Co-Develop
Digital Public Infrastructure for an Equitable Recovery

The ROCKEFELLER FOUNDATION

Digital Public Goods Alliance

Norwegian Ministry of Foreign Affairs

August, 2021

Foreword

More than a decade ago, in 2009, India started a bold initiative. It created a program to give more than a billion residents a unique identity, and I was fortunate enough to have led this mission called Aadhaar.

The word Aadhaar means "foundation" in several Indian languages and summarizes the thinking behind the program. Aadhaar is just a 12-digit number. The physical identity cards issued have no special significance and can be reprinted by residents as needed. A number is issued to every resident who wants one, even if they have no previous identification on record.

By itself, the card does not entitle you to any benefits. It is only used to prove you are who you claim to be. Just five and a half years after its launch, India issued its billionth Aadhaar. Today, more than 92% of India's now 1.4 billion people have an Aadhaar.[1] For the people, Aadhaar became the foundational document.

For the Indian government, the Aadhaar system became the foundation for digitization of multiple government schemes and welfare programs. With a unique identifier, the government could clean up their beneficiary lists and remove duplicates. The unique identifier was used to speed up know-your-customer processes and open bank accounts, in order to enable beneficiaries to receive cash transfers directly and instantly.
The point to take home here is that the Indian government wasn't rolling out one development intervention; they were building digital public infrastructure. Aadhaar by itself could only prove your identity. However, plugging Aadhaar into multiple programs supercharged the overall welfare delivery experience for both governments and residents.

Aadhaar was a foundational identity system, but over the next decade, complementary digital infrastructure has been built in the space of payments and data exchange. These systems were all designed as Lego blocks—they could be recombined and stacked on top of each other to create new and unique solutions. A Bank of International Settlements report published in 2019 said that due to its digital public infrastructure, India managed to achieve in 7 years the kind of progress in financial inclusion that would've taken 47 years otherwise.[2]

The same infrastructure was used to deliver financial aid directly and rapidly to residents when the pandemic first hit. India may have been early on the digital infrastructure initiatives, but we are definitely not the only ones. Today, many countries are adopting the approach of building digital public infrastructure to support their visions of a digital future. There are multiple open source digital public goods being developed to support these journeys.

The pandemic has made the need for this infrastructure even more pressing. We can't just aim for recovery, we need to aim for a better, more resilient future. It is time for us to act together and mobilize more resources to co-develop digital public infrastructure.

Nandan Nilekani
Chairman and Co-founder, Infosys
and Founding Chairman UIDAI (Aadhaar)

Executive Summary

As Covid-19 spread across the world, digital systems that enabled people to continue working together, to collect and manage data, and to build new tools proved to be an important foundation for response. These were digital public infrastructure (DPI)—systems that accomplish basic but widely useful functions at a societal scale and that can be used to build new applications for the greater good.

Around the world, governments and partners responded to Covid-19 by combining and building upon DPI functions like digital identity, digital payments, and health data exchanges. These systems became a crucial tool for gathering the data needed to understand disease spread, organize the logistics of response, and distribute emergency cash transfers to mitigate hunger while helping people stay safe at home.

As the battle to control Covid-19 and recover from it continues, DPI will be a key tool for including more people in the digital economy, for enabling good governance and service delivery, and for developing new tools to respond to other urgent threats, especially climate change and its disastrous impacts.

However, billions of people live in places with no functional DPI; billions more, in countries of all income levels, are poorly served by, excluded from, or can't trust key DPI systems.

This is fixable. We can build strong, locally appropriate DPI everywhere. It will require a new approach, one that integrates domestic investments, international cooperation, and international development assistance alike. Every country can benefit from cooperating with others to create shared software, standards and governance expectations, and a more robust ecosystem of private partners. And every country can contribute something, be it code, money, or expertise.

An agenda for international cooperation could focus on six key elements:

1. A vision for DPI as a whole, backed by practice, research, and evaluation. The different layers of DPI can enable new applications and innovations—if they can work together. They also have common inclusion, security, and rights challenges. Connecting the layers, and the communities building them, is a first step.

2. A global commons based on Digital Public Goods. Open source software and standards that qualify as Digital Public Goods (DPGs), such as DHIS2, the world's largest health information management system platform, provide a new, more equal model of international development cooperation. They can spread development costs, rapidly propagate innovation, and promote interoperability, transparency, and other good practices.

3. Safeguards for inclusion, trust, competition, security, and privacy. DPI systems have the potential to accelerate inclusion and responsible knowledge sharing—or to exclude and surveil people. A mix of institutional, policy, and technological protections will be needed.

4. Tools for using data in DPIs for public value and private empowerment. While protecting people and privacy is paramount, the data flowing through DPI systems is potentially a rich source of insight for applications like detecting disease outbreaks.

5. Private and public capacity, particularly in implementing countries. Implementing DPI starts with people with the right technical and design skills—but it also requires the right policies, procurement processes, and governance ability. There are promising new strategies for building relevant capacity in governments, businesses, academia, and international networks alike.

6. Silo-busting, built-for-purpose coordination, funding, and financing. DPI systems contribute to multiple societal goals and are used by many different types of agencies and businesses. Governments, businesses, and funding agencies structured around fragmented programs struggle to see their value and manage them to their full potential. International coordination can support domestic political vision in breaking down silos and delivering DPI that works for everyone.

Introduction: Co-Developing Digital Public Infrastructure

By understanding digital identity, payments, and data exchanges as elements of DPI, we can build them more rapidly, maximize their benefits, and minimize the risks they create.

The Covid-19 pandemic accelerated two existing global trends: Increasing reliance on digital systems and growing economic and social inequality. The two intersected. In cases where digital systems worked effectively and served all people, they helped reduce inequality. In other cases, the poorest were ill-served or excluded by digital tools.

In particular, the pandemic proved the value of digital systems that were already in widespread use, had basic but flexible functions, and could be applied to the pandemic response effort and other common challenges.

These digital public infrastructure (DPI) systems included digital identification, payments, and data exchanges. None of them were created with the pandemic in mind, but they became critical enablers of the public health, social protection, and economic responses by governments, businesses, organizations, and individuals.

This report argues that DPI systems are their own class of digital tool distinguished from others by their broad scale and the importance of their functions for societal-level goals. By understanding digital identity, payments, and data exchanges as elements of DPI, we can build them more rapidly, maximize their benefits, and minimize the risks they create.

Billions of people aren't served by even the most basic DPI. Billions more—including many living in high-income countries—are served by weak DPI or are excluded from using it. Closing that gap will require changing how we think about development assistance, international cooperation, and domestic infrastructure in every country. An emerging co-development model, based on collective, open-source software and standards, offers ways of building DPI in which high-income and low-income countries alike both contribute and benefit, and in which public and private entities partner in new ways.

This report collects and distills lessons acquired from the collective research, writing, and thinking of many people and organizations. We especially learned from group conversations organized by The Rockefeller Foundation, the Digital Public Goods Alliance, and The Brookings Institution, most notably successive editions of the 17 Rooms process from 2019 to 2021 and a set of four convenings with representatives of funding organizations in June and July of 2021. However, the views expressed here are those of the authors and are not meant to represent the position of any of these organizations or individuals.

The experiences of the pandemic led a broad range of visionary technologists and public servants to see a window of opportunity to collaborate on building DPI and thereby change how we approach both digital systems and international development.
This is an attempt to capture and communicate the pathway and potential that they see.
The body of this report is followed by examples of work carried out by this community that add detail to the arguments laid out here.

What is Digital Public Infrastructure?

As Covid-19 spread across the world last year, its impacts were fast and society-wide, ravaging health and livelihoods. The question was:
How can our societies respond with equivalent speed, scale, and breadth?

Digital systems played a key role in this response. Amid the profusion of apps, dashboards, data collection tools, and other resources used for pandemic response, one specific type of digital system consistently proved its worth beyond all others.
These were digital platforms that had a set of three specific characteristics that enabled pandemic responses to be built and stacked atop other platforms:

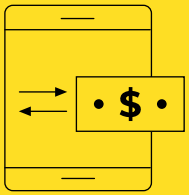
1.
They were already in widespread use by people and organizations across whole countries or sectors, creating a common platform that promoted connection at societal scale.

2.
Their functionality was basic but powerful and broadly applicable. They could be combined with each other and additional systems, allowing them to be creatively repurposed or built on top of to meet the challenge.

3.
The functions these systems enabled had core societal importance. While not always built or operated by the government, they were regulated or managed by the government, and their functions could be applied to solving public problems.

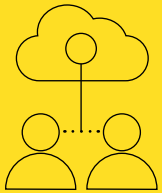
IDENTIFICATION

(e.g. Digital personal identification or civil registration and vital statistics systems)



PAYMENTS

(e.g. Digital money transfers or government-to-person payments)



DATA EXCHANGE

(e.g. Health information exchanges or information management systems, logistics management systems, and financial data exchanges)

These characteristics distinguish these systems from other digital systems, making them digital public infrastructure (DPI). These attributes are shared by other familiar society-wide, non-digital tools such as roadways or currency. DPI systems build on telecommunications infrastructure, allowing the public to do new things with their connectivity.

DPI is often described as a stack, with individual DPI systems playing specific functions as layers that interface with each other. What these are will depend on local context and change over time. However, three general functions are critical almost everywhere:

→ **Identification systems that promote trust by verifying information about a person, business, or other entity. Examples include digital personal identification, civil registration and vital statics systems, and digital business registries.**

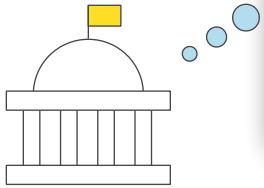
→ **Payment systems that enable transactions and the exchange of value. Examples include digital money transfers or government-to-person payments.**

→ **Data exchange layers that allow information to be managed and shared easily but securely among a diverse network of users. Examples include health information exchanges or information management systems, logistics management systems, integrated social registries, and integrated financial management systems.**

Togo's emergency cash transfer program (See Example 1) is one example among many of a pandemic response built on top of these DPI systems. The West African country used elements of DPI to quickly target and deliver cash assistance to its most vulnerable residents in areas most impacted by the virus.

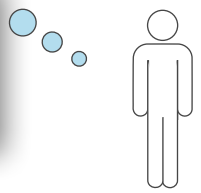
Other countries also deployed cash transfers. However, Togo's DPI and cash transfer deployment model through a public-private coalition allowed the country to execute more quickly and efficiently than its peers, including many countries with far greater resources at their disposal.

DPI IN ACTION	HOW CAN DPI SYSTEM WORK TOGETHER? TWO EXAMPLES.
TARGETED EMERGENCY CASH TRANSFERS	GETTING A LOAN



Government:
There's a drought. We want to send cash transfers to poor farmers in the affected area.

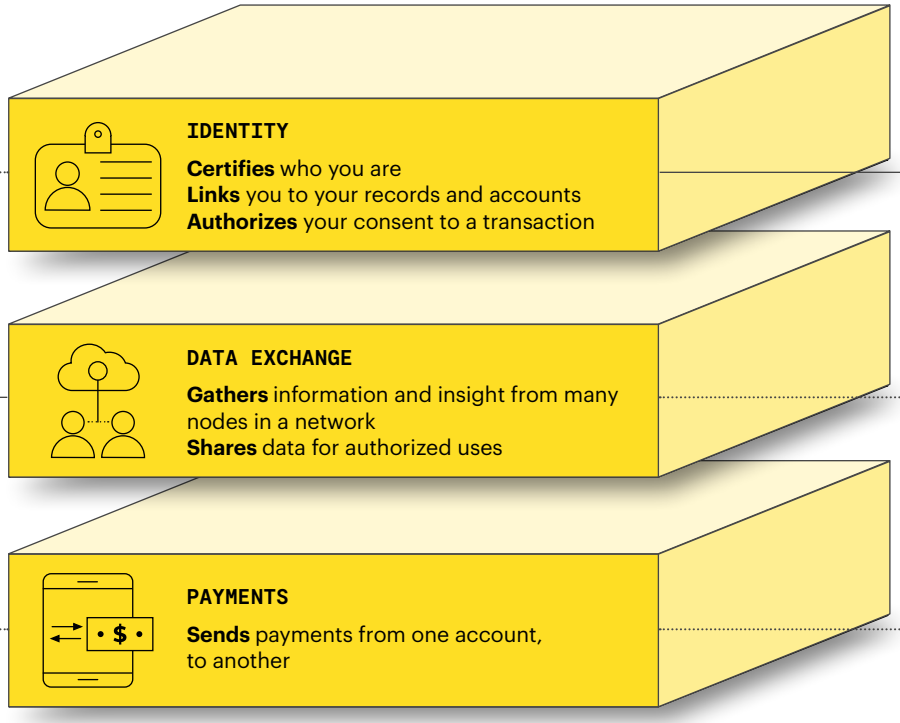
Thandi: I'd like a loan to expand my business. There's no bank in my village. My business is growing and my payments records prove it.



1. We link databases to find people who are 1) farmers, 2) in the affected area and 3) low income. We **link** to their bank accounts.

2. We gather data from agriculture, social welfare, and disaster agencies.

3. We send emergency cash transfers to the selected people.



1. I certify that I'm Thandi and authorize the bank to access payments records linked to me.

2. My payments provider **shares the records** with the bank.

3. The bank grants my loan and **sends the money.**

DPI is not a one-size-fits-all solution. Each country will have unique needs for DPI and a unique set of challenges in building it. However, the basic functionality is inherently similar everywhere, opening up opportunities for global cooperation.

Many, but not all, DPI systems are built using open source software and standards classified as digital public goods (DPGs). DPGs channel the shared effort of a community of contributors—past, present and future. They also promote good practices and provide a way to rapidly share innovations around the world, as was seen in the fight against Covid-19.

DPGs are a crucial tool in the creation of digital identity, payments, and data exchanges. For the purposes of this report, however, the key distinction is that DPI refers to implemented, operational systems; DPGs refer to open software, data, content, and standards that can be used to build a system (DPI or otherwise). DPI and DPGs overlap in an important and growing set of “DPGs-for-DPI” primarily intended to be used to build DPI systems (See Example 2).

DPI for Impact and Equity

One of the barriers to building DPI is that systems like identity, payments, and data exchanges benefit multiple types of users in different ways, making it difficult to assess their value. Covid-19 showcased several clear use cases for DPI. Pandemic recovery and other challenges, such as climate change, point towards others.

1. A NERVOUS SYSTEM TO ASSIST PANDEMIC RESPONSE, PUBLIC HEALTH, AND HEALTHCARE DELIVERY

Covid-19 required a response that stretched across facilities, agencies, and even borders, making DPI that could do the same especially useful. Health data exchanges, such as Sri Lanka's Covid-19 tracking modules (See Example 2), were essential to detecting and understanding outbreaks; even patterns in digital payments provided clues to the course of the disease. Logistics management systems, digital identification, and payments were all tools for managing and tracking responses such as vaccine delivery.[3]

2. A CORNERSTONE FOR SOCIAL PROTECTION

Cash transfers were an imperative first response to the livelihoods and food security impacts of the pandemic in countries around the world, doubling in value in 2020 relative to 2019.[4] They also were an important tool for encouraging people to stay at home to reduce transmission. Digital identity, payments, and government data exchanges made it possible to deliver money promptly and securely, to target payments to the most vulnerable, and to reach people who were isolated or moving.

3. AN ON-RAMP TO THE DIGITAL ECONOMY

DPI reduces the practical and cost barriers to using payments, savings, credit, and other tools for individuals and small businesses. It can also give them access to and use of important data about their lives, businesses, and markets. These factors explain why one estimate suggests that a digital identity system can create value of between 3% and 6% of a nation's economy.[5] While financial inclusion has long driven attention to digital identity and payments, the need for these DPI systems intensified in a pandemic where social distancing and contactless transactions became paramount. Even as the global economy contracted in 2020, mobile payments boomed: Total transaction volume mobile payments increased by 22% globally, the number of active users by 17%, and the value of international remittances sent through mobile accounts increased 65%.[6]

4. AN ENGINE FOR EFFECTIVE, ACCESSIBLE, AND ACCOUNTABLE GOVERNMENT

Covid-19 demonstrated the key societal role of government, but also exposed weakness in many governments' ability to collect data and coordinate complex responses. Meanwhile, efficiency and fighting corruption are perennial priorities for governments and citizens alike. Rigorous research shows that DPI systems like digital payments and digital identity can have measurable results on government effectiveness. For example, a study of use of Aadhaar in one Indian state estimated that the digital identity reduced "leakage" in the distribution of subsidies to families by 14% of the total subsidy value. DPI can allow governments to eliminate redundant systems and data collection, close data gaps and silos, cut leakage in payments to and from governments, enable transparency, and facilitate mobile and online engagement and service delivery. Examples like Estonia (See Example 3) point to the potential.[7]

5. A PLATFORM FOR FUTURE INNOVATIONS FOR EDUCATION, CLIMATE, ENERGY ACCESS, AND OTHER CHALLENGES

DPI systems are already being applied to facilitate both online and in-person education during the pandemic.[8] New possible applications include making it easier to purchase renewable energy and to manage complex energy grids that integrate wind and solar generation at varying scales.[9]

A focus on equity

Within each of these use cases, strong DPI systems make it possible to promote equity. Cash transfers provide an example. People living in poverty have smaller cash reserves, are less likely to have a bank account, and, in many countries, are more likely to migrate internally. Strong DPI can help deliver aid quickly, prioritize the poorest, and reach everyone everywhere, while ensuring that the execution promotes equity.

The impact of DPI can be seen in the results. Globally, emergency cash transfer programs using primarily electronic distributions distributed their first payments 51 days after the first stay-at-home order on average, versus 86 days for those using manual methods.[10] Having information about who was where and their approximate level of vulnerability enabled Togo to prioritize getting funds to residents most in need (See Example 1). In India, Covid-19 lockdowns forced an estimated 10 million people to migrate internally, making digital identity and payments one critical tool for helping cash and food aid reach people on the move.[11]

Elsewhere, weak DPI made the response slower and less equitable—in the United States, 58.6% of eligible adults below the poverty line had received emergency cash transfers within one month of disbursement, versus 77.5% of adults not in poverty. This resulted, in part, from the fact that poor people were less likely to have a bank account and more likely to have their account and eligibility data on file with the US Government.[12]

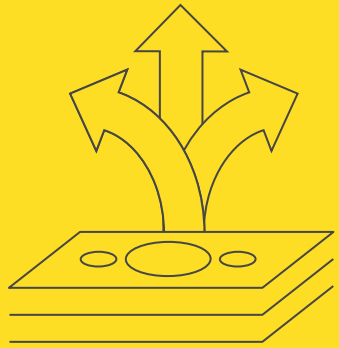
Simply implementing DPI systems is not enough to support equity; the programs and products using them—whether in business or government—must also be designed to promote equity. Results from India consistently showed that using digital identity to verify recipients reduced corrupt leakage of subsidies. However, some studies also showed unintended consequences: A small proportion of people were wrongly excluded or experienced significant inconvenience, with the most vulnerable most affected. Elsewhere, there were broadly shared benefits in both convenience and subsidy receipt. The difference appears to be the way the programs were designed around the identity system.[13]

The pandemic is still ongoing, with deeply unequal impacts. As of this writing, the majority of the world's population has yet to be vaccinated for Covid-19. Other public health and education programs have faced enormous setbacks. To the extent that recovery has happened, it has favored the wealthiest people in rich countries, especially those able to use digital tools to adapt. True recovery will take years and will almost certainly involve obstacles. The climate crisis will add to the already heavy burden faced by the world's poorest. Ensuring all countries can build out DPI systems is one of the most proactive steps the world can take to help drive recovery, make recovery more equitable, and prepare for future challenges and threats.

Digital Public Infrastructure in Action: Pandemic and Recovery

Countries that already had in place digital ID systems, digital payment systems, and trusted data sharing systems have been better equipped to mitigate the socioeconomic impacts of the pandemic.

EXAMPLES OF DIGITALLY ENABLED COVID-19 RESPONSE	SUPPORTING DPI SYSTEMS		
	ID	PAYMENTS	DATA
Vietnam leveraged its existing communicable disease surveillance/data sharing system and developed a new online case reporting system for tracking suspected and confirmed Covid-19 cases			●
Bangladesh rapidly developed a Covid vaccine prioritization plan using population data from the Bangladesh National Identity Card system	●		●
Mozambique rapidly added global product definitions to their existing digital supply chain system (OpenLMIS) to immediately track PPE, diagnostic, and vaccine delivery supplies for Covid response	●		●
Togo leveraged its election database and mobile-payment system to introduce a cash-transfer program which delivered emergency-relief payments to workers in the informal economy (e.g., street vendors, hairdressers) whose livelihoods were impacted by lockdown measures		●	●
India delivered emergency financial support to 200 million women by direct payments to women's ID-linked payment accounts	●	●	●
Pakistan expanded the number of residents receiving cash-transfer support by 281% (supporting 101 million people during the pandemic), using its digital-identity and social-registry systems and launching a mobile-based platform so citizens could enroll without face-to-face interaction	●	●	●



Global cash transfer coverage grew by **240%** from March–December 2020. **166** governments launched **429** cash-transfer programs, expanding the number of global government-to-person payment recipients by **1.1 billion** people, covering **14%** of the world's population.

*Table recreated, with permission, from *The Case for a Global Financing Platform Digital Public Infrastructure* presentation prepared by SEEK Development on behalf of the Bill & Melinda Gates Foundation.

A Common Global Need

Developing a common vision, political buy-in, and coordination across the whole of government or even the whole of society can be a challenge everywhere.

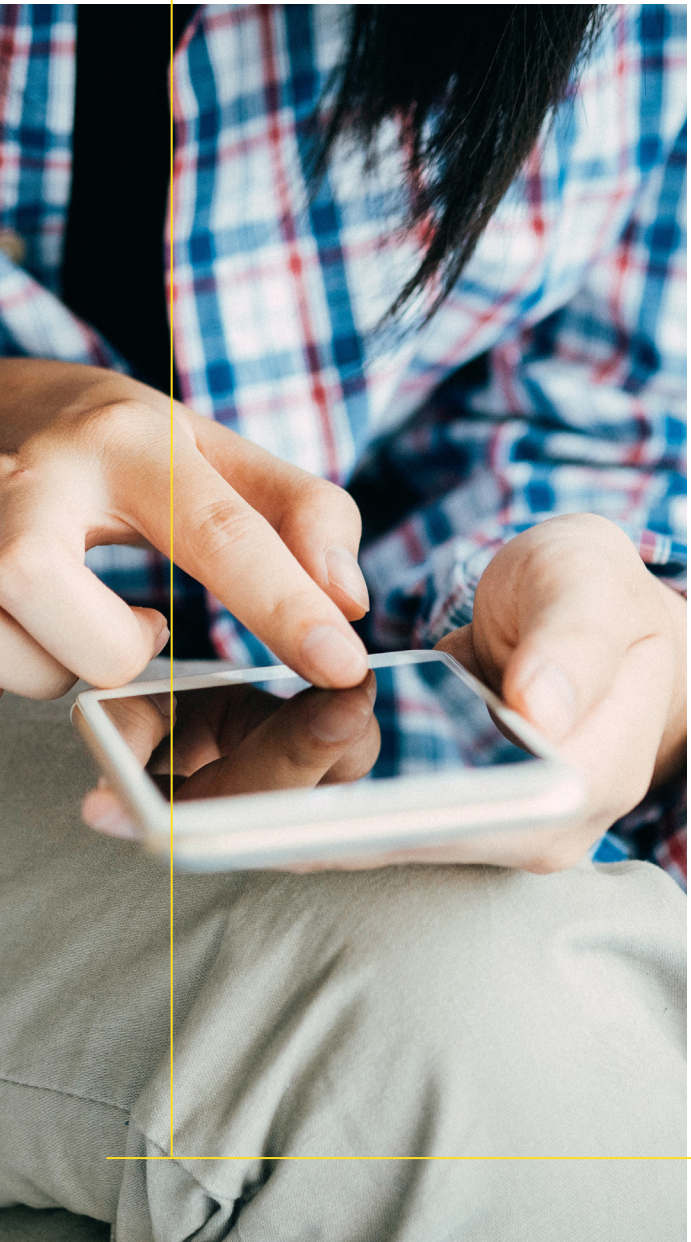
An estimated one billion people lack access to any foundational identity, digital or otherwise—in low-income countries, one in two women lack identification, limiting their access to participate in formal economic and political structures.[14] 1.7 billion cannot send digital payments; another 1.9 billion are not served by the most rudimentary digital health services.[15] Billions more people live in places where DPI doesn't cover most people, costs too much, raises privacy or surveillance risks, or simply doesn't work well.

This need is not limited to lower or even middle-income countries. Many high-income countries have weak DPI and the process of improving and evolving DPI is never truly finished. The nature of the barriers can vary: In lower-income countries, cost and capacity are barriers; in high-income countries, unwinding legacy systems can be as formidable. Developing a common vision, political buy-in, and coordination across the whole of government or even the whole of society can be a challenge everywhere.

India showed what is possible when it rolled out its Aadhaar digital identity program in 2009, which today covers 1.2 billion Indians or 99% of the country's adult population.[16] Since then, it has further developed the "India stack" by adding additional layers, pioneering the concept of DPI.

The lessons of Covid-19 make the problem-solving value of DPI clear. This will make it simpler to build the necessary political will and vision. However, business as usual won't make this vision reality with the required scale and speed. To move forward fast enough, we need a different approach. Thanks to the efforts of visionary public servants, technologists, designers and others, we have one: Co-development.

Co-Development: Global Cooperation, Local Ownership



In consultations with a broad set of public servants, technologists, and advocates we've heard a common refrain: The world needs a positive vision for technology that strengthens societies by supporting innovation, inclusion, human rights, and good governance. Governments need to show that they can use technology to deliver services for their people and take a proactive role in creating the systems that underpin the digital economy, on behalf of all their residents.

This vision calls for a world in which every country has DPI that supports its social and economic needs and is open to broad usage and application to new purposes. DPI systems will enable all people to have full participation in markets and government services equally, no matter a person's income, disability, gender, rural/urban location, or other status. A robust set of safeguards will protect people and businesses from surveillance, misuse of data, and exclusion from services, while still giving them the ability to access and use their data, and allow data in the system as a whole to be analyzed for legitimate research, advocacy, and public value purposes.

Just as importantly, this vision calls for a different approach to development, one that integrates domestic investments, international cooperation, and international development assistance alike.

Every country needs better DPI, no matter the income level or technical capacity. Every country can benefit from cooperating with others to create shared software, standards and governance expectations, and a more robust ecosystem of private partners. And every country can contribute something, be it code, money, or expertise.

This model has been put into action around the world. However, outdated approaches to governance, budgets, financing, and procurement are blocking the way. Rapid progress toward this vision will thus require changes that extend across government, businesses, and international organizations. Fortunately, we do have good examples that show what is possible and what is needed.

Co-developing DPI requires six key elements to come together:

1. **A vision for DPI as a whole, backed by practice, research, and evaluation**
2. **A global commons based on Digital Public Goods**
3. **Safeguards for inclusion, trust, competition, security, and privacy**
4. **Tools for using data in DPI for public value and private empowerment**
5. **Private and public capacity, particularly in implementing countries**

1.
A vision for DPI as a whole, backed by practice, research, and evaluation

Two new perspectives are needed to co-develop DPI. Both are already embedded in other terms used for DPI such as "national stack" or "societal platforms."

The first perspective is horizontal, seeing digital systems not as just "IT" but potentially forming infrastructure that connects whole societies. For example, rather than help a group of clinics keep track of its patients, manage their data, and process payments, can we develop DPI that helps all clinics do the same—or the entire health sector, or even the whole country?

The second perspective is vertical, seeing the connections between identity, payments, and various data exchange layers as tools that can be combined and integrated, instead of separate, siloed standalones.

There are substantial differences between varying layers of DPI, such as identity, payments, and data exchanges. But they all share characteristics that make them a hybrid of infrastructure (e.g., roads, telecom networks, currency) and other digital platforms (search engines, social media):

- **Diversity of impact,** with a variety of use, users, and problems that can be applied
- **Network effects,** which create more value as more people and places connect—but can also create natural monopolies
- **Integrative,** meaning that the value of DPI grows as new functions are built "on top"
- **Universal,** with functions that are fairly similar across sectors and borders
- **Human-facing,** used by people in their social, economic, and physical context
- **Evolving,** with a need to be continually improved (not just maintained) as technology and society changes
- **Ubiquitous,** with a tendency to become de facto prerequisites for modern governance and commerce, making it difficult to opt-out of their use
- **Data generating,** potentially creating detailed information about users and their activities and interactions

How we co-develop a vision

More support for research on DPI will help, but so will more and better cases of DPI in action. Focusing international attention on a set of reference implementations to rapidly build knowledge and serve as inspiration is one option for moving more quickly. Moving forward will require investment in a new body of practice, research, and evidence that answers the following questions:

How will we measure progress on DPI?

Despite important advances, the development community is only beginning to create broadly comparable performance measures for identity, payments, and data exchanges as individual layers. A vision for DPI would go beyond that, establishing common measures across layers, and assessing the stack as a whole. Crucially, measurement systems would need to look at the systems themselves, the experience of people using it, and its role in society, answering questions such as: Are systems secure? Do the layers interoperate? Do women use them less than men? Do people trust them?

What is the impact of DPI?

Evidence that DPI results in progress against the Sustainable Development Goals and national priorities is needed to drive financing, funding, and political commitment. Gathering evidence on which attributes and investments have the highest value will help us direct them. A growing body of research supports the impacts of individual layers on narrow outcomes, but very little research exists on the impact of DPI as a whole across multiple use cases. It will take time and ingenuity to assess the broad and varied nature of DPI impacts. In the meantime, we can track how DPI makes specific, highly important capabilities possible, such as the ability to rapidly and securely deliver targeted cash transfers, or to detect and organize response to an outbreak.

What works?

Again, playbooks, case studies, and peer networks exist for specific layers but still need investment; for DPI as a whole, they are in their infancy. It will be important to have a range of cases to understand not just what works best, but under what conditions and for what objectives. Crucially, practice research should include not just technology and design but also policy, procurement, community engagement, and governance.

2.
A global commons based on digital public goods

Countries wanting to implement DPI face a dilemma: The technical burden of creating, maintaining, and evolving a DPI system from zero is infeasible for most countries, and yet each country will want to ensure that it can set its own path, accommodating its unique needs, legacy systems, and future challenges.

DPGs provide a resolution to this dilemma. DPGs, as defined by the UN Secretary-General, are "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." The Digital Public Goods Alliance manages the DPG Standard that operationalizes this definition (See Example 4).

DPGs are at the heart of co-developing DPI. They are collective digital solutions, freely available for all to modify, add to, and deploy. This distributes core development costs across many different implementations, while allowing implementers to customize to local conditions and extend functionality to new needs.

The use of well-established, well-supported DPGs and other open source solutions for scaled, sensitive, mission-critical systems is neither new nor risky. Governments have quietly been using DPG-like projects to build scaled systems since the 1960s.[17] Almost every modern commercial digital product now relies on open source solutions such as Linux in some way.

A particularly relevant class of DPGs are those that can be used to build DPI systems such as digital ID or health data exchanges in-country. These "DPGs-for-DPI" include a growing set of screened and well-coordinated open source solutions listed on the Digital Public Goods Registry. The development and maintenance of these DPGs is typically either funded by international development donors, as in the case of MOSIP (See Example 2), or funded by one or several governments as part of maintaining their own DPI, as in the case of X-Road (See Example 3).

Many of the most relevant DPGs-for-DPI-projects originated in low- and middle-income countries, but now have implementations and contributors around the world, shattering outdated stereotypes of how technical innovation spreads.

Sri Lanka's response to Covid-19 provides an example. The government deployed a customized, real-time Covid-19 monitoring system days before its first case of the virus. The system was built on top of DHIS2, a free, open source software health data system that originated in South Africa in the late 1990s and is now a global resource coordinated by the University of Oslo (See Example 2). Sri Lanka in turn shared its Covid-19 modules with the other countries using DHIS2—73 countries representing 30% of the world'spopulation. That community further developed the models and many of them implemented it themselves, in turn contributing further improvements to the community.

DPGs have several features that make them especially useful for implementation as part of DPI:

→ DPGs can generate competition and prevent vendor lock-in by lowering entry barriers and opening up new roles for vendors. Businesses play a critical role in DPG implementation, contrary to the myth that DPGs displace for-profit providers. Instead of full system builds, vendors can offer DPI management consultancies and implementation services, building on DPGs. This can include DPGs implemented as software, as service, or as proprietary product offerings within an open-standards structure.

→ The code in a DPG is openly accessible by nature, making it easier to examine for security and other potential problems.

→ Most DPGs-for-DPI are designed for interoperability, both domestically with other common DPI systems and internationally with other deployments.

→ Well-established DPGs like DHIS2 are supported both by a well-resourced core team and the collective contributions of a community, making ongoing maintenance, development, and extension easier.

→ DPGs support modern software development practices, such as early user testing, rapid iteration, and the use of modular components.

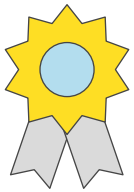
Over time, DPGs can be built by many: governments, vendors, academics, individuals, and others with a stake in the success of DPI. They can reduce barriers to entry and encourage smaller local firms to work on DPI and also innovate on top of them, supporting local tech ecosystems and helping countries take ownership of their own digital ecosystems.

How we co-develop digital public goods

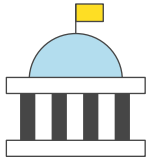
For most governments and potential DPI operators, using a DPG will only be viable if it is backed by strong project management and a robust community of contributors and vendors. The following will help build a critical mass of competitive DPG options across the range of DPI needs:

Sufficient, stable funding for DPGs-for-DPI and support for the communities that build and maintain them is an essential first step toward this common toolset.

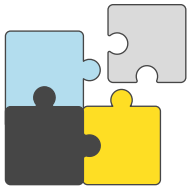
Promotion of DPGs-for-DPI to governments, private companies, and universities is essential to grow the ecosystem of contributors and implementers. In particular, helping firms of all sizes understand DPGs-for-DPI, identify market opportunities, and pitch their DPG-based services could be helpful.



More reference implementations will help build the credibility for DPGs-for-DPI. Only a few DPGs (DHIS2 is one exception) have a large number of implementations with long track records. Defraying the costs and reducing the risks for first movers could help blaze the path for others.



Intentional contribution of code to DPGs by governments, vendors, and others is critical. We can celebrate the commitment of governments such as Sri Lanka, Sierra Leone, and Estonia in sharing as they build out their own systems—and call for others to join them. One constructive proposal is for every government to have open-source strategies specifying how they plan to use and contribute to DPGs, and what they plan to ask of vendors in terms of code contributions.



Coordination of the landscape is crucial given the collaborative and distributed nature of DPGs. The Digital Public Goods Alliance offers a framework for this through a model of core, coordinated, and aligned activities, inspired by open source communities.

3.
Safeguards for inclusion, trust, competition, security, and privacy

DPI, nonetheless, raises significant risks. If DPI systems don't meet the needs of the vulnerable and marginalized, they will only reinforce inequality and exclusion. If they are used for corrupt, extractive, or authoritarian purposes, they can become ways of surveilling people, of denying them access to basic activities and services, or of extracting undue profit or competitive advantage.

All of this can happen intentionally, or simply out of inadequate attention. The preconditions are there. For example, we know that there is gender imbalance in mobile phone use and access to the internet in many parts of the world; intentional effort will be needed to help ensure the same pattern isn't reinforced in DPI.

At the same time, the answer to these risks can't be disengagement or obstruction. Analog systems and weak, subscale DPI systems usually allow more substantial problems of inequity, exclusion, rent extraction, and security risk. Not acting leaves these more familiar problems in place, while it also raises the possibility that demand for these tools will be filled without due attention to safeguards.

How we co-develop safeguards

There are steps that governments, businesses, funders, international organizations, and others can take—and are already working on. Joining forces can help. These include:

→ Adopt and operationalize a normative framework of "good DPI"

Building and using DPI is the work of many different institutions and people. They should all have clear expectations about what "good DPI" looks like, how to assess it, and what safeguards can be placed in and around systems. Communities that have been building identity, payments, and data exchanges have conducted value-setting exercises for their layers that provide a basis for creating complementary expectations across the stack. The following "Good DPI" example builds on these to capture one vision for what good DPI should be. However, statements of intent will still need to be converted into real-world measures and action.

→ Start with good design and technology choices

For example, limiting data collection and using tokens, encryption, and on-device computing to limit data exposure can help protect rights and privacy. Exhaustively testing that technologies and interfaces work for every user in the social and physical context can promote inclusion. Using open, well-tested code can promote transparency and security. Portals that allow users to see and control who has access to their data and how it is being used can help prevent abuse.

→ Build up institutions and processes

Most of the factors that promote good DPI aren't technical; they are processes and institutions. These include redressal mechanisms and alternatives for when systems fail; marketing, outreach, community consultation, and inclusive design processes to ensure everyone is served; and transparency and outside advocacy to hold systems accountable. So, too, are general data protection rules and institutions to administer them. Institutional capacity isn't just government; the media and civil society need support in deeply analyzing the implications of DPI and changing it for the better.

→ Promote good use of DPI

Crucially, field research shows that many of the decisions that shape the impact of DPI on inclusion and other factors are external to the systems themselves. No one should be denied healthcare, schooling, social protection, or other essentials because a system (digital or otherwise) didn't work, they didn't have an opportunity to enroll, or because they choose not to use it. These are questions of policy and program design—both the benefits, and risks, of using the DPI system need to be planned for. Denial of services should never be used to promote uptake of digital systems. Even where DPI operators can't directly control such decisions, they have a responsibility to set the right expectations and guidance.

→ Experiment and learn from other fields

As with other areas where technology is having major impacts on societies, we don't yet have a full toolbox of safeguards, and DPI invokes complicated questions of national sovereignty and balances between public and private interests. Ideas drawn from other fields like bioethics—such as an institutional review board for DPI systems—will be worth testing.[18] Exercises to understand risks to security and rights will also help.

→ Imagine the worst case scenarios, but be realistic

The most likely problems aren't the stuff of dystopian science fiction, but ones we've already seen. These include a government denying payments to opposition-linked organizations or using the implication of surveillance to intimidate voters, or a payments system operator quietly using the data passing through a DPI system to gain an edge over competitors in other business lines.[19]

"Good" DPI

Norms such as the following are crucial to making DPI not only useful, but supportive of innovation, human rights, and democratic societies:

→ Commonality and interoperability
As more people use a function to interact with each other, the possibility for collaboration and commerce grows. Integration and interoperability are thus key to realizing the potential of DPI, whether that integration occurs across borders, sectors, or organizations.

→ Openness
DPI creates unexpected value when it allows a variety of uses and users to work together, enabling new innovations and markets to be built upon them.

→ Inclusion and equity
Being usable by all without regard to socioeconomic status, disability, or other barriers promotes commonality and makes DPI an engine for equality and an escape from poverty.

→ Integrity and security
As a system that is trusted and promotes trust, DPI reduces the friction and cost of doing business.

→ Sustainability and iteration
DPI must not just be maintained, but also adapted and extended to better meet the needs of users and societies and to respond to new innovations and challenges.

→ Competition and public agency
Like other types of infrastructure, agency over DPI systems confers power and creates the risk of monopoly; no single for-profit or foreign entity should have formal or de facto structural agency over DPI without appropriate checks.

→ Transparency, accountability, and redress
The essential nature of DPI functions raises the stakes for people, communities, and businesses; we all need to know how DPI functions and have reasonable alternatives and the ability to correct problems.

→ Legitimate public and private use of data
The data passing through DPI as aggregate is an important public resource for policy, research, and innovation; public value use should be promoted while protecting privacy. Similarly, individuals and companies need to be able to access, use, and share the data that concerns them.

→ Protection of rights and privacy
Use of data passing through DPIs must be actively protected from extralegal and abusive use to ensure that systems do not become instruments of surveillance.

4.
Tools for using data in DPI for public value and private empowerment

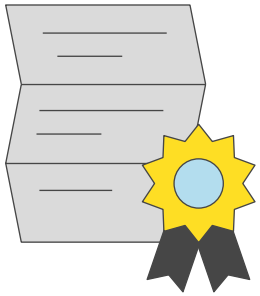
DPI systems process and sometimes store large amounts of data about users and their activity in real-time. As we note above, this can pose risks, but it also has enormous potential value for both users and society, strengthening the case for investments in DPI.

This value is most obvious for DPI systems like a health data exchange, whose core functions might include helping ensure continuity of care for a single patient and analyzing disease patterns across an entire population. However, the data passing through other DPI systems is also valuable. This value could be generated by an individual or business using "their" data. For example, a small business owner might send her record of transactions over a payments platform to a bank in order to qualify for a loan. In other cases, the value might be generated by analyzing patterns across data describing the activity of many users. For example, using the frequency of in-person payments in a particular area has assisted in studying compliance with stay-at-home orders and their economic impact.

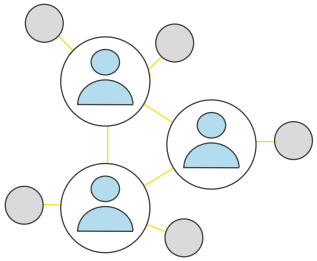
These private and public uses of data need to be balanced with an effort to protect users and data. There are ways of achieving both use and protection, but none are perfect.

How we co-develop tools for data use and empowerment

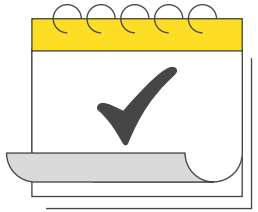
Balancing and resolving the apparent conflict between use and protection of data is an active area of experimentation that stretches far beyond DPI systems. Some promising practices and ideas are:



Promote standardization of data structures across countries and systems to make analysis and portability.

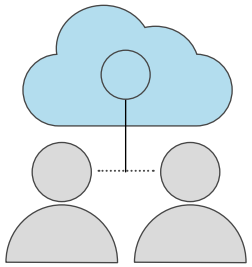


Invite stakeholders from research and policy communities into conversations about DPI design early on to understand their data needs and show them potential DPI applications.



Create rules and mechanisms for data portability, giving users the ability to grant consent for others to access data about them, to move it between services, and to download it. India's Digital Empowerment Architecture is a promising experiment in this.[20]

Invest in the development and use of privacy-preserving computing methods that allow insight to be generated from individual records while still limiting data exposure, such as federated learning.



Create institutional processes that can steward data by making decisions about who can access which data, for what purpose, and under what conditions.

5.
Private and public capacity, particularly in implementing countries

DPI requires a different set of capabilities from more traditional infrastructure: human-centered research and design, product development, social outreach and training, cross-sector planning, data governance and security, and never-ending iteration and improvement.

This is both a challenge and an opportunity for governments, academia, and businesses in every country. These capabilities can be rare and costly, but investing in them has the potential to spill over beyond DPI, energizing local tech sectors and making government more effective.

How we co-develop capacity

Governments, development agencies, and international organizations will all need to invest more in capacity and shift the types of capacity they prioritize. Crucially, "capacity" should be understood broadly, including policies and processes as well as skills and technical tools. Some specific ideas include:

→ Greater support for cross-functional, cross-agency capacity promotes a DPI mindset. For example, the creation of government digital service teams that provide expertise and coordination across silos leads to a horizontal approach to problem solving and the use of common tools.[21]

→ National digital strategies that specify the role of DPI and an approach to DPGs can help set overall vision, so long as they are specific, flexible, and realistic.

→ DHIS2 and its global community successfully proved the strategy that supporting implementation-oriented academic programs relevant to DPI and DPGs can serve as long-term generators and repositories of expertise.

→ Governments need people at every level who can take ownership of a vision for DPI and set direction, whether or not they rely on outside help for execution. Salaries are often a barrier, but changing other barriers—such as job titles, hiring requirements, and remote work or professional development policies—can also help.

→ Budget, procurement, and development assistance policies need to be modernized to encourage good practices in developing DPI and in using DPGs. For example, traditional risk-mitigation practices encourage rigid, detailed specifications up front. This works for highway construction, but cripples the fast, iterative process of modern digital product development. Alternative risk-management approaches—such as shorter project cycles—can both improve results and allow smaller local vendors to bid successfully.

→ Other models exist for helping governments and other DPI-implementing entities access talent from the private sector or peer governments. Secondments and short-term rotations are one; organizations such as iSPIRT or US Digital Response, which deploy well-qualified volunteers alongside their peers in government, are another proven method.[22]

→ Good data governance and data protection rules, both general and specific to DPI, are important, but must also be supported by institutions and processes that enforce and update them.

6.
Silo-busting, built-for-purpose coordination, funding, and financing

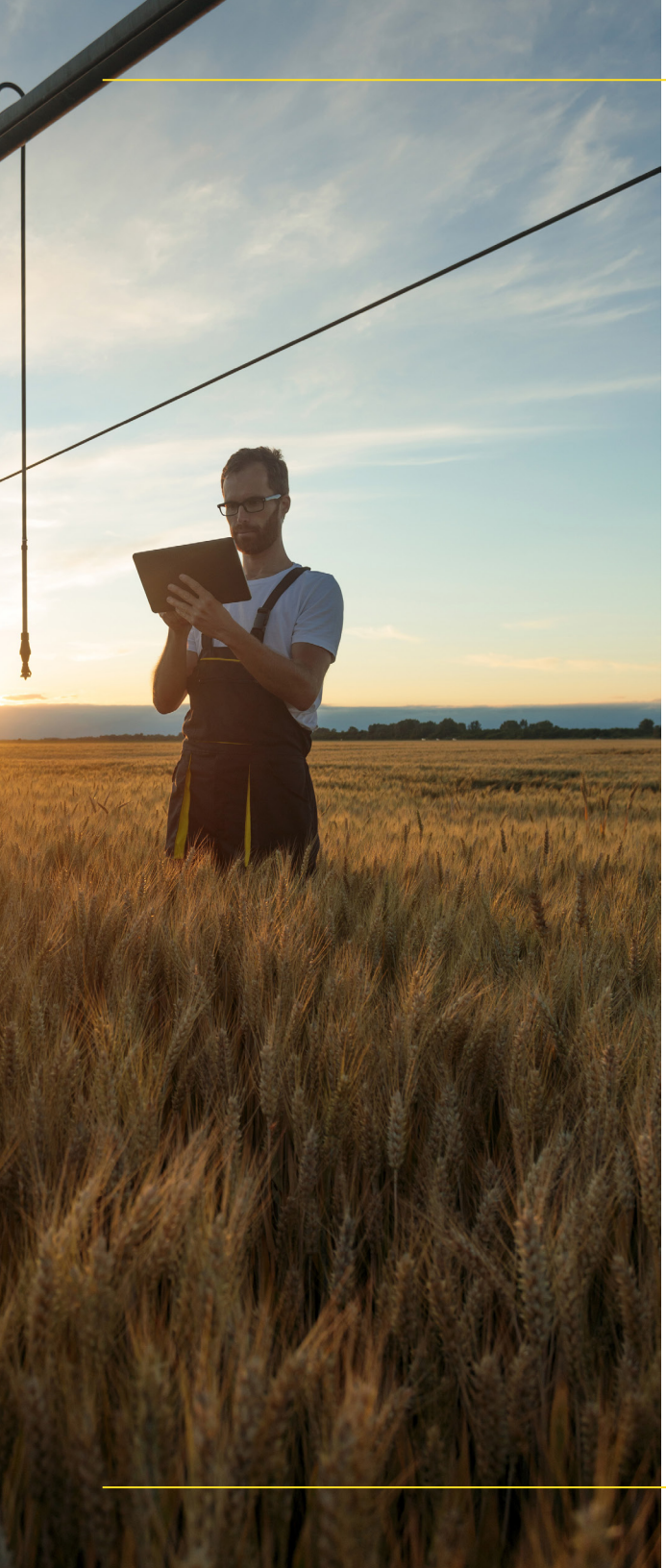
DPI poses a challenge for the governments, businesses, and development finance institutions charged with supporting its creation for the following reasons:

DPI has impacts that stretch across specific projects, organization, sectors, and problems, making it difficult to value, justify, and coordinate in institutions that are built around programmatic and project silos.

DPI needs to be continually developed over time, yet can still have substantial up-front costs delivering long-term returns, making it neither a capital or operating expense.

Many official institutions still treat digital systems as a novelty sitting outside of core programs or bury them as a lower-level priority within program silos.

Funding and procurement processes intended to reduce uncertainty can eliminate the fluidity that constitutes best practice in digital product development, as described above.



How we co-develop better coordination, funding, and financing

Resourcing is a critical part of the development cycle for DPI, and governments and development institutions can help by changing how they work and coordinate practice at both the domestic and international level.

→ Invest more in DPI by justifying its value across multiple programmatic objectives.

→ Create horizontal coordinating mechanisms and strategies that can help identify opportunities to invest in DPI rather than siloed funding for potentially duplicative, isolated systems (e.g., discrete systems for vaccinations and HIV could be replaced with a general health information management system with modules for each objective).

→ Increase investment in common tools (such as DPGs) that can be adapted to multiple contexts and roles, and encourage projects to take advantage of these whenever appropriate, rather than developing their own tools from scratch.

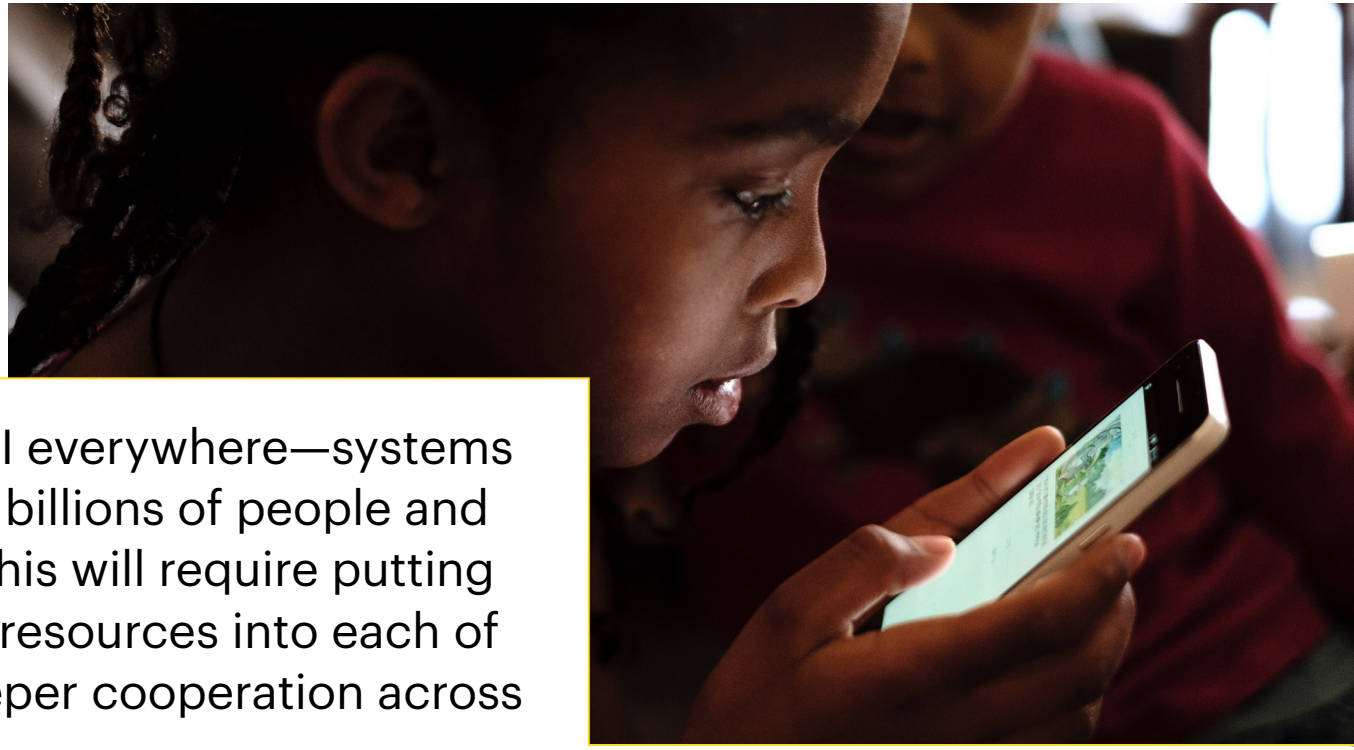
→ Individual governments can reach out to each other directly or via entities such as the Digital Public Goods Alliance (See Example 4) to find governments with similar needs to co-develop tools.

→ Reform procurement and funding policies to accommodate best practices in developing digital systems and a wider range of vendors.

→ Provide more longer-term support for DPI and DPGs-for-DPI to account for continual evolution and development, and to build confidence in their stability.

→ Consider pooled funding approaches meant to help with all of the above. The Bill & Melinda Gates Foundation commissioned early research that estimated a coordinated fund to accelerate progress on DPI for identification, payments, and health data exchanges might initially need $160–$340M annually, supplementing existing funding for DPI. This would have three streams: core DPG-for-DPI projects, technical assistance and capacity building, and support for the early stages of implementation in certain countries.[23]

Next Steps in Co-Development



We want to build strong DPI everywhere—systems that are capable of serving billions of people and meeting new challenges. This will require putting much greater thought and resources into each of these six elements and deeper cooperation across borders and across sectors.

Innovators around the world are already putting into place the elements of co-development: a vision, DPGs, safeguards, tools for data use, capacity, and coordination and funding. Their successes in building DPI and using it to tackle big problems show what the next steps look like. Co-development is already here; it's on us to make it happen everywhere.

EXAMPLE 1

Togo's NOVISSI Platform: Emergency Cash Transfers for the Most Vulnerable

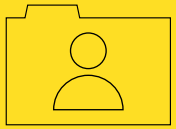
According to the World Bank, in 2020, about **62%** of the country's jobs were affected, nearly **22%** of the population needed some form of humanitarian assistance, and **23.8%** of children suffered from malnutrition.

As Covid-19 cases increased in Togo—a country where half the population lives under the international poverty line—years of poverty rate declines were threatened. For many, especially in the informal sector, such as manual laborers or seamstresses, Covid-19 restrictions and stay-at-home orders cut off their income overnight. People had less money to spend on food or to meet basic needs. According to the World Bank, in 2020, about 62% of the country's jobs were affected, nearly 22% of the population needed some form of humanitarian assistance, and 23.8% of children suffered from malnutrition.[24] The pandemic was on track to create not just a health and economic crisis, but a food security crisis as well.

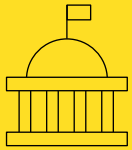
In response, the Government of Togo, led by its Ministry of Digital Economy, launched NOVISSI, a digital, emergency cash-transfer platform.[25] NOVISSI is a 100% digital, government-to-citizen/donor-to-beneficiary cash transfer platform that delivers emergency financial aid directly to recipients, sans intermediaries. Built by an in-house team within 10 days, the NOVISSI platform does not require beneficiaries to have an Internet connection to register for aid. Launched on April 8, 2020, NOVISSI provided monthly financial aid to the most vulnerable individuals and families throughout the duration of the health state of emergency, supplementing Togo's other cash-transfer programs.

NOVISSI drew on four critical elements:[26]

Utilization of mobile phone and mobile payments networks used by 82% and 62% of the adult population, respectively, as well as good relationships between network providers and the government.



A recently updated voter registry, indexing addresses and occupations of 93% of adults in the country.



A government digital services team that had worked on cash transfers, knew the relevant systems and data sources, and was already engaged in development of DPI systems in the nation.

Collaboration with academic and non-profit experts.

Beneficiaries were selected at first based on their addresses and occupation, and then later using a machine-learning technique that predicts consumption patterns based on geospatial, survey, and phone metadata for 5.7 million people, or 70% of the country's population. The entire process was contactless, allowing government officials to avoid in-person household registrations.

As of August 2021, the effort—expanded to include a partnership between Give Directly; the Center for Effective Global Action (CEGA) at the University of California, Berkeley; Innovations for Poverty Action (IPA); and the Government of Togo—has paid 140,000 people over $10 million. The majority of payments went directly to women, who received larger payouts. Furthermore, other countries such as Nigeria, are now replicating this model to reach their vulnerable populations.

As inspiring as the Togo example is, it also shows how investment in DPI could improve inclusion further. Mobile payments and the country's voter-registration coverage falls short of 100%, especially for the most vulnerable. The algorithmic targeting of beneficiaries could be improved by better, more current data about the country's vulnerable people. Plans for a more robust digital identification system and a social protection data exchange, potentially built using DPGs, are on the agenda to ensure that Togo can mount an even stronger response to future challenges.

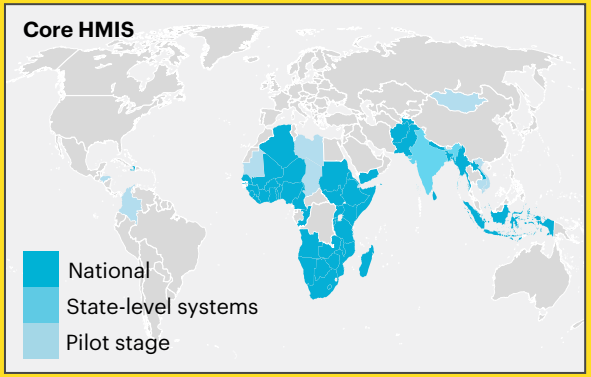
EXAMPLE 2

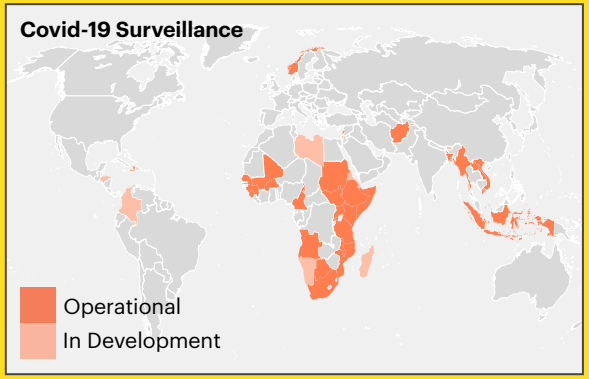
Digital Public Goods for Building DPI

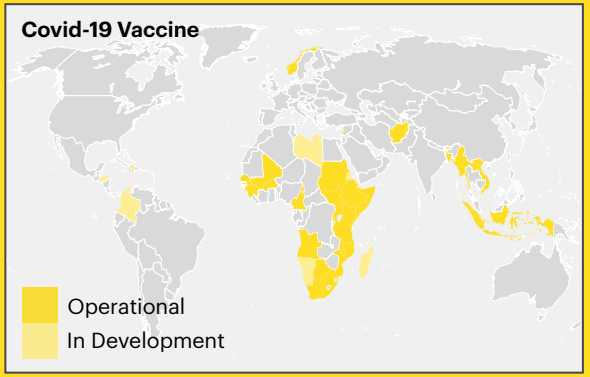
An array of well-supported DPGs-for-DPI can be used as the basis for implementing systems carrying out functions such as identity, payments, and data exchanges. Here are three examples.

DHIS2 IMPLEMENTATIONS: CORE AND COVID-19 MODULES

*Source: dhis2.org







DHIS2—The world's largest health management information system

District Health Information Software 2 (DHIS2), is an open source software project that was first created to address gaps in health data collection, access, and use at the local level. From its roots in post-Apartheid South Africa, DHIS2 has become the largest Health Management Information System (HMIS) platform. DHIS2's core HMIS functionality is used by ministries of health in 73 low- and middle-income countries representing 30% of global population, as well as the World Health Organization (WHO) and NGOs such as Doctors Without Borders.[27] Each of these has implemented DHIS2 as DPI, facilitating public service delivery in the areas of health, nutrition, sanitation, and education.

Despite this scale, the software is flexible to local and emergent needs, knowledge, and expertise. DHIS2 users and collaborators, backed by an officially supported expert network and affiliated academic programs, continually develop standards-based packages to extend DHIS2's functionality that other users can rapidly deploy or customize to meet local needs. Functionality has continually evolved—for example, tools for inputting, managing, and analyzing individual patient records are a relatively recent addition to DHIS2. Notably, six countries have extended DHIS2 for use in education data management, showing the potential range of a DPG for data exchange.[28]

Covid-19 showed the advantages of this adaptability. The DHIS2 community quickly developed and released packages to accelerate case detection, strengthen surveillance and response, and to monitor and support vaccine delivery, which were then implemented around the world.

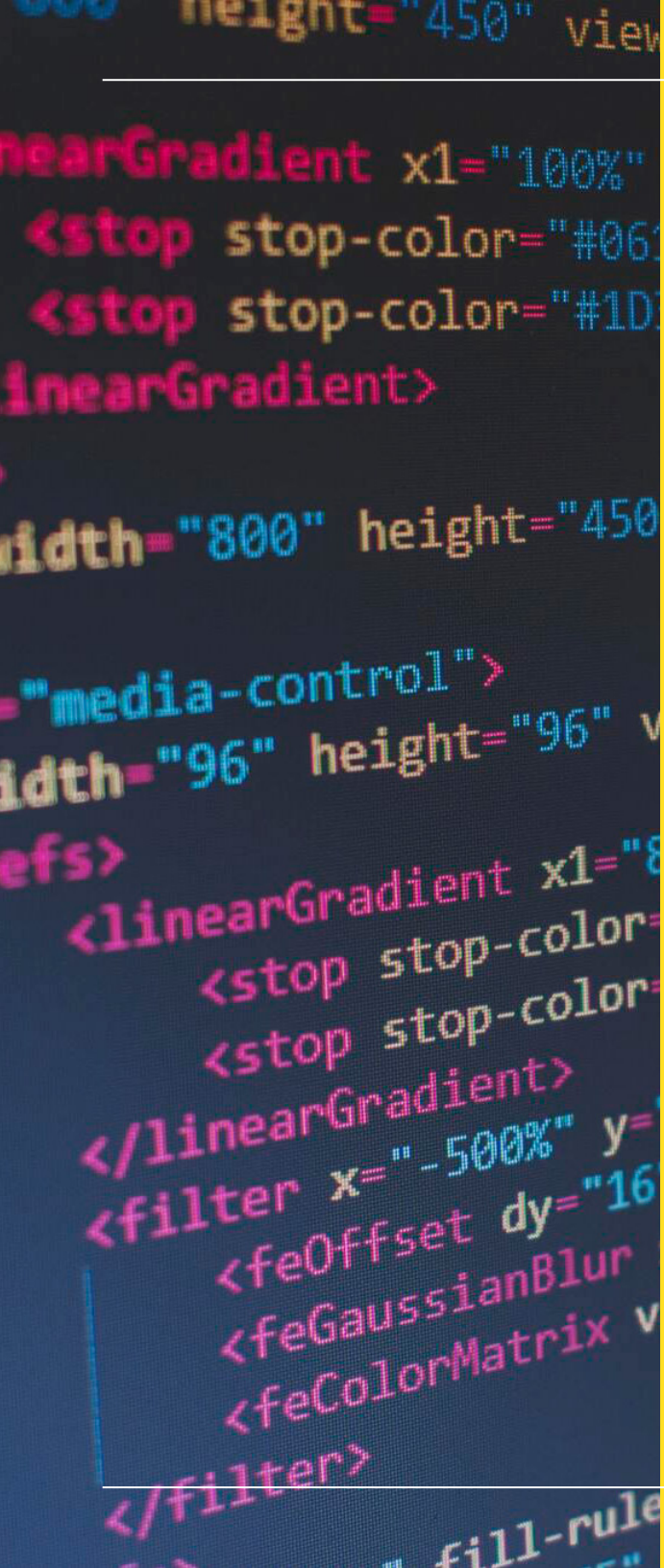
The first DHIS2 Covid-19 surveillance package was inspired by the Sri Lankan Ministry of Health's pioneering design of a DHIS2 tracker.[29] This design drew on years of collaboration with the WHO on designing standardized packages for key health programs, including disease surveillance. Within just a few months of the start of the coronavirus pandemic, more than 30 countries had deployed DHIS2 for Covid-19 surveillance.[30] Another example is Rwanda, which deployed a paperless Covid-19 testing process powered by the DHIS2 Android app on mobile tablets and smartphones, and an electronic vaccination registry complete with digital vaccine certificates.[31] As of mid-2021, 41 countries are actively using these packages and 13 are in pilot.

Laos, which was among the first countries to deploy DHIS2 for Covid-19 response, was an early adopter of DHIS2 for Covid vaccine delivery. In Laos, the standard DHIS2 metadata packages were customized in-country to support national prioritization plans and reflect local workflows, and were enhanced by locally-developed custom apps. This included a web portal built on top of DHIS2 that allows users to register for vaccine appointments with a QR confirmation code linked to their patient record, which has helped reduce vaccine center data entry time per patient to 10 seconds or less, and an EU Digital Covid Certificate solution verification of vaccination status.[32]

Mojaloop—Payments systems for inclusion

Mojaloop is open source software whose purpose is to remove the barriers—including time, money, and technical complexity—that have hindered payment models from meeting the digital financial needs of the world's 1.7 billion unbanked people, while promoting interoperability, cost reduction, and local adaptation. Mojaloop isn't itself a financial product or user-facing application. Rather, it provides a blueprint and toolset that central banks, commercial banks, mobile operators, and others can use to themselves implement real-time, low-cost, high-transaction-volume, broadly interoperable, mobile-first payments platforms.

Systems based on Mojaloop will go into service shortly in Tanzania (operated by The Bank of Tanzania) and in multiple



African countries via Mowali, a joint venture between telecoms Orange and MTN.[33] Other implementations are in design or piloting.

The project is managed by the Mojaloop Foundation, which was launched in early 2020. Its members include central banks, financial services, and technology companies such as Google, Coil, and Ripple, and philanthropies such as the Bill & Melinda Gates Foundation and The Rockefeller Foundation. The Mojaloop Foundation and its community also advances financial inclusion by shaping international standards and innovations—for example, through a research partnership with the Monetary Authority of Singapore on central bank digital currencies.[34]

MOSIP—"Good ID" at scale

MOSIP derives its name from "modular and open source/open standard identity platform." It provides the technical architecture for governments and other organizations to implement a foundational digital ID in a secure, flexible, cost-effective way. MOSIP was inspired and informed by India's Aadhaar digital identity, but has since grown in its own direction.

Crucially, MOSIP allows national identity systems to be context-specific and based on local laws and decisions. Like Aadhaar and many peer DPGs-for-DPI, MOSIP relies heavily on open standards and APIs (application programming interfaces) that allow different modules to be plugged in. This means that a MOSIP-based system can accommodate multiple types of authentications (including but not limited to biometrics). It also means that devices from multiple vendors or suppliers can be used within the same system. This gives operators a variety of options, future-proofs the system, and encourages competition in hardware provision, a major cost center.

MOSIP is managed by the International Institute for Information Technology Bangalore and is supported by a coalition of international partners and contributors. The project itself and advisory engagements are explicitly guided by principles of "good ID" to promote inclusion and protect users and their privacy.

The first code was released in early 2019, and MOSIP-based systems are being implemented in Morocco, the Phillipines, and Ethiopia so far, with others in piloting or development. In the next two years, the Philippines Statistics Authority expects to enroll 112 million Filipino citizens and 10 million Filipinos living overseas in their foundational ID system. After the pandemic subsides, they anticipate leveraging the system to transfer social benefits directly to the bank accounts of 18 million households.[35]

EXAMPLE 3

Estonia: Pioneer in both DPI and Co-Development

Estonia's remarkable digital transformation, centered around digital government, is by now widely known. At the heart of that transformation is X-Road, an open source software and ecosystem solution that provides unified and secure data exchange between organizations. It allows fully digital delivery of thousands of public and private services—legislation, voting, education, justice, healthcare, banking, taxes, policing, and more. It has also transformed the business of government in other ways. For example, macroeconomic estimates are informed by real-time information on new hiring and tax reporting, rather than lagged surveys and quarterly reports.[36]

However, some of the key elements of "E-Estonia" are arguably underappreciated and hold critical lessons for everyone building DPI.

→ Cutting-edge institutions and policies are arguably more important to Estonia's success than cutting-edge technology. For example, independent authorities, backed by legislation, are responsible for identity, data protection, and for maintaining, organizing, and setting collection and access rules for all Estonian government data and other databases connected to X-Road. Meanwhile, some elements of the system are not particularly high-tech in order to minimize risk and complexity; the digital identity system does not rely on biometrics, for example.

→ A simple set of guidelines, most of them enforced by law, make it easy to understand the system and its advantages. X-Road operates on the "one-time principle" that a person should be asked for any particular data point (say, an address) only a single time. This means a person applying for a loan needn't provide their address or income—rather, the bank uses their digital identity to directly query servers operated by the postal and tax authorities

→ A set of practical safeguards protect privacy and rights. Most queries on X-Road require a person's consent and all are limited to authorized users, purposes, and times. All requests for access of personal data are logged in an encrypted record and monitored for patterns of abuse. Individuals can go to their personal portal to see each request to

access data about them and have the right to an official explanation for any request. Nonetheless, there are credible critiques of a system that is so deeply embedded across society, pointing to the importance of ongoing activism by civil society, journalists, and independent watchdogs in even the best of cases.[37]

→ No system is invulnerable, making redundancy, transparency, and compartmentalization crucial. In 2017, the Estonian Government announced that academic researchers had identified an as-yet-unexploited security flaw in the identity cards provided to Estonia and other governments by an outside vendor, forcing a temporary shutdown in use of the cards and demonstrating the value of in-person service options and alternative digital ID verification methods—such as those based on mobile phones rather than the cards.[38]

Today, Estonia shares its tools and experience with others as a way to build together, support international development, and exert soft power disproportionate to its population of 1.3 million.

The X-Road system at the heart of the Estonian project was made open-source in 2015, and core development is now managed by the Nordic Institute for Interoperability Studies (NIIS), jointly supported by Estonia, Finland, and Iceland.[39] NIIS continues to refine X-Road—recently, examining its energy use to improve sustainability of government IT. Today, X-Road as a DPG is implemented in Finland, Iceland, Faroe Islands, Colombia, and Japan, among other countries.

The Estonian Government also operates an "e-residency" program giving non-resident foreigners the ability to operate virtually within Estonia and collaborates with the independent Estonian e-Governance Academy in training governments and their partners around the world. This includes advising implementations in Ukraine, Namibia, and elsewhere.

EXAMPLE 4

The Digital Public Goods Alliance

The Digital Public Goods Alliance (DPGA) was founded in 2019 by the Governments of Norway and Sierra Leone, iSPIRT, and UNICEF in response to recommendations made in the report, *The Age of Digital Interdependence*, by the United Nations Secretary-General's High-level Panel on Digital Cooperation.[40] It is a multi-stakeholder initiative with a mission to accelerate the attainment of the Sustainable Development Goals in low- and middle-income countries by facilitating the discovery, development, use of, and investment in DPGs.

The DPGA believes DPGs represent an unprecedented opportunity to enable countries to drive their own digital transformation, access cutting-edge features by default, and develop local ecosystems.

The DPGA maintains the DPG Standard, an open standard designed to be relevant for all digital public goods regardless of sector, and to cover minimum viable criteria. The DPG Standard is critical to ensuring DPGs do no harm and safeguard human rights. Once a digital solution is found to adhere to the Standard, it becomes searchable as a digital public good in the DPG Registry, a resource for those seeking to implement digital public goods.[41]

In 2021, the DPGA released a five-year strategy to align international leaders around digital public goods; encourage the adoption and use of the DPG Standard and Registry; engage expert groups in advancing high-impact DPGs; mobilize resources; enable and support country adoptions of DPGs; and strengthen country and regional capacity to build, implement, and manage DPGs.[42]

DPGA convenes expert communities of practice (CoPs) to support the discovery, assessment, and advancement of high-potential DPGs within a specific sector. In 2020 and early 2021, two CoPs in Health and Financial Inclusion produced reports highlighting DPGs for their potential to enable inclusive financial workflows at scale as DPI and immunization delivery management.[43]

Moving forward, the DPGA will continue to broaden this work, further identifying DPGs that are relevant for DPI implementation. The DPGA will also take an active role in coordinating and mobilizing resources that can help build out a more holistic support ecosystem around DPGs. The DPGA strongly believes in digital public goods as an enabler of co-development and a new model for international digital cooperation

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Acknowledgements

This report was written by Kevin O'Neil and Nicole Rasul of The Rockefeller Foundation, with substantial input and advice from Liv Maarte Nordhaug of the Digital Public Goods Alliance and the Norwegian Agency for Development Cooperation (Norad).

The thinking represented—especially on the definitions of DPI, characteristics of "Good DPI," and the co-development agenda—emerged in large part from a series of group conversations with CV Madhukar, Dan Radcliffe, Govind Shivkumar, Lucy Harris, David Roos, Merrick Schaefer, Rebecca Saxton-Fox, Max Schumann, Michelle Parker, and Allana Nelson, with conversation design support from Fred Dust, Bailey Foote, Rob Healey, and Sarah Geisenheimer. The report does not necessarily represent the views of any of these individuals or their employer.

Participants in "Room 9" of the 17 Rooms process in 2019, 2020, and 2021 also co-developed much of this thinking, including Sanjay Jain, Lucy Harris, Liv Nordhaug, and CV Madhukar who served as co-moderators of sessions focused on DPI in 2020 and 2021. For more on 17 Rooms, see https://www.brookings.edu/project/17-rooms/.

Zia Khan, Chuk Onike, Vyjayanti Desai, Anna Zita Metz, Georgina Marin, Jameson Voisin, Sarah Watson, Priya Vora, Kay McGowan, and Johnathan Dolan improved the text through helpful insights or comments.

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