



AADHAAR:

PLATFORM OR INFRASTRUCTURE?

DEVELOPING A TAXONOMY
FOR INDIA'S DIGITAL PUBLIC
ECOSYSTEM

POLICY
BRIEF

3

FEBRUARY 2023

Abstract

According to economists, digital platforms are two-sided markets that bring buyers and sellers together to enable exchange and create value. For Aadhaar, India's digital identity program, while service providers requesting authentication of customer identities are on one side of the market, there is no other side, just a central database that stores and provides the relevant information. Aadhaar, in this sense, is not a two-sided marketplace, yet it is almost always referred to as a platform. This is due to the absence of a widely accepted taxonomy for India's digital public ecosystem, resulting in disciplinary siloes among economists, technologists and legal professionals who use competing vocabulary. This policy brief is an attempt to bridge this difference and to build an interdisciplinary foundation for a taxonomy of digital public ecosystems. We define four distinct components of the digital public ecosystem and explain how these inter-relate with each other. These are digital public goods (DPGs), digital public infrastructure (DPIs), digital public platforms (DPPs) and other digitised government services (DGS). Each component is defined and illustrated using examples from India's rapidly evolving digital public ecosystem.

Prepared by Deepak Mishra, Mansi Kedia, Shiva Kanwar, Bhargavee Das

Authors' email: dmishra@icrier.res.in; mkedia@icrier.res.in; skanwar@icrier.res.in; bdas@icrier.res.in

Disclaimer: Opinions and recommendations in the report are exclusively of the author(s) and not of any other individual or institution. This policy brief has been prepared in good faith on the basis of information available on the date of publication. All interactions and transactions with sponsors and their representatives have been transparent and conducted in an open, honest and independent manner.

Acknowledgements

This policy brief is a product of the ICRIER-Prosus Centre for Internet and Digital Economy (IPCIDE). The authors would like to thank Apar Gupta and Prateek Waghre (Internet Freedom Foundation); Hemant Adarkar and Vikram Sinha (Artha Global); Rohit Kumar, Deepro Guha, and Aishwarya Viswanathan (The Quantum Hub); and Sunil Abraham (Meta) for their insightful comments on the taxonomy and impact assessment framework of the Digital Public Ecosystem. Appreciations are also in order for Devendra Damle, Monisha Kumar, Saransh Agarwal, and the ONDC Introductory Briefing Team (ONDC); Ameya Naik, Gautham Ravichander, and Krishnakumar Thiagarajan (eGov Foundation); and Dilip Asbe (NPCI) for helping us develop a comprehensive understanding of the Digital Public Ecosystem. We would also like to express our gratitude to Sehraj Singh, Paroma Bhat and Shashank Ramireddy (Prosus) for being the progenitor as well as the sounding board for many of our ideas.

About IPCIDE

The ICRIER-Prosus Centre for Internet and Digital Economy (IPCIDE) is a collaboration between ICRIER, one of India's well-known economic think tanks, and Prosus, amongst the largest investors in digital start-ups in India. The Centre was established in April 2022 with the view to support India's transition towards a more efficient, inclusive, and sustainable digital economy. The Advisory Panel of IPCIDE includes Professor Payal Arora, Mr. Rajesh Bansal, Mr. R. Chandrashekhar, Professor Carl Benedikt Frey, Mr. Toomas Ilves, and Ms. Aruna Sundararajan. Through its research and policy work, the Centre has emerged as a thought leader in shaping the next phase of India's digital transformation. For more details, visit our website <https://icrier.org/ipcide/>



IPCIDE

Indian Council for Research on International Economic Relations (ICRIER)

4th Floor, Core 6A, India Habitat Centre, Lodhi Road, New Delhi-110003

Plot No. 16-17, Pushp Vihar, Institutional Area, Sector 6, New Delhi-110017

O: +91 11 43112400 / 24645218

F: +91 11 24620180 | **E:** ipcide@icrier.res.in

W: <https://icrier.org/ipcide/>

List of Abbreviations

API	Application Programming Interface
BHIM	Bharat Interface for Money
CoWIN	COVID Vaccine Intelligence Network
DEPA	Data Empowerment and Protection Architecture
DGS	Digitized Government Service
DHIS2	District Health Information Software 2
DIVOC	Digital Infrastructure for Verifiable Open Credentialing
DPE	Digital Public Ecosystem
DPG	Digital Public Good
DPI	Digital Public Infrastructure
DPIP	Digital Public Infrastructure and Platforms
DPP	Digital Public Platforms
e-KYC	Electronic Know Your Customer
FHR	Framework Federated Health Records Framework
GDP	Gross Domestic Product
GEM	Government e-Marketplace
ICT	Computers and Information Technology
MOSIP	Modular Open-Source Identity Platform
ONDC	Open Network for Digital Commerce
SDG	Sustainable Development Goal
UHI	Unified Health Interface
UMANG	Unified Mobile Application for New-age Governance
UPI	Unified Payment Interface



CONTENTS

1. Why a taxonomy for the digital public ecosystem?	1
2. The interdisciplinary overlap	2
3. Taxonomy for the Digital Public Ecosystem	3
3.1. Digital Public Goods (DPGs)	4
3.2. Digital Public Infrastructure (DPI)	4
3.3. Digital Public Platforms (DPPs)	5
3.4. Digitized Government Services (DGS)	7
4. India's Digital Public Ecosystem	7
4.1. Foundational/Horizontal DPI	8
5. Sectoral DPEs	8
6. Concluding Remarks	10
References	12
Annexure 1: Select Definitions of Digital Public Goods	15

List of Tables

Table 1: Select definitions of 'Digital Platform'	6
---	---

List of Figures

Figure 1: India is a world leader in developing and deploying Digital Public Goods	1
Figure 2: The term 'public' is interpreted differently by technologists, economists and legal practitioners	3
Figure 3: Taxonomic Classification of a Digital Public Ecosystem (DPE)	4
Figure 4: Complete Taxonomy of the Digital Public Ecosystem demonstrated with foundational and sectoral examples from India	8
Figure 5: India's Digital Public Ecosystem - Finance	9
Figure 6: India's Digital Public Ecosystem - Health	9
Figure 7: India's Digital Public Ecosystem - Commerce	10

Aadhaar: Platform or Infrastructure?

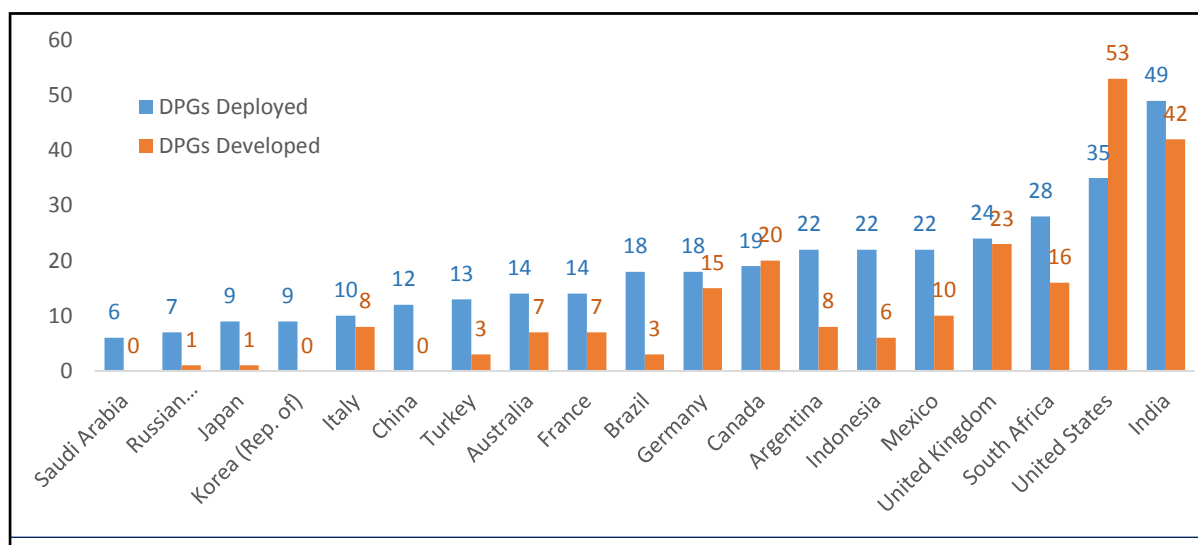
Developing a Taxonomy for India's Digital Public Ecosystem

1. Why a taxonomy for the digital public ecosystem?

Most people are likely to shrug off the question that is central to this paper: Is *Aadhaar*, the world's largest biometric identification system, a digital public platform (DPP) or digital public infrastructure (DPI)? For most Indians, *Aadhaar* is a homegrown technology system that helps in verification and authentication of individual identity, easily and efficiently, from anywhere, at any time. They are likely to be indifferent to whether *Aadhaar* is referred to as a platform or an infrastructure, as long as it does its job well.

There are however at least three compelling reasons why such a question needs to be answered. First, India is the world leader in developing and deploying digital public goods (DPGs). As Figure 1 shows, with 42 developed and 49 deployed DPGs, India tops the list of G20 countries using DPGs, followed by United States. As a leader in DPGs, which are the building blocks of a digital public ecosystem, it is incumbent upon India to contribute to developing a common vocabulary for its components that is broadly understood and accepted.¹

Figure 1: India is a world leader in developing and deploying Digital Public Goods



Source: Digital Public Goods Alliance Map

Secondly, a taxonomy will allow better delineation of components and their role in the digital public ecosystem (DPE). It is not uncommon to see observers clubbing all forms of digital public innovations as public digital

platforms.² For example, *Aadhaar*, Unified Payment Interface (UPI), Covid Vaccine Intelligent Network (CoWIN), Bharat Interface for Money (BHIM), myGov are all referred to as digital public platforms, even if each one of them is functionally and technologically different

¹ In the absence of a globally accepted vocabulary, each country invents its own. What is generally referred to as the "IT Enabled Services (ITES)" in India, is more popularly known as the "Business Process Outsourcing (BPO)" in the United States. Similarly, what we call as OTT (over-the-top) services in India are generally referred to as streaming services in many other parts of the world.

² See NASSCOM report "Digital India: Digital Public Goods Platformisation Play" that refers to a wide range of digital public innovations as platforms (<https://nasscom.in/product/146>).

from each other.³ This confusion becomes more evident when one compares it with physical infrastructure such as the transport network, where the highways are not the same as the establishments and settlements that emerge around them. The fact that *Aadhar* and UPI do not fit into the standard definition of multi-sided markets that connect different groups—first conceptualized by noble prize-winning economist, Jean Tirole — while Co-WIN and BHIM do, is something that can be explained only with the help of a taxonomy.⁴

Finally, and most importantly, creation of a taxonomy will facilitate better assessment of the benefits and limitations of DPEs and its various components including cross-country comparisons. The United Nations 77th General Assembly noted the transformative role of Digital Public Infrastructure (DPIs) in addressing the sustainable development goals set out for 2030. India is at the forefront of deploying a series of DPIs, the most prominent and expansive being its digital identity programme, *Aadhaar*. The centrality of DPIs in India's development strategy begs a serious understanding of how they are different from other components of the ecosystem that include digital public goods (DPGs), digital public platforms (DPPs) and other digitised

government services (DGSs), and consequently their role in bridging development divides and enabling growth.

2. The interdisciplinary overlap

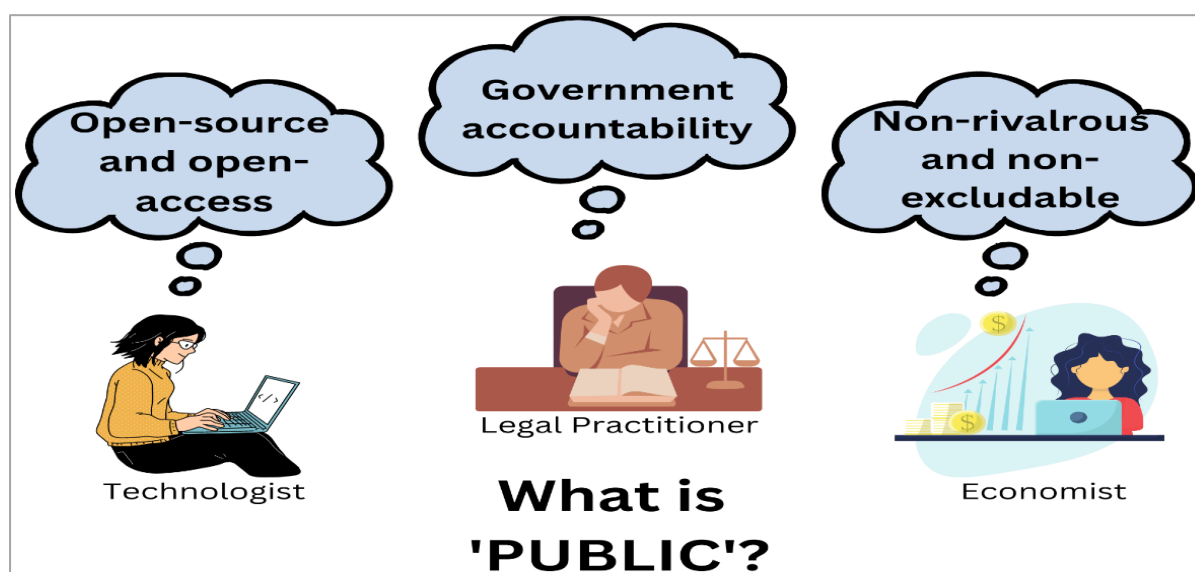
Commonly used terms such as platforms are interpreted differently in different disciplines, which can become a source of confusion when applied without specific context. Platforms, a catch all for anything that can be stood on or built upon, found a specific connotation following the rise of the software industry.⁵ The technologists saw platforms as a combination of open-source software and cloud computing that form the basis of new digital products, while economists referred to platforms as a market place that connects buyer and sellers. Defining concepts with interdisciplinary overlaps where elements from different theories all come together in a single application is extremely complex. This is the challenge of building a taxonomy for DPEs, which is similarly interdisciplinary, reflecting different standpoints. For instance, the term 'public' in the digital ecosystem, is interpreted differently from the lens of technology, law and economics (see Figure 2).

³ It is important to note that the founders of DPIs were more careful in their choice of nomenclature than the subsequent cheerleaders. That's why UPI is referred to as an interface and ONDC as a network, while some call them platforms. Even *Aadhaar* was rarely referred to as platform.

⁴ Jean-Charles Rochet and Jean Tirole, Platform Competition in Two-Sided Markets, *Journal of the European Economic Association* 1, no. 4 (January): 990–1029

⁵ Something to Stand On, Special Report, 2014 edition

Figure 2: The term 'public' is interpreted differently by technologists, economists and legal practitioners



Source: Authors

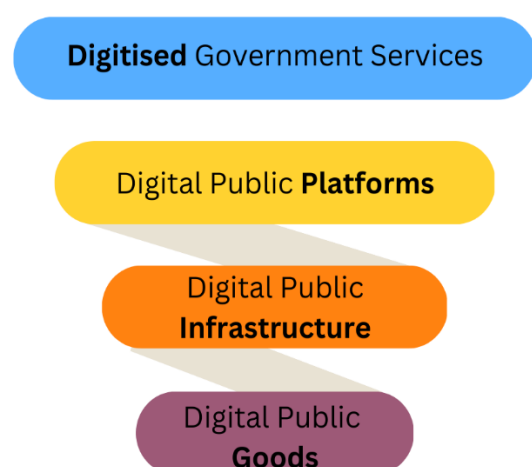
From the technology standpoint, public signifies open-source (the source code is accessible to the public and can be modified) and open-access (can freely work with other systems) technology. In economics, public goods are essentially non-rivalrous (consumption of the good by anyone does not reduce the quantity available to others) and non-excludable (no one can be prevented from consuming the good). And for legal professionals, the term public represents government accountability.

Does this mean that all components of a public digital ecosystem are based on open access and open-source technology, are accessible to all users and involve government ownership and accountability? We attempt to answer this question by providing a taxonomy for various components of DPEs, illustrating with examples from India. We also acknowledge that real world examples may not always fall into neat boxes and rigid boundaries for purposes of classification. The dynamic and ever-evolving nature of technology necessitates flexibility, recognising which the classifications have been left broad.

3. Taxonomy for the Digital Public Ecosystem

In our taxonomy, DPEs comprises of four components: Digital Public Goods (DPGs), Digital Public Infrastructure (DPIs), Digital Public Platforms (DPPs) and Digitised Government Services (DGS). These components can be organised in a loosely organised multi-layer structure as illustrated in Figure 3. The inter-relations are inspired from our understanding of the infrastructure and application layers of the internet. A variety of standardised internet protocols – transmission control protocol, hypertext transfer protocol, file transfer protocol, IPv6 are the building blocks of the internet infrastructure. The internet infrastructure enables the creation of applications including two or multi-sided platforms (also, over-the-top services) as well as consumer facing websites that do not function as a market place. Using this understanding, we explain the taxonomy of digital public ecosystems illustrated in Figure 3 below.

Figure 3: Taxonomic Classification of a Digital Public Ecosystem (DPE)



Source: Authors

In order to explain the different components of a DPE we use standard definitions provided in international literature, as well as our own interpretation of their functionality, to logically organise the overall ecosystem.

3.1. Digital Public Goods (DPGs)

Digital Public Goods (DPGs) are open-source technological goods that are available at zero or negligible cost and form the building blocks of any digital ecosystem. DPGs include open standards, open application programming interfaces (API), open protocols, open software and open data. Many organisations have provided a definition for DPGs, some of which are summarised in Annexure 1. DPGs came into vogue with the recognition of the increasing contribution of the ICT industry towards

attainment of United Nations' Sustainable Development Goals (SDGs). They embody transparency as a characteristic, and promote sustainability, adaptability and interoperability in a DPE. They easily integrate with third-party software, thus enabling customisation for countries to create and implement technology enabled solutions that are tailor made to their needs. The open-source code also helps reduce implementation costs, avoid vendor lock-in, and enable independent audit and scrutiny of the code base⁶. DIVOC, an open-source software and Beckn, an open protocol are some examples of DPGs.

3.2. Digital Public Infrastructure (DPI)

Digital Public Infrastructure (DPIs) can be defined as digital utilities, often built using DPGs, to create a foundation on which various digital services can be provided⁷. Some existing definitions of DPIs include -systems and solutions that are mediated through technology and enable the effective provision of essential society-wide functions and services in the public and private sectors.⁸ As mentioned above, DPGs are often used as 'building blocks' to develop DPIs, but DPIs can also be built using proprietary software.⁹ DPGs are therefore, neither necessary nor sufficient to create DPIs. So far, DPI, as developed in India can be one of the three types of technology systems: identity, integration or data exchange.¹⁰

- *Digital identities* help verify and authenticate information about a

⁶ Digital Public Goods Alliance, "Digital Public Goods" <https://digitalpublicgoods.net/digital-public-goods/>

⁷ We borrow from a definition proposed by Pramod Varma at the G20 GPFI Symposium held in Kolkata on January 9th 2023. According to him DPIs are a set of shared digital utilities, powered by interoperable standards, operated under a set of enabling rules, providing equal access to individuals, addressing sovereignty and control, built as a set of digital building blocks to drive innovation, inclusion and competition having open, transparent and participatory governance.

⁸ European Commission. (2018). "Digital Platform for public services". <https://joinup.ec.europa.eu/sites/default/files/document/2018-10/330043300REPJRCDigitalPlatformsBM-D2.5FinalReportv051018.pdf>

⁹ Digital Public Goods Alliance, GovStack Community of Practice. (2022, May). 'GovStack Definitions: Understanding the Relationship between Digital Public Infrastructure, Building Blocks & Digital Public Goods' <https://digitalpublicgoods.net/DPI-DPG-BB-Definitions.pdf>

¹⁰ The Rockefeller Foundation, Digital Public Goods Alliance and Norwegian Ministry of Foreign Affairs. (2021, August). "Co-Develop Digital Public Infrastructure for an Equitable Recovery" [Co-Develop-Digital-Public-Infrastructure-for-an-Equitable-Recovery-Full-Report.pdf](https://rockefellerfoundation.org/Co-Develop-Digital-Public-Infrastructure-for-an-Equitable-Recovery-Full-Report.pdf) (rockefellerfoundation.org)

person. A robust digital identity system becomes the foundation for digitisation of several public initiatives including government schemes and welfare programmes. Digital identities have the potential to create economic value of an estimated 6 per cent of GDP in emerging economies by 2030.¹¹ Such economic value can be unlocked by fostering inclusion and efficiency. Efficiencies can be realised through different stakeholder interactions in the form of time and costs saved.¹²

- *DPIs for integration* are open, decentralised networks that help address limitations of closed and centralised platforms that operate in silos.¹³ They result in expansion of demand-supply ecosystems through the creation of open and interoperable networks that foster innovation and competition, enable contestable entry in several sectors and enhance consumer choice. They provide an opportunity to improve the competitiveness of smaller players.¹⁴ Some good examples from India include the Open Network for Digital Commerce (ONDC) and the Unified Payment Interface (UPI).
- *Data exchanges* enable secure sharing of information among a diverse network of users.¹⁵ DPIs enabling data

exchange, address an important problem of information asymmetry and lack of trust among users of digital services.¹⁶ They address critical challenges such as the unavailability of data, low quality of available data, lack of interoperability of datasets, etc. A well-designed data exchange platform helps solve some of these constraints by enabling data discoverability, data discipline, unlocking combinatorial power of data and trust management (through a strong consent layer).¹⁷ The significance of frictionless acquisition and integration of data provided by data exchanges can be seen in new applications for fleet management in transportation, transmission and distribution of electricity, preventive crop care, etc.¹⁸ A good example from India is the Data Empowerment and Protection Architecture (DEPA) being implemented for the financial services and credit industry in India.

3.3. Digital Public Platforms (DPPs)

Digital Public Platforms (DPPs) are non-exclusive, non-rivalrous digital networks that allow two or more parties to interact and are

¹¹ McKinsey Global Institute. (2019, January). "Digital Identification: A key to inclusive growth" <https://www.mckinsey.com/nl/-/media/mckinsey/featured%20insights/innovation/the%20value%20of%20digital%20id%20for%20the%20global%20economy%20and%20society/digital-id-a-key-to-inclusive-growth-january%202019.pdf>

¹² *ibid*

¹³ National Health Authority (2021), "Consultation Paper on Unified Health Interface Synopsis". [https://abdm.gov.in:8081/uploads/Synopsis Consultation Paper on UHI v H 83b81ca1f7.pdf](https://abdm.gov.in:8081/uploads/Synopsis%20Consultation%20Paper%20on%20UHI%20v%20H%2083b81ca1f7.pdf)

¹⁴ Team ONDC (2022, July), "How ONDC seeks to democratize digital commerce" <https://ondc.org/blog/how-ondc-seeks-to-democratize-digital-commerce/>

¹⁵ The Rockefeller Foundation, Digital Public Goods Alliance and Norwegian Ministry of Foreign Affairs. (2021, August). "Co-Develop Digital Public Infrastructure for an Equitable Recovery" [Co-Develop-Digital-Public-Infrastructure-for-an-Equitable-Recovery-Full-Report.pdf \(rockefellerfoundation.org\)](https://www.rockefellerfoundation.org/reports/co-develop-digital-public-infrastructure-for-an-equitable-recovery-full-report/)

¹⁶ World Economic Forum (WEF). (2021, August). "Towards a Data Economy: An enabling framework". [https://www3.weforum.org/docs/WEF Towards a Data Economy 2021.pdf](https://www3.weforum.org/docs/WEF_Towards_a_Data_Economy_2021.pdf)

¹⁷ *Ibid*

¹⁸ *Ibid*

fully or partially owned by the government.¹⁹ DPPs are often built on foundations established by DPLs. The reference to digital platforms is more popular in the private sector context. Most services provided by Big Tech companies are designed as digital platforms. Table 2 provides a set of popular definitions for digital platforms. The economics literature has outlined key characteristics of platform businesses: two sidedness, network effects, low to zero marginal costs, etc.²⁰ These

characteristics are all applicable to public platforms as well. Drawing a comparison with DPLs, we find that while DPLs can be foundational in function, i.e., act as the backbone of public service delivery, horizontally across all sectors of the economy, DPPs are almost always sectoral, or enablers of public service delivery in one or a few sectors. The Bharat Interface for Money (BHIM) and e-Sanjeevani are good examples of DPPs in India.

Table 1: Select definitions of ‘Digital Platform’

Source	Definition
Martin Kenney and John Zysman (2016)²¹	Kenney and Zysman (2016) A set of online digital arrangements whose algorithms serve to organize and structure economic and social activity; a set of shared techniques, technologies, and interfaces that are open to a broad set of users who can build what they want on a stable substrate; a set of digital frameworks for social and marketplace interactions. Catalyst that allows value to be created through interactions between various groups of market participants.
Tat Koon Koh and Mark Fichman (2014)²²	Two-sided networks that facilitate interactions between distinct but interdependent groups of users, such as buyers and suppliers.
OECD (2019)²³	Digital services that facilitate interactions between two or more distinct but interdependent sets of users (whether firms or individuals) who interact through the service via the internet.
Nico Heerschap, Nicky Pouw, Cybele Atmé. December (2018)²⁴	A digital service based on a technological, sociocultural, and economic infrastructure for the facilitation and organization of online social (interactions) and economic (transactions) traffic between two or more distinct but interdependent groups of providers and users, with data as fuel. Providers and users can be both individuals and businesses as well as science organizations and government.

Note: Definitions have been taken from Chapter 8 of the Asian Economic Integration Report 2021: Making Digital Platforms Work for Asia and the Pacific²⁵.

¹⁹ European Commission. (2018). "Digital Platform for public services". <https://joinup.ec.europa.eu/sites/default/files/document/2018-10/330043300REPJRCDigitalPlatformsBM-D2.5FinalReportv051018.pdf>.

²⁰ Xiaolan Fu, Elvis Avenyo & Pervez Ghauri (2021) "Digital platforms and development: a survey of the literature, Innovation and Development", 11:2-3, 303-321, DOI: 10.1080/2157930X.2021.1975361

²¹ Martin Kenney, John Zysman. (2016, March). "The Rise of the Platform Economy". https://www.researchgate.net/publication/309483265_The_Rise_of_the_Platform_Economy

²² Tat Koon Koh, Mark Fichman. (2014, December). "Multihoming Users' Preferences for Two-Sided Exchange Networks". <https://www.jstor.org/stable/26627958#metadata.info.tab.contents>

²³ Organisation for Economic Co-operation and Development (OECD). (2019, May) "An Introduction to Online Platforms and Their Role in the Digital Transformation." https://read.oecd-ilibrary.org/science-and-technology/an-introduction-to-online-platforms-and-their-role-in-the-digital-transformation_53e5f593-en#page1

²⁴ Nico Heerschap, Nicky Pouw, Cybele Atmé. (2018, December). "Measuring Online Platforms". <https://www.cbs.nl/-/media/pdf/2018/51/2018ep58-measuring-online-platforms.pdf>

²⁵ Asian Development Bank (ADB). (2021, February). "Asian Economic Integration Report 2021: Making Digital Platforms Work for Asia and the Pacific". <https://www.adb.org/sites/default/files/publication/674421/asian-economic-integration-report-2021.pdf>

3.4. Digitized Government Services (DGS)

Finally, Digitised Government Services (DGS) encompass all government services that have been digitised. These services do not possess characteristics of platforms; they merely comprise of converting the mode of delivery or process of providing the service into a digital format. Passport Seva, online filing of Income tax returns, e-KYC and myGov are examples of DGS.

4. India's Digital Public Ecosystem

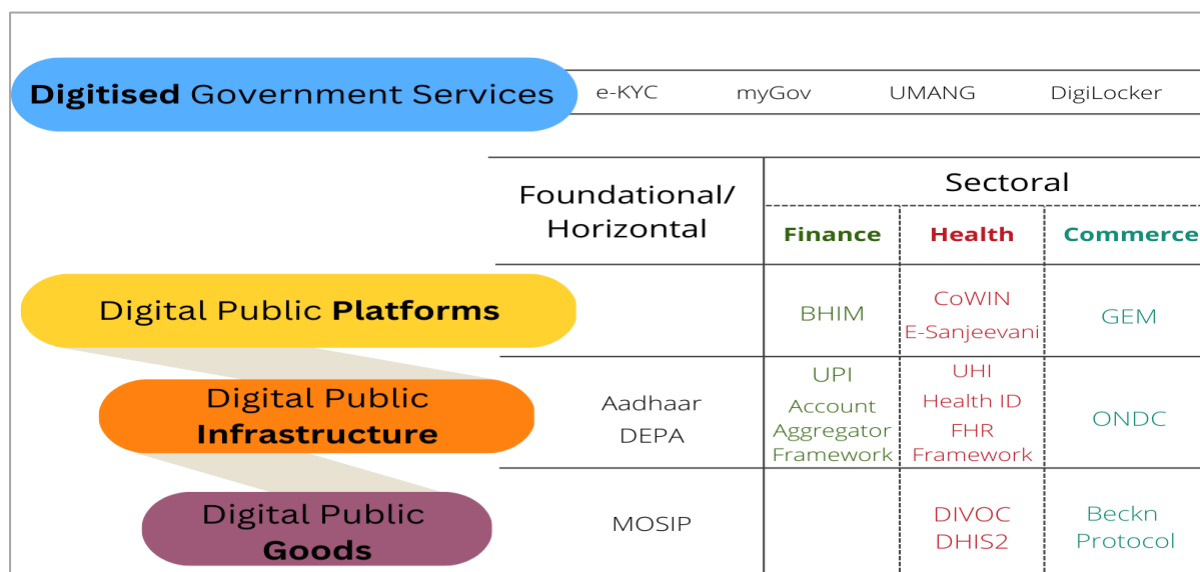
Over the last decade, India has championed the development and deployment of several digital public infrastructure and platforms (DPIPs). A prominent example of such intersection of foundational and sector-specific DPIs can be found in what has been called the **India Stack**—the trinity of Aadhaar, Unified Payments Interface (UPI) and the Data Empowerment and Protection Architecture (DEPA) set up to “unlock the economic primitives of identity, data, and payments at population scale and to establish a level playing field for members of a digital ecosystem”.²⁶

In this section, an attempt has been made to illustrate India's Digital Public Ecosystem and its components using the taxonomy defined above. Our taxonomy allows for a different organisation of the components that cuts through vertically from DPGs to DPPs, for each sector. While DGS have been around for decades, DPGs, DPIs and DPPs have become new and important components of DPEs for many sectors. There is also a foundational ecosystem that lends itself to different sectoral applications. (Refer Figure 4). We explain the application of the taxonomic classification using examples from India in the subsections below.

Figure 4 below provides a complete illustration of the DPE in India, with examples and interrelations across different layers. We must note that DGSs are not necessarily linked or dependent on DPGs, DPIs and DPPs. In the figure, they are shown as a detached layer of services that belong in the DPE. The digitisation of government services began much before the effort towards building DPPs, DPIs or even DPGs.

²⁶ <https://indiastack.org/>

Figure 4: Complete Taxonomy of the Digital Public Ecosystem demonstrated with foundational and sectoral examples from India



Source: Authors

Note: e-KYC = Electronic Know Your Customer, UMANG = Unified Mobile Application for New-age Governance, DEPA = Data Empowerment and Protection Architecture, MOSIP = Modular Open Source Identity Platform, BHIM = Bharat Interface for Money, UPI = Unified Payments Interface, CoWIN = COVID Vaccine Intelligence Network, UHI = Unified Health Interface, FHR Framework = Federated Health Records Framework, DIVOC = Digital Infrastructure for Verifiable Open Credentialing, DHIS2 = District Health Information Software 2, GEM = Government e-Marketplace, ONDC = Open Network for Digital Commerce

4.1. Foundational/Horizontal DPI

One of the most successful examples of India's foundational DPI is its digital identity, Aadhaar. Aadhaar has inspired the creation of MOSIP- a DPG whose modular architecture is enabling the implementation of digital identity programs in various other countries. As a foundational ID, Aadhaar also serves as one of the methods to obtain a Health ID (a health sector specific DPI) and a way for citizens to integrate into the UPI ecosystem (a finance sector specific DPI). With regard to data exchange, the Data Empowerment and Protection Architecture (DEPA) today serves as a foundational DPI to facilitate consent-based, secure exchange of customer data by granting control over user data to the rightful owners. It conceptualises a new set of market players called 'consent managers' (standing between information providers and information users) that compete with each other to reach various customer

segments with inclusive and innovative ways of obtaining informed consent for data sharing.²⁷ It is meant to be a flexible and evolving framework and has served as a basis for the Account Aggregator Framework in the finance sector and the Federated Health Records (FHR) Framework for secure access and exchange of personal health records in the health sector.

5. Sectoral DPEs

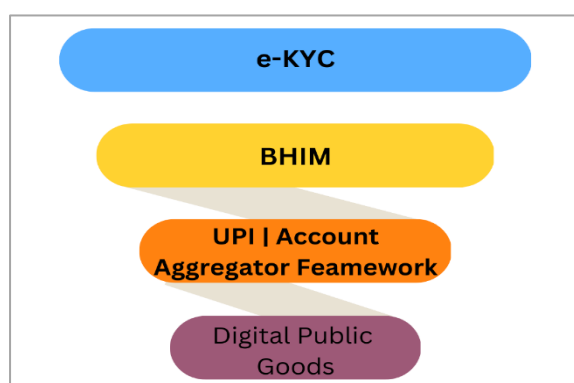
While Aadhaar has already achieved scale, with visible impact on financial inclusion and ease of governance, the other sector-specific ecosystems, being developed using a combination of foundational and sector-specific DPGs, DPIs and DPPs – in commerce, health, education, agriculture, skilling, etc. are all in various stages of development. The use of DPIs and DPPs are at the core of India's public policy strategy and one that is also becoming globally popular. It also features as a priority in India's

²⁷ <https://niti.gov.in/sites/default/files/2020-09/DEPA-Book.pdf>

agenda for its ongoing G20 presidency.²⁸ Using the taxonomy developed above, we illustrate how the sectoral DPEs are being created in India using examples from Finance, Health and Commerce.

Finance: The digital public ecosystem for finance is a combination of different DPIs and DPPs. The Unified Payments Interface (UPI) is an *integrated*, interoperable, instant real-time payments system that creates a single payment interface for bank accounts and wallets. It also includes the Account Aggregators (AA) Framework, a data exchange DPI, on the foundations of the Data Empowerment and Protection Architecture (DEPA), discussed above.

Figure 5: India's Digital Public Ecosystem - Finance

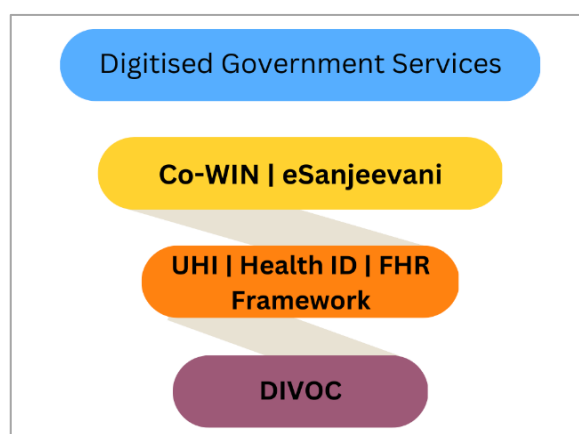


All consent managers for personal data in this sector are called account aggregators, who retrieve or collect information related to financial assets of a customer from Financial Information Providers (such as banks, insurance providers, etc) and present it back to customers or other Financial Information Users.²⁹ BHIM – the mobile payments app, is the DPP, built by the National Payments Council of India (NPCI), the implementing agency of UPI, to demonstrate the interoperability gains from UPI. Many digitised government services (DGS)

such as DigiLocker and e-KYC facilitate the smooth functioning of the financial sector's digital public ecosystem. It is important to note that UPI and AA, as a part of the India Stack are often considered as foundational DPIs. However, in this taxonomy we consciously choose to categorise them as sectoral, given their limited application to digital payments and lending in the financial sector, and therefore not comparable to the foundational features of identity DPIs like Aadhaar on which sector agnostic DPIs and platforms can be created.

Health: India's digital public ecosystem for health is the Ayushman Bharat Digital Mission (ABDM) which is a combination of multiple DPIs and DPPs.³⁰ It includes three DPIs, one each for identity, integration and data exchange and are supported by different DPGs. The Ayushman Bharat Health Account (or Health ID) enables the creation of longitudinal patient electronic health records.

Figure 6: India's Digital Public Ecosystem – Health



The Unified Health Interface (UHI), analogous to UPI in the finance sector, is an open, interoperable network of digital health services connecting healthcare providers and patients. The Federated Health Records (FHR)

²⁸ Sharma, S. (2022, November 15). "India to showcase its digital transformation at Bali summit: G20 Sherpa Amitabh Kant" <https://economictimes.indiatimes.com/news/india/india-to-showcase-its-digital-transformation-at-bali-summit-g20-sherpa-amitabh-kant/articleshow/95526876.cms>

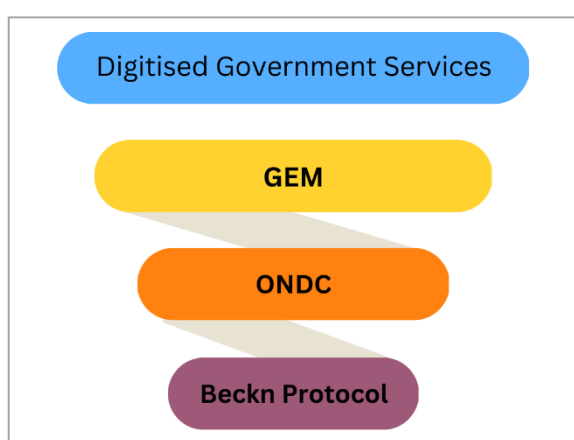
²⁹ <https://rbidocs.rbi.org.in/rdocs/notification/PDFs/MD46859213614C3046C1BF9B7CF563FF1346.PDF>

³⁰ Ayushman Bharat Digital Mission (2021), National Health Authority. <https://abdm.gov.in/>

Framework is the data exchange architecture within the ecosystem.³¹ Important DPPs integrated with ABDM are e-Sanjeevani, the teleconsultation app and CoWin, used for Covid vaccination and verification of vaccine certificates

Commerce: The digital public ecosystem for digital commerce is defined by the Open Network for Digital Commerce (ONDC),³²

Figure 7: India's Digital Public Ecosystem - Commerce



a DPI based on the principle of ‘unbundling’ a complex system of e-commerce to modular services which can be transacted through different players. It is built using Beckn, an open protocol (DPG) for commerce. The architecture is somewhat analogous to Unified Health Interface (UHI) in health. It uses open APIs to create an integrated, interoperable network wherein buyers and sellers can use any buyer side and seller side applications, respectively, to carry out transactions. A DPP belonging to the digital commerce ecosystem, is the Government eMarketplace or GeM, an online platform launched in 2016 for public procurement. This is independent from the ONDC, although there is an expectation that it might onboard in future.³³

6. Concluding Remarks

With India emerging as a global leader in developing and deploying DPGs, we argue that it is in India's interest to take the lead in developing a taxonomy for various components of DPEs. The absence of such a taxonomy has led to considerable confusion in the literature, with claims and counterclaims about the benefits and risks of DPE that are not testable. Taking an inspiration from the way the internet ecosystem was built and named, we have created a taxonomy for various components of DPEs, namely DPGs, DPIs, DPPs and DGS..

This policy brief provides a taxonomy of India's DPE, clearly delineating one component from the other. In this taxonomy, Digital Public Infrastructure (DPI) is defined as digital utilities that create a foundation on which various digital services can be provided. Therefore, *Aadhaar* is a DPI and not a DPP. The taxonomy helps to clearly delineate various components of India's DPE based on their openness, ownership and functionality.

This exercise is a stepping stone for an assessment of the outcomes of the ongoing efforts towards building DPIs and other components in India's digital public ecosystem. It helps to provide an understanding of what outcomes one is likely to expect from the deployment of these initiatives. For example, how do outcomes from UPI and BHIM differ, or for that matter between UHI and e-Sanjeevani? Through this taxonomy, we hope to provide a better understanding of the commonly known, but less understood technology stacks. It is meant to serve as a bridge towards building impact assessment frameworks for DPEs in the future; DPEs that form the foundation of India's

³¹ https://sandbox.abdm.gov.in/docs/overview_fhr

³² Team ONDC (2022, January), "Open Network for Digital Commerce: Democratizing Digital Commerce in India". https://ondc-static-website-media.s3.ap-south-1.amazonaws.com/res/daea2fs3n/image/upload/ondc-website/files/ONDCStrategyPaper_ucvfjm/1659889490.pdf

³³ [ETGovernment Explained: What is Open Network Digital Commerce and how it enables MSMEs to sell worldwide, Government News, ET Government \(indiatimes.com\)](https://www.etgovernment.com/news/ETGovernmentExplained:What-is-Open-Network-Digital-Commerce-and-how-it-enables-MSMEs-to-sell-worldwide-Government-News-ETGovernment(indiatimes.com))

policy response to several growth and development challenges.

References

- Anit Mukherjee and Shankar Maruwada; Center for Global Development. September, (2021). *Fast-Tracking Development: A Building Blocks Approach for Digital Public Goods*.
<https://www.cgdev.org/sites/default/files/fast-tracking-development-digital-public-goods.pdf>. Accessed 24 November 2022.
- Asian Development Bank (ADB). (2021, February). *Asian Economic Integration Report 2021: Making Digital Platforms Work for Asia and the Pacific*.
<https://www.adb.org/sites/default/files/publication/674421/asian-economic-integration-report-2021.pdf>. Accessed 24 November 2022.
- BHIMUPI.org. (n.d.). *Who We Are*. <https://www.bhimupi.org.in/who-we-are>. Accessed 24 November 2022.
- D'Silva, D., Filkova, Z., Packer, F., and Tiwari, S. for Bank for International Settlements. (2019, December). *The design of digital financial infrastructure: lessons from India*.
<https://www.bis.org/publ/bppdf/bispap106.pdf>. Accessed 24 November 2022.
- David Eaves, Leonie Bolte, Omayra Chuquihuara, and Surabhi Hodigere; Ash Centre for Democratic Governance and Innovation, Harvard Kennedy School. (2022, April). *Best Practices for the Governance of Digital Public Goods* <https://ash.harvard.edu/publications/best-practices-governance-digital-public-goods>. Accessed 24 November 2022.
- DHIS2. (n.d.). <https://dhis2.org/>. Accessed 24 November 2022.
- Digital Public Goods Alliance, Digital Square, UNICEF Health and Information Communication Technology (ICT) Divisions. (2021, April). *Understanding the Relationship between Digital Public Goods and Global Goods in the Context of Digital Health* <https://digitalpublicgoods.net/DPG-GlobalGoods.pdf>. Accessed 24 November 2022.
- Digital Public Goods Alliance, GovStack Community of Practice. (2022, May). 'GovStack Definitions: Understanding the Relationship between Digital Public Infrastructure, Building Blocks & Digital Public Goods' <https://digitalpublicgoods.net/DPI-DPG-BB-Definitions.pdf>. Accessed 24 November 2022.
- Digital Public Goods Alliance. (n.d.). *Digital Public Goods*. <https://digitalpublicgoods.net/digital-public-goods/>. Accessed 24 November 2022.
- E-Estonia.com. (n.d.) *Factsheet: X-Road*. <https://e-estonia.com/wp-content/uploads/2019aug-facts-a4-v02-x-road.pdf>. Accessed 24 November 2022.
- European Commission. (2018). *Digital Platform for public services*.
<https://joinup.ec.europa.eu/sites/default/files/document/2018-10/330043300REPJRCDigitalPlatformsBM-D2.5FinalReportv051018.pdf>. Accessed 24 November 2022.
- European Commission. (n.d.) *About X-Road Data Exchange Layer*. <https://joinup.ec.europa.eu/collection/ict-security/solution/x-road-data-exchange-layer/about>. Accessed 24 November 2022.
- Galani, U. (2022, February 22). India Insight: Digital diplomacy builds bridges. *Reuters.com*.
<https://www.reuters.com/article/us-india-tech-breakingviews-idDEKBN2KQ08Q>. Accessed 24 November 2022.
- GovTech, Singapore. (2018) *MEDIA FACTSHEET Singapore Government Tech Stack*
<https://www.smartnation.gov.sg/files/press-releases/2018/sg-tech-stack-media-factsheet.pdf>. Accessed 24 November 2022.
- GovTech, Singapore. (2021) *SingPass – Singapore's national digital identity*
[https://www.tech.gov.sg/files/media/media-releases/Media%20Factsheet%20on%20Singpass%20\(National%20Digital%20Identity\)_28%20October%202021.pdf](https://www.tech.gov.sg/files/media/media-releases/Media%20Factsheet%20on%20Singpass%20(National%20Digital%20Identity)_28%20October%202021.pdf). Accessed 24 November 2022.

- GovTech, Singapore. (2022). *Understanding SingPass*.
https://www.singpass.gov.sg/home/ui/assets/pdf/Understanding_Singpass_January_2022.pdf.
 Accessed 24 November 2022.
- IndiaStack. (n.d.). *India Stack is....* <https://indiastack.org/index.html>. Accessed 24 November 2022.
- Martin Kenney, John Zysman. (2016, March). *The Rise of the Platform Economy*.
https://www.researchgate.net/publication/309483265_The_Rise_of_the_Platform_Economy.
 Accessed 24 November 2022.
- McKinsey Global Institute. (2019). *In brief; Digital India: Technology to transform a connected nation*.
<https://www.mckinsey.com/~media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Digital%20India%20Technology%20to%20transform%20a%20connected%20nation/Digital-India-technology-to-transform-a-connected-nation-In-brief.ashx>. Accessed 24 November 2022.
- McKinsey Global Institute. (2019, January). *Digital Identification: A key to inclusive growth*
<https://www.mckinsey.com/nl/~media/mckinsey/featured%20insights/innovation/the%20value%20of%20digital%20id%20for%20the%20global%20economy%20and%20society/digital-id-a-key-to-inclusive-growth-january%202019.pdf>. Accessed 24 November 2022.
- Monetary Authority of Singapore, (2021, April). *Foundational Digital Infrastructure for Inclusive Digital Economies*. <https://www.mas.gov.sg/~media/MAS/Fintech/FDI/Foundational%20Digital%20Infrastructures%20for%20Inclusive%20Digital%20Economies.pdf>. Accessed 24 November 2022.
- National Digital Education Architecture (NDEAR). (2021, July). NDEAR Formal Complete Report.
https://www.ndear.gov.in/images/pdf/NDEAR%20Main%20Report_July%2026_210728_194926.pdf. Accessed 24 November 2022.
- National Health Authority (NHA). (n.d.). *Ayushman Bharat Digital Mission*. <https://abdm.gov.in/>. Accessed 24 November 2022.
- News Service Division, All India Radio. (2022, November 16). *G20 Summit: PM Modi emphasizes on rapid growth of public digital infrastructure in the country at third working session on 2nd day in Bali*.
<https://newsonair.gov.in/News?title=G20-Summit%3A-PM-Modi-emphasizes-on-rapid-growth-of-public-digital-infrastructure-in-the-country-at-third-working-session-on-2nd-day-in-Bali&id=450921>. Accessed 24 November 2022.
- Nico Heerschap, Nicky Pouw, Cybele Atmé. (2018, December). *Measuring Online Platforms*.
https://www.cbs.nl/-/media/_pdf/2018/51/2018ep58-measuring-online-platforms.pdf. Accessed 24 November 2022.
- NITI Aayog. (2018, July). *National Health Stack: Strategy and Approach*.
https://abdm.gov.in:8081/uploads/NHS_Strategy_and_Approach_1_89e2dd8f87.pdf. Accessed 24 November 2022.
- Norwegian Ministry of Foreign Affairs. (2020). *Report to the Storting (white paper), Summary: Digital transformation and development policy*
https://www.regjeringen.no/contentassets/4250970ee8e845aeb9114143fff45d84/en-gb/pdfs/digital_transformation.pdf. Accessed 24 November 2022.
- NPCI.org. (n.d.). *Unified Payments Interface (UPI) Product Overview*. <https://www.npci.org.in/what-we-do/upi/product-overview>. Accessed 24 November 2022.
- Omidyar Network and The Centre for Internet and Society (CIS). December, 2019. *Mapping Digital Identity Systems Estonia* https://digitalid.design/docs/CIS_DigitalID_EstoniaResearchMaps_2019.12.pdf.
 Accessed 24 November 2022.

- Organisation for Economic Co-operation and Development (OECD). (2019, May) *An Introduction to Online Platforms and Their Role in the Digital Transformation*. https://read.oecd-ilibrary.org/science-and-technology/an-introduction-to-online-platforms-and-their-role-in-the-digital-transformation_53e5f593-en#page1. Accessed 24 November 2022.
- Sharma, S. (2022, November 15). *India to showcase its digital transformation at Bali summit: G20 Sherpa Amitabh Kant*. <https://economictimes.indiatimes.com/news/india/india-to-showcase-its-digital-transformation-at-bali-summit-g20-sherpa-amitabh-kant/articleshow/95526876.cms>. Accessed 24 November 2022.
- SmartNation, Singapore. (n.d.). *Singapore Financial Data Exchange: The central gateway for efficient and secure data sharing*. <https://abs.org.sg/docs/library/sgfindex-infographic.pdf>. Accessed 24 November 2022.
- Tat Koon Koh, Mark Fichman. (2014, December). *Multihoming Users' Preferences for Two-Sided Exchange Networks*. https://www.jstor.org/stable/26627958#metadata_info_tab_contents. Accessed 24 November 2022.
- The Rockefeller Foundation, Digital Public Goods Alliance and Norwegian Ministry of Foreign Affairs. (2021, August). *Co-Develop Digital Public Infrastructure for an Equitable Recover'* <https://www.rockefellerfoundation.org/wp-content/uploads/2021/08/Co-Develop-Digital-Public-Infrastructure-for-an-Equitable-Recovery-Full-Report.pdf>. Accessed 29 May 2022. Accessed 24 November 2022.
- United Nations Development Programme (UNDP). (2022, February 1). *Building Digital Public Goods: takeaways from India's COVID-19 vaccine implementation programme*. <https://www.undp.org/digital/blog/building-digital-public-goods-takeaways-india%E2%80%99s-covid-19-vaccine-implementation-programme>. Accessed 24 November 2022.
- United Nations Office of the Secretary-General's Envoy on Technology. (2021, April). *Digital Cooperation: "Digital Public Goods" Implementation Plan*. https://www.un.org/techenvoy/sites/www.un.org.techenvoy/files/general/210415_Digital_Public_Goods_roundtable_workplan.pdf. Accessed 24 November 2022.
- United Nations. (2020, June). *Report of the Secretary General: Roadmap for Digital Cooperation* https://www.un.org/en/content/digital-cooperation-roadmap/assets/pdf/Roadmap_for_Digital_Cooperation_EN.pdf. Accessed 24 November 2022.
- World Bank. (n.d.). *ID4D Data: Global Identification Challenge by the Numbers*. <https://id4d.worldbank.org/global-dataset>. Accessed 24 November 2022.
- World Economic Forum (WEF). (2021, August). *Towards a Data Economy: An enabling framework*. https://www3.weforum.org/docs/WEF_Towards_a_Data_Economy_2021.pdf. Accessed 24 November 2022.

Annexure 1: Select Definitions of Digital Public Goods

Source	Definition
Digital Public Goods Alliance: GovStack Definitions (2022) ³⁴	Refers to open-source software, open data, open AI models, open standards, and open content that adhere to privacy and other applicable laws and best practices, do no harm by design, and help attain the Sustainable Development Goals (SDGs). <ul style="list-style-type: none"> • DPGs may be implemented as a part of a country's digital public infrastructure. • When they provide a generic service at scale, DPGs may be considered building blocks. • DPGs may also advance the SDGs but not contribute to public service delivery or be customisable across multiple use cases. Therefore, DPGs are not always building blocks and may not be implementable as digital public infrastructure
David Eaves, Leonie Bolte, Omayra Chuquihuara, and Surabhi Hodigere (2022) ³⁵	An institutionalized sharing of “open-source software, open data, open AI models, open standards, and open content” between government and other actors.
UN Secretary General's Roadmap for Digital Cooperation (2020) ³⁶	Open-source software, open data, open AI models, open standards and open content that adhere to privacy and other applicable laws and best practices, do no harm, and help attain the SDGs.
Norwegian Ministry of Foreign Affairs (2020) ³⁷	Digital public goods are not a specific technology but a collective term for digital goods that have the potential to benefit or help countries and individuals. To qualify as digital public goods, a project or product must be <ol style="list-style-type: none"> i) non-rivalrous (meaning its use does not prevent others from using it), ii) non-exclusive (meaning no one can prevent others from using it) and iii) available across national borders.
Digital Public Goods Alliance, Digital Square, UNICEF Health and Information Communication Technology (ICT) Divisions. (2021) ³⁸	Demonstrate: relevance to the SDGs; use of an approved license; clear ownership; platform independence; documentation; a mechanism for the extraction of non-personally identifiable information; adherence to privacy and applicable laws; adherence to standards and best practices; and a commitment to do no harm. ³⁹

Note: Definitions have been taken directly from sources indicated.

³⁴ Digital Public Goods Alliance and GovStack Community of Practice (2022, May), “GovStack Definitions: Understanding the Relationship between Digital Public Infrastructure, Building Blocks & Digital Public Goods” <https://digitalpublicgoods.net/DPI-DPG-BB-Definitions.pdf>

³⁵ Eaves, D., Bolte, L., Chuquihuara, O., and Hodigere, S (2022, April), “Best Practices for the Governance of Digital Public Goods” Ash Center for Democratic Governance & Innovation, Harvard Kennedy School (<https://ash.harvard.edu/publications/best-practices-governance-digital-public-goods>)

³⁶ Report of the Secretary General (2020, June), “Roadmap for Digital Cooperation”, United Nations https://www.un.org/en/content/digital-cooperation-roadmap/assets/pdf/Roadmap_for_Digital_Cooperation_EN.pdf

³⁷ Norwegian Ministry of Foreign Affairs. (2020). *Report to the Storting (white paper), Summary: Digital transformation and development policy* https://www.regjeringen.no/contentassets/4250970ee8e845aeb9114143fff45d84/en-gb/pdfs/digital_transformation.pdf

³⁸ Digital Public Goods Alliance, Digital Square, UNICEF Health and Information Communication Technology (ICT) Divisions. (2021, April). “Understanding the Relationship between Digital Public Goods and Global Goods in the Context of Digital Health” <https://digitalpublicgoods.net/DPG-GlobalGoods.pdf>

³⁹ UN Roadmap for Digital Cooperation translated into standards by the Digital Public Goods Alliance



OUR OFFICES:

4th Floor, Core 6A, India Habitat Centre, Lodhi Road,
New Delhi-110003
Plot No. 16-17, Pushp Vihar, Institutional Area, Sector 6,
New Delhi-110017

O: +91 11 43112400 / 24645218

F: +91 11 24620180 | **E:** ipcide@icrier.res.in

W: <https://icrier.org/ipcide/>