

AN OPEN TECH STRATEGY FOR INDIA - A WORKING DRAFT

A strategy for India to achieve strategic autonomy, economic growth, technology leadership, and skill development using open-source technologies.

*Takshashila Report
Version 1.1
December 20, 2022*

*Apar Gupta
Arjun Gargeyas
Bharath Reddy
Kailash Nadh
Nitin Pai
Pranay Kotasthane
Rushubh Mehta
Saurabh Chandra
Venkatesh Hariharan*



This is a working draft that we would like people to contribute to. In the spirit of open source, we invite contributors to build on and add to the ideas in this document. If you have any feedback or would like to contribute to any of the sections in this document, please get in touch with us with your comments at research@takshashila.org.in.

EXECUTIVE SUMMARY



"Open Tech" refers to technology that is transparent, inclusive and embodies the freedom to use, study, modify and redistribute to the maximum extent possible.

The definitions of open-source software, open standards, and open-source hardware are well understood. "Open Tech" is used as an umbrella term that includes all of these technology areas.

Open Tech can help India achieve techno-strategic autonomy, economic growth, technology leadership, and skill development. Transparency and inclusivity also help foster trust, broaden access to technology and further democratic values.

We recommend a range of policy initiatives for software, hardware and standards that will nurture a sustainable Open Tech ecosystem.

Software

- Adopt an open-source first policy in government procurement
- Establish an open source programme office to coordinate policies, use and contribution of open source software (OSS) across government bodies
- Inculcate OSS skills in the education curriculum
- Fund existing open-source projects of interest to the government and public
- Nurture a sustainable OSS community
- Mandate acknowledgement of OSS Use

Hardware

- Co-create robust open-source hardware products with like-minded partners
- Award grants for open-source electronic design automation (EDA) tools
- Open-Source the process design kit (PDK) of government research fabs

Standards

- Promote the adoption of open standards
- Participate actively in standards development organisations (SDOs)
- Facilitate the development of open standards



THE OPEN TECH STRATEGY IMPERATIVE

Technology is crucial for India's development in the Information Age. It is also an essential element of national power.

The acquisition of advanced technologies is not an end, but a means to bring peace and prosperity to all Indian citizens. Unhindered access to state-of-the-art technology and foundational knowledge is, therefore, in India's national interest.

External Affairs Minister S Jaishankar echoed this sentiment when he said India "cannot be agnostic about technology" as there is "a strong political connotation in-built into technology". [1].

As India takes on the G20 presidency, a focus on Open Tech is indispensable. Whether building population-scale digital public infrastructure or leveraging technology to overcome developmental challenges, embracing Open Tech has several advantages.

The transparency and inclusivity inherent to Open Tech will help disseminate these technologies more widely and help India achieve technology leadership. Given the uncertain economic and geopolitical climate, Open Tech also helps achieve strategic autonomy and economic growth.

Open standards and open source software are invisible critical digital infrastructure powering almost all software we use today. However, most OSS projects are maintained by small communities of developers without adequate funding. As the open hardware movement gathers momentum, it will face similar challenges OSS faces. A sustainable Open Tech ecosystem that provides regular maintenance and bug fixes and addresses security risks is crucial to keep this infrastructure robust and reliable.



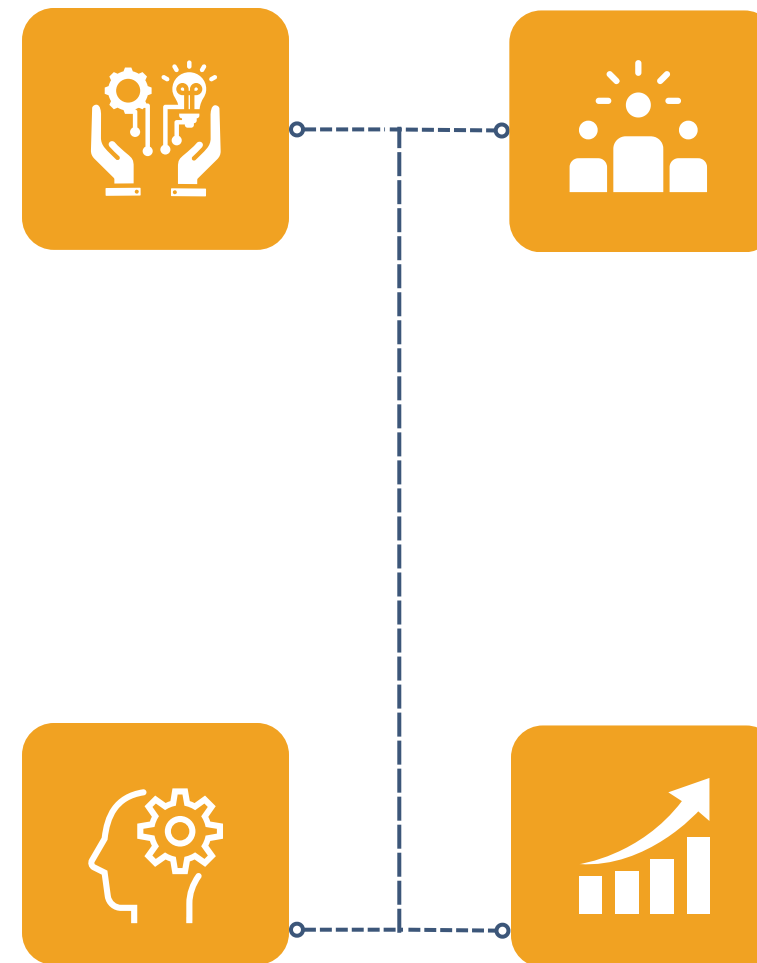
OPEN TECH CAN HELP INDIA IN FOUR WAYS

Techno-strategic Autonomy

- securing India's national security interests by providing unfettered access to secure, reliable and transparent technologies
- enabling a diversified supply chain resilient to geopolitical risks
- serving as critical digital infrastructure which allows further innovation

Skill Development

- leveraging India's strength in human resources in technology to build capability and capacity while collaborating with the world.



Technology Leadership

- attaining technological leadership in areas that are important to India's long-term strategic interests and leveraging it to bring peace and prosperity to its citizens
- serving as an instrument of soft power for India

Economic Growth

- encouraging competition by reducing entry barriers
- reducing costs through the reuse of components
- avoiding technology/vendor lock-in while increasing self-sufficiency and freedoms
- promoting interoperability

Given the importance of Open Tech, it is essential to have a far-reaching policy framework to nurture a contribution culture and create incentives for a sustainable Open Tech ecosystem. The rest of this document describes the current state of affairs and recommendations for each of the three verticals - software, hardware and standards.



Consumption vs Contribution

Indian software developers have a significant presence on GitHub, but contributions originating from India are minuscule. There is a massive disparity between consumption and contribution.

Contribution Culture

India's transformation from an IT services and outsourcing destination to a hub of cutting-edge software innovation has been a leap within a short span of time. A contribution culture around OSS at the grass root level needs to be nurtured.

Strain on Developers

A recent study shows that 97% of commercial software contains OSS[2]. This increased reliance on OSS puts additional strain on the communities of developers who maintain the code.

Overview of Existing Policies

The Digital India Programme of 2014 states that the Government of India shall endeavour to adopt OSS in e-governance systems and that OSS should be mandatorily considered as one of the options. The Framework For Adoption of Open Source Software In e-Governance Systems, 2015 details how government departments can adopt and develop OSS. There are many other disparate efforts at developing and promoting OSS.[3]

Among states, Kerala has some of the most well-documented and comprehensive OSS policies. The State IT policy 2017 mandates OSS for all software solutions purchased through public funding. The State IT Strategy, 2007, includes using open standards, formats and architectures in e-governance projects. Other initiatives include using OSS technologies in schools and establishing the International Center for Free and Open Source Software (ICFOSS), which coordinates and advocates the use and contribution of OSS.

Free and open-source software (FOSS) is software that is free to use, copy, study, change and redistribute. The software section of this document shall focus on FOSS. It includes both "free software" and "open-source software"(OSS), which differ in their origins and values but have substantial overlap. This document uses FOSS and OSS interchangeably.

RECOMMENDATIONS



Adopt Open-Source First Policy in Government Procurement

Union and state government IT procurement policies should mandate that all software purchased through tax-payer funding be open-source. Proprietary and closed technologies should be considered only where adequate OSS technologies are not an option.

The government being a significant purchaser of technology and IT services, such a mandate can go a long way in creating the right incentives for the entire OSS ecosystem. Current union government policies [3] favour the adoption of OSS but do not mandate it.

An open-source first policy mandate will have several positive spillover effects, such as:

- Incentivising large corporations to focus on OSS. This also accelerates local technical skill development.
- levelling the playing field and widening the market significantly by allowing new enterprises to rapidly use high-quality OSS to provide services to the government and participate in the market
- Forcing the market to compete not just in terms of cost but the quality of technology
- Avoiding lock-in and licensing fees which can bring massive cost savings to governments
- Helping achieve strategic autonomy and self-sufficiency in technology



Establish an Open Source Programme Office

To overcome the challenges of disparate OSS adoption and development efforts, an open-source Programme Office (OSPO) must be established as a statutory organisation under MeitY.

The focus of the OSPO should be coordinating policies, use and contribution of OSS across government bodies. It will also advocate for and promote OSS both nationally and globally.

OSPO should also push for project standards such as documentation, roadmap, code style and contribution guidelines for government-funded OSS projects.



Inculcate OSS Skills in Education Curriculum

The technical curriculum in undergraduate and postgraduate engineering programmes should be revamped to incorporate skills and practices in demand in the industry.

Hands-on involvement in contributing to OSS can aid students to enter industries better prepared or chart them on a course to start their own technology enterprises.



Fund Existing Open Source Projects

Instead of reinventing the wheel, the government could identify and fund existing open-source communities through grants issued by the proposed OSPO. These grants could focus on OSS projects (either domestic or international) that are of broad interest to the Indian government and the public.

As Frank Nagle recommends[4], this could also include funding security support for widely used OSS projects. The tangible and intangible benefits would far outweigh the investments incurred.



Nurture a Sustainable OSS Community

At the heart of OSS is a contribution culture that nurtures these assets, not just consumes them. A balanced community must have both creators and users.

Such a community has to have a symbiotic relationship between the government, academia, private sector and non-profits. The proposed OSPO should help nurture and coordinate the efforts of such communities.



Mandate Acknowledgement of OSS Use

As Frank Nagle recommends[4], mandating a software bill of materials (SBOM) that lists all OSS components of software will help to identify supply chain risks if these components were to become unmaintained. It also ensures that OSS projects get the acknowledgement and support they deserve.

These mandates should be for the government and private sector software purchases and can be managed through the Ministry of Electronics and Information Technology.



Like its software counterpart, Free and Open Source Hardware (FOSH) is growing fast, albeit from a lower base. Estimates suggest that FOSH today is where OSS was 15 years ago [5].

Research suggests that low-cost open-source 3D printers can reduce costs for mass-manufactured consumer goods, on average, by 90% [5]

Telephones, Computers, and Integrated Circuits (ICs) are India's top imports after energy, gold, and diamond. In 2020, 64% of telephones, 68% of computers, and 64% of ICs by value came from China and Hong Kong. Fostering OSH, then, is an approach to reduce dependence on a strategic adversary.

While OSH can help tackle the dependence on phones and computers, this section only focuses on open-sourcing the production of a critical component that goes in all of them – ICs or chips.

Open Source Hardware (OSH) refers to physical objects whose schematics, design parameters, etc. have been made public in a way that enables someone else to recreate the object.



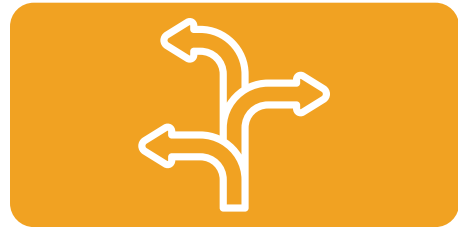
INDIA'S NEED FOR OPEN-SOURCE CHIPS



Besides the dependence on China, the imperative for strategic autonomy in the chips originates from the nature of the supply chain itself. This supply chain has two or three companies dominating each segment, resulting in a situation where countries can cut off others' access through controls or "contaminate" the entire supply chain through hardware espionage.

Open-source Hardware allows companies to adopt designs and begin manufacturing their own derivative products, significantly reducing the costs of manufacturing [6]

"The [semiconductor supply chain] structure is best thought of as a transcontinental relay race with hidden hurdles"
— Willy Shih, Professor, Harvard Business School



PATHWAYS TO OPEN-SOURCING CHIPS



Open-sourcing the software used for making hardware

The licensing costs of Electronic Design Automation (EDA) tools used to make ICs are prohibitively high for start-ups. DARPA projects such as OpenROAD aim to build no-human-in-loop layout design tools with permissive licensing to reduce chip design costs for trailing-edge node chips dramatically.

A vibrant ecosystem of open-source EDA tools will help many more Indian hardware start-ups build intellectual property that is Indian.

Open-sourcing key hardware blocks

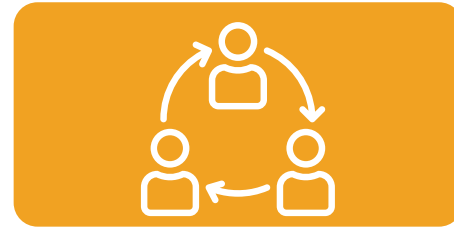
Open-source IP blocks, instruction-set architectures (ISA), cell libraries, and analog blocks can supercharge hardware innovation by cutting licensing costs.

Just one company, Arm, powers 90 per cent of mobile phone application processors and 34 per cent of the entire market of chips with processors. Developing open-source alternatives to ISAs can bring more competition in Systems-on-Chip (SoCs).

Open-sourcing foundry Process Design Kit

Process Design Kits (PDKs) are a set of files that a foundry provides to describe the necessary physical and electrical parameters of basic building blocks. Making these files open-access can improve the performance of open-source EDA tools, thereby reducing design costs.

RECOMMENDATIONS



Co-create robust open-source hardware products with like-minded partners

Open-source Hardware need not always be Indian. Collaborations with like-minded partners will address the strategic imperatives for OSH more effectively. Outputs generated by global open-source projects such as RISC-V will benefit everyone, including India.

OSH should be a vital pillar of the India-EU Trade and Technology Council, as the EU also identifies OSH as a way to attain strategic autonomy in technology.



Award grants for Open Source EDA Tools

Award grants for creating the next generation of open-source EDA tools. Identify crucial toolchains required for chips used in critical applications and fund research to develop open-source alternatives.

Open-source EDA tools can also be brought under the Design Linked Incentive (DLI) Scheme proposed by the government in December 2021.



Open-Source the PDK of Government Research Fabs

Make Semiconductor Lab (SCL) Chandigarh's PDK for CMOS 180nm open access. SCL should enable Indian companies to fabricate prototypes of their designs cost-effectively.

DARPA funded the Metal Oxide Silicon Implementation Service (MOSIS), which allowed US fabless start-ups to produce chips quickly. India, too, must enlist government research fabs in this project through a MOSIS equivalent fabrication service.



Open standards bring in interoperability, efficiency, competition, choice, ease of access, cost savings, and a level playing field. The government must ensure that the standards adopted are fair and transparent, as civil society is underrepresented in the standardisation process.

Most of the standards that govern the internet and other technologies are developed by Standards Development Organisations (SDOs). Large private tech companies and government agencies wield significant influence over these bodies, which lack representation from non-western countries [14].

India-specific requirements, which could be unique to the demography and economic conditions of the subcontinent, must be represented at these fora so we are not at a disadvantage.

Overview of Existing Policies

- The Policy on Open Standards for e-Governance, 2010, sets a set of guidelines for identifying open standards. It has been praised for taking the stand that identified standards should be made available on a royalty-free basis for the lifetime of the standard.
- The Technical Standards for Interoperability Framework for E-Governance in India, 2012, follows this up with recommendations on the standards to be used for different applications in different domains.

Open standards give users permission to study, copy, use and distribute the technology. It is developed and maintained openly with a complete implementation accessible to all.

RECOMMENDATIONS



Promote the Adoption of Open Standards

The government has to take up the responsibility of being the forerunner in adopting and promoting open-standards-compliant technology.

The Policy on Open Standards for e-Governance, 2010, is a laudable initiative. It mandates that GoI shall adopt uniform and royalty-free open standards for a specific purpose within a domain. Given the scale and scope of Indian e-governance applications in India, this will have positive network effects for the standards selected.

Efforts by the RBI and SEBI in mandating the adoption of open standards by banks and stock brokers have brought significant efficiency gains and should be emulated.

For digital public infrastructure platforms, the government should ideally play a role in defining open standards and protocols and leave the implementation to market players. This brings in a diversity of implementations that can compete and provide the best results for end users.



Participate Actively in SDOs

India's interests should be actively represented in all global SDOs.

To enable this, the government must invest in strengthening research capacity in areas of strategic interest such as internet standards, cyber security, and telecom.

Collaborations with stakeholders across government, academia, industries and non-governmental organisations can be leveraged to coordinate standardisation efforts.

The Centre for Internet and Society recommendations, citing the example of the debate around Transport Layer Security (TLS) 1.3 at the IETF, are noteworthy [8].



Facilitate Development of Open Standards

The Indian government should be a facilitator for creating open standards in select strategic domains such as telecom or cybersecurity.

For example, in telecom, a reliable and diversified supply chain resilient to geopolitical risks is crucial. Proprietary interfaces in the 4G and 5G protocol stacks favour tightly integrated systems from a single vendor. Open RAN (O-RAN) initiatives focus on standardising the proprietary interfaces and promoting vendor interoperability while disaggregating software and hardware dependencies.

Working with groups such as the QUAD, India should strengthen efforts to promote the adoption of open standards in such strategically important sectors.

ACRONYMS



DARPA - Defence Advanced Research Projects Agency

DLI - Design Linked Incentive

EDA - Electronic Design Automation

FOSH - Free and Open Source Hardware

FOSS - Free and Open Source Software

IC - Integrated Circuit

IETF - Internet Engineering Task Force

ISA - Instruction-Set Architectures SoCs - System on a Chip

MOSIS - Metal Oxide Silicon Implementation Service

O-RAN - Open Radio Access Network

OSH - Open Source Hardware

OSPO - Open Source Programme Office

OSS - Open Source Software

PDK - Process Development Kit

RBI - Reserve Bank of India

RISC - Reduced Instruction Set Computer

SBOM - Software Bill of Materials

SCL - Semiconductor Lab

SDO - Standard Development Organisation

SEBI - Securities and Exchange Board of India

TLS - Transport Layer Security

REFERENCES



- [1] PTI. "Technology No Longer Agnostic, Has Strong Political Connotation, Says S Jaishankar." The Economic Times, 29 Nov. 2022, <https://m.economictimes.com/news/india/technology-no-longer-agnostic-has-strong-political-connotation-says-s-jaishankar/articleshow/95851969.cms>.
- [2] Bals, Fred. "2022 OSSRA Discovers 88% of Organizations Still behind in Keeping Open Source Updated." Application Security Blog, Synopsys, 13 Apr. 2022, <https://www.synopsys.com/blogs/software-security/open-source-trends-ossra-report/>.
- [3] Gupta, Apar. "Analysis of Foss Government Policies in India." SSRN, 17 July 2022, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4146240.
- [4] Nagle, Frank. "Strengthening Digital Infrastructure: A Policy Agenda for Free and Open Source Software." Brookings, Brookings, 26 May 2022, <https://www.brookings.edu/research/strengthening-digital-infrastructure-a-policy-agenda-for-free-and-open-source-software/>.
- [5] Pearce, Joshua M. "Strategic Investment in Open Hardware for National Security." MDPI, Multidisciplinary Digital Publishing Institute, 18 Apr. 2022, <https://www.mdpi.com/2227-7080/10/2/53>.
- [6] "Why Open Source Hardware? ." Google Open Source, 4 Jan. 2022, <https://opensource.google/documentation/reference/why-hardware>.
- [7] Gupta, Harsh. "(Lack of) Representation of Non-Western World in Process of Creation of Web Standards." Centre for Internet & Society, 20 Oct. 2016, <https://cis-india.org/a2k/blogs/lack-of-representation-of-non-western-world-in-creation-of-web-standards>.
- [8] Rathi, Aayush, et al. "Regulating the Internet: The Government of India & Standards Development at the IETF." Centre for Internet & Society, 30 Nov. 2018, <https://cis-india.org/internet-governance/blog/regulating-the-internet-the-government-of-india-standards-development-at-the-ietf>.
- [9] "What Are Open Standards?" Opensource.com, <https://opensource.com/resources/what-are-open-standards>.
- [10] CivicDataLab. The State of Free and Open Source Software in India. CivicDataLab, <https://civicaldatlab.in/work/foss/stateoffoss/>.
- [11] Blind, Knut, et al. "Study about the Impact of Open Source Software and Hardware on Technological Independence, Competitiveness and Innovation in the EU Economy." Shaping Europe's Digital Future, 6 Sept. 2021, <https://digital-strategy.ec.europa.eu/en/library/study-about-impact-open-source-software-and-hardware-technological-independence-competitiveness-and>.



- [12] The Takshashila Institution. "Takshashila Doctrine Document - A Techno-Strategic Doctrine for India." The Takshashila Institution, The Takshashila Institution, 30 Aug. 2022, <https://takshashila.org.in/research/a-techno-strategic-doctrine-for-india#:~:text=India%20seeks%20a%20global%20environment,Constitution%20and%20the%20UN%20Charter>.
- [13] Mazzucato, Mariana. "Innovation Policy as Creating Markets, Not Only Fixing Them ..." ResearchGate, Aug. 2016, https://www.researchgate.net/publication/345722191_Innovation_Policy_as_Creating_Markets_Not_Only_Fixing_Them_Implications_for_Complexity_TheoryImplications_for_Complexity_Theory.
- [14] De, Rahul, et al. "Economic Impact of Free and Open Source Software Usage in ... - ICFOSS." International Centre For Free and Open Source Software, IIM Bangalore, June 2015, [https://icfoss.in/doc/ICFOSS_economic-impact-free\(v3\).pdf](https://icfoss.in/doc/ICFOSS_economic-impact-free(v3).pdf).
- [15] Nagle, Frank, and David A. Wheeler. "Report on the 2020 Foss Contributor Survey." Linux Foundation - Decentralized Innovation, Built with Trust, 10 Dec. 2020, <https://www.linuxfoundation.org/resources/publications/foss-contributor-survey-2020>.
- [16] Mozilla Corporation. "Open Source Archetypes: A Framework for Purposeful Open Source." Open Tech Strategies, Mozilla Corporation, Nov. 2019, <https://opentechstrategies.com/archetypes-files/open-source-archetypes-v2.pdf>.
- [17] Netcraft Ltd. "May 2022 Web Server Survey." Netcraft News, 30 May 2022, <https://news.netcraft.com/archives/2022/05/30/may-2022-web-server-survey.html>.
- [18] Express Computer. "Kerala Schools to Save Rs 3,000 Crore by Using Linux OS." Express Computer, 14 May 2019, <https://www.expresscomputer.in/news/kerala-schools-to-save-rs-3000-crore-by-using-linux-os/35871/>.
- [19] Forsgren, Nicole. "Empowering Healthy Communities." The 2020 State of the Octoverse, Github, 2020, <https://octoverse.github.com/2020/>.
- [20] Serrano, Javier. "Why (and How) Public Institutions Should Release More of Their Hardware Designs as Open-Source..." Medium, Medium, 1 June 2020, <https://medium.com/@j.serrano/oshw-in-public-institutions-7726d2ea92a8>.
- [21] Tripathy, Samparna, et al. "Takshashila Discussion SlideDoc - India's Semiconductor Ecosystem: A SWOT Analysis." The Takshashila Institution, The Takshashila Institution, 26 Sept. 2022, <https://takshashila.org.in/research/takshashila-discussion-slidedoc-indias-semiconductor-ecosystem-a-swot-analysis>.
- [22] Schuman, Michael. "Why Biden's Block on Chips to China Is a Big Deal." The Atlantic, Atlantic Media Company, 26 Oct. 2022, <https://www.theatlantic.com/international/archive/2022/10/biden-export-control-microchips-china/671848/>.



- [23] Hariharan, Venkatesh. "Open Standards Policy in India: A Long, but Successful Journey." Opensource.com, 19 Nov. 2010, <https://opensource.com/government/10/11/open-standards-policy-india-long-successful-journey>.
- [24] Eghbal, Nadia. Roads and Bridges: The Unseen Labor behind Our Digital Infrastructure. 2016, <https://www.fordfoundation.org/media/2976/roads-and-bridges-the-unseen-labor-behind-our-digital-infrastructure.pdf>.
- [25] Ministry of Communications and Information Technology . Technical Standards for Interoperability Framework for E-Governance in India. Government of India, May 2012, <http://egovstandards.gov.in/sites/default/files/2021-07/Policy%20on%20Open%20Application%20Programming%20Interfaces%20%28APIs%29%20for%20Government%20of%20India.pdf>.
- [26] Ministry of Communications & Information Technology. "Policy on Open Standards for e-Governance ." Government of India, Nov. 2010, <http://egovstandards.gov.in/sites/default/files/2021-07/Policy%20on%20Open%20Application%20Programming%20Interfaces%20%28APIs%29%20for%20Government%20of%20India.pdf>.
- [27] Ministry of Communication & Information Technology. "Policy on Adoption of Open Source Software for Government of India." Government of India, 2014, <http://egovstandards.gov.in/sites/default/files/2021-07/Procedure%20For%20Change%20Management%20and%20Release%20of%20e-Governance%20Standards%20Ver1.0.pdf>.



This is a working draft that we would like people to contribute to. In the spirit of open source, we invite contributors to build on and add to the ideas in this document. If you have any feedback or would like to contribute to any of the sections in this document, please get in touch with us with your comments at research@takshashila.org.in.