infrastructure, providing input assistance to farmers and promoting new seed varieties.



It is imperative for the government to have proper guidelines to ensure ethical collection and processing of agricultural data. Both ADeX and ADMF provide the right platform to ensure fair and efficient usage of agricultural data by the industry and startups, giving a big boost to the data economy specifically in the agri-sector. These initiatives will help Telangana in leading the country, using innovation and technology to drive the transformation of food systems, and to improve the livelihoods of farmers.

KT Rama Rao, Minister for Municipal Administration and Urban Development of Telangana (2019-2023)

Telangana became the first state in India to adopt the agri.DPI framework and deploy the first agriculture DPI, launched on 11 August 2023. It is comprised of:

- **Agriculture data exchange:** a technology platform that connects data providers with data consumers and enables secure and consent-based access to high-value agriculture datasets.
- **Agri data management framework:** a comprehensive framework that has been developed in the context of global and domestic best practices, and lays down roles and

responsibilities of various stakeholders, including effective accountability mechanisms and enabling innovation.

- **Data enablement:** using established specifications such as JSON (a JavaScript format), 33 data objects have been developed out of the 70 identified. This schema, tentatively called as AgriJSON, will enable data interoperability and standardization. The roadmap envisages enlarging the AgriJSON schema to serve all the major use cases in addition to development of new protocols for data exchange.



ADeX and ADMF launch on 11 August 2023
Source: Government of Telangana, India

The purpose of the pilot is to increase accessibility of quality and transparent agriculture data to give an impetus to research and innovation in the sector.

The development of ADeX, ADMF and AgriJSON has been undertaken over 12-18 months, with

more than 50 experts and almost 60-70 working sessions, highlighting the power of multistakeholder communities in addressing complex challenges and fostering inclusive growth.

TABLE 3 **Various stakeholders and their roles in evolving this ecosystem**

Stakeholder	Role
Government of Telangana	Funded and anchor by engaging in consultations, working with several teams to deploy the platform, and notifying the policy framework.
World Economic Forum	The Centre for the Fourth Industrial Revolution India has conceptualized the initiative, curated discussions with diverse expert groups and continues to provide thought leadership.
Indian Institute of Science	The institute is the technical partner, working to develop core technical capabilities of the ADeX platform and data models, leveraging the previously developed IUDX.
Telangana State Agriculture University (PJSTAU)	The university has shared its domain knowledge and expertise on agriculture datasets; it also contributes as a data provider.
Vidhi Centre for Legal Policy	The think tank has provided its legal expertise in developing the ADMF and related standard operating procedures (SOPs) as well as supporting with consultations.
Startups and agritechs	Startups and agritechs such as Niruthi, NaPanta and Krishitantra have joined the ecosystem as a data provider or data consumer.

4

Next steps

Digital agriculture has the potential to achieve several goals, including inclusivity, efficiency and sustainability for the agriculture and food systems. To this end, quality data and responsible sharing of data are critical. The concept of digital public infrastructure has already shown significant success in enabling digital solutions at scale in the sectors in which it has been deployed. The agriculture sector should leverage existing DPIs while developing more foundational layers to enable research and innovation.

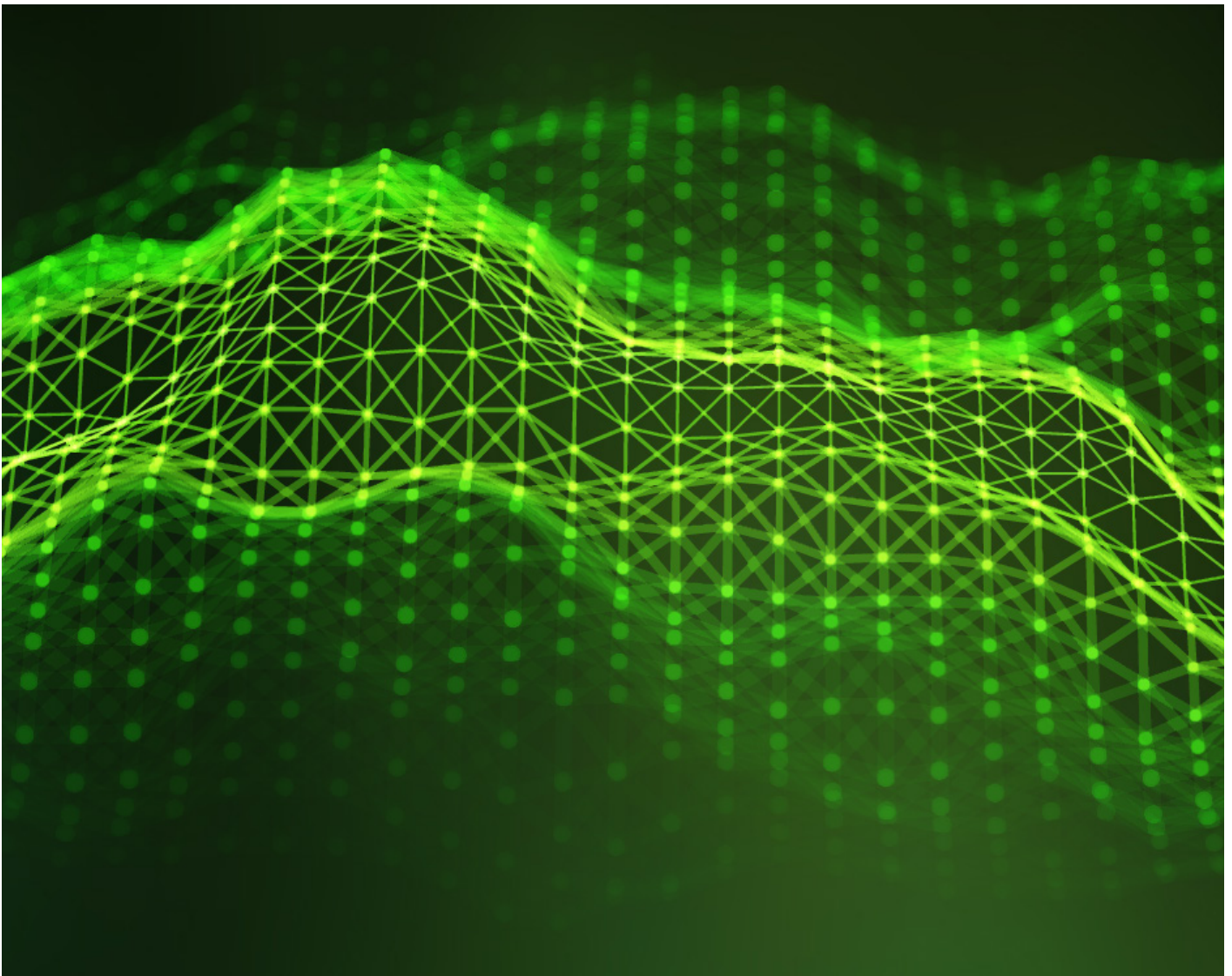
This paper is an attempt to share the journey, challenges, outcomes and some learnings from one such DPI deployment undertaken in the State of Telangana in India.

While the initial phase is focused on testing the concept by aligning databases, deploying the platform and onboarding limited partners, the next phase will be focused on scaling the ecosystem of data providers, use cases and service providers in the next 3-5 years. This will involve encouraging

adoption of this foundational infrastructure, in collaboration at the national level and other states by building mutually beneficial partnerships.

Furthermore, a set of indicators, quantitative and qualitative will be developed to test the progress of the initiative. Quantitative indicators would include the number of registered data providers and users, the number of datasets (including volume of data) and economic impact on farmers and markets in short and long term. On the qualitative side, user feedback, data trustworthiness and feedback from farmers would be considered.

As ADeX as well as other components of the ecosystem, develop and converge, it will be crucial to bolster capacity in the public and private sectors, cultivate a sustainable business model and incentivize stakeholders to join the ecosystem. Additionally, effective policy implementation and undertaking measures to increase awareness and adoption of digital services will be imperative to build trust and transparency in the digital world.



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