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
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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 contact us at research@takshashila.org.in or raise it on the GitHub repository (github.com/TakshashilaInst/open-tech-strategy-for-india.git)

EXECUTIVE SUMMARY

Open-source technologies 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-source technology ecosystem.

Software

- Adopt Open Standards, Open Protocols and Networks and Open Ecosystems
- 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

Software

- Fund existing open-source projects of interest to the government and public
- 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
- Implement a durability index for electrical and electronic products

Standards

- Promote the adoption of open standards and protocols
- 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.

Given the uncertain economic and geopolitical climate, Open source also helps achieve strategic autonomy and economic growth. 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 source technologies is indispensable. Whether building population-scale digital public infrastructure or leveraging technology to overcome developmental challenges, embracing open source has several advantages.

The transparency and inclusivity inherent to open-source technologies will help disseminate these technologies more widely and help India achieve technology leadership. This is especially important in the context of digital public infrastructure, which is redefining the nature of interactions between the citizen and the state.

Open standards, protocols and open source software are invisible critical digital infrastructure powering almost all software we use today. Small communities of developers maintain most OSS projects, and funding is typically inadequate. As the open hardware movement gathers momentum, it will face similar challenges. A sustainable open-source ecosystem that addresses maintenance, bug fixes and security risks is crucial to keep this infrastructure robust and reliable.

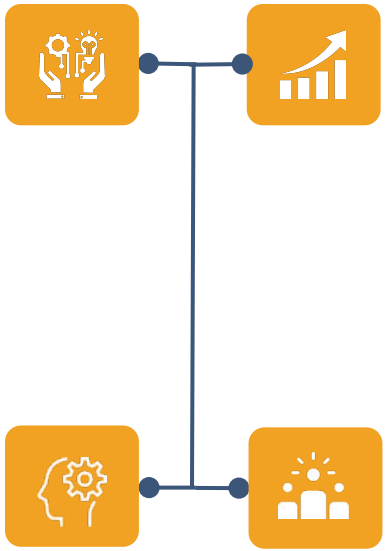
OPEN SOURCE TECHNOLOGIES CAN HELP INDIA IN FOUR WAYS

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

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



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

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

CURRENT STATE OF AFFAIRS

Unprecedented Reliance on OSS

A recent study shows that 97% of commercial software contains OSS[2]. This unprecedented reliance on OSS is a strain on the communities of developers who maintain the code due to which they might not be provide adequate support.

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.

Rise of Cloud Based Services

The rise of platforms and the increasing adoption of cloud-based software services render the conventional OSS adoption models insufficient. These services are convenient to use and manage but come at the cost of the freedoms and ownership associated with OSS. Users get tied down to the platforms, and their data is locked in silos. Open ecosystems built with open standards and protocols can alleviate these concerns.

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.

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.

CURRENT STATE OF AFFAIRS

Digital Public Infrastructure

Digital public infrastructure (DPI), such as identity or payment systems, has immense potential to improve government service delivery and boost economic output.

This infrastructure needs to go beyond just using open-source components, as transparency helps build trust in the platforms and makes them more secure. They needs to be built as open ecosystems using OSS, open standards and protocols.

From a governance perspective, the centralised nature of these platforms poses several risks.

- The centralised infrastructure is a significant cybersecurity risk.
- There is often no competition to these public infrastructure platforms, which could lead to a lack of innovation and technology becoming obsolete.
- Entry barriers to participating on these platforms is detrimental to having a competitive market.

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.

RECOMMENDATIONS

Adopt Open Standards, Open Networks and Open Ecosystems

State-run digital infrastructure platforms should be based on open standards, open networks and open ecosystems. The following design principles should be adhered to:

- The platforms should be implemented using open-source software and adopt open standards and protocols for communication.
- They should be based on an open network without barriers to entry to encourage participation from multiple market players.
- They should be designed as open ecosystems allowing integration with other technologies, services and platforms.

Applying these principles to a tax filing system - the core database could be maintained as state run infrastructure with an open standards based interface for integrating with a third party developed user interface.

The market could then address user requirements such as support for multiple languages, tax-planning built into the filing software or simplifying the interface for certain categories of users. Overall, it results in a more robust system that allows for competition and innovation at the user-facing end.

These principles could be applied to DPI, such as identity or payment platforms and other digital infrastructure platforms, such as income tax filing or railway booking systems.

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. It should be staffed by OSS experts and practitioners, academics, and be headed by a bureaucrat with relevant experience.

The OSPO should be lightweight office with the primary responsibility of being a knowledge repository. The focus should be on coordinating policies, licenses, use and contribution of OSS across government bodies.

Inculcate OSS and Related Skills in Education Curriculum

The initiatives pioneered by Kerala Infrastructure and Technology for Education should be adopted nationally. This includes setting up infrastructure and broadband connectivity in schools, mandatory IT curriculum, and use of OSS tools to improve learning outcomes.

The technical curriculum in undergraduate and postgraduate engineering programmes should be revamped to incorporate tools, 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 should identify and fund existing open-source communities through grants. The proposed OSPO can be tasked with identifying candidates for receiving such grants.

These grants should be recurring and fund OSS projects (either domestic or international) that are critical to government digital infrastructure. This model of funding has been adopted by corporations as well and has proved to be a viable model for maintaining open source projects.

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

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.

HARDWARE

CURRENT STATE OF AFFAIRS

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.

Implement a Durability Index for Electrical and Electronic Products

The last recommendation is more general and applies to commonly used electrical and electronic equipment. The durability of these products is not known to customers who purchase them. To address the information asymmetry, a durability index needs to be implemented. Customers will then be able to make more informed decisions based on the durability and repairability of products.

The durability Index can be implemented similarly to the one proposed in France. Initially, it could be limited to a few categories of products - mobile phones, computers, washing machines, televisions and dishwashers. The manufacturer must rate the product's durability and repairability based on criteria such as documentation, disassembly, availability of spare parts, price of spare parts, and other product-specific aspects. The department of consumer affairs shall ensure that manufacturers comply with these regulations. This will ensure customers are better informed and benefit from the "option to repair".

CURRENT STATE OF AFFAIRS

Open standards and protocols 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 and Protocols

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.

As discussed in the recommendation under software, for state-run digital 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

DPI - Digital Public Infrastructure

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

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Feedback Received

Version	Contributor	Topic	Comments
1.1	Akshay S Dinesh	General: On the term "Open Tech"	Please do not create a vague umbrella term. Prepare 3 strategy documents if required. Or call it open source, open hardware, open standard strategy. By combining these into one ambiguous, term that's defined with "to the maximum extent possible" we're paving way for people to create confusion by mixing things up. I had suggested an alternative in the thread which is to call this "open-source, open standard, and open hardware strategy recommendations". At minimum avoid defining a new word. If you want to call three things with one word, define it as "the three things taken together". I'm specifically concerned about the new definition of a new umbrella which mischaracterizes the individual components.
1.1	Rahul Matthan	General: On the term "Open Tech"	The "open tech" definition is broad and inclusive and gives the freedom to include DPI in its scope. Given that DPI is a reality, our focus should be on how to make it work better. The report should focus on the art of the possible instead of idealism.
1.1	Rushubh Mehta	General: Purpose of the report	We should specifically refer to the eGovernance Policy of 2015 - Chapters 2-4 shared on the TG group. It is very comprehensive and covers a lot of what we are already proposing.
1.1	Rahul Matthan	General: On inclusion of DPI in the report	Digital public infrastructure (DPI) is an important technology development that must be addressed in the report. While DPI is built using open-source components, it does not qualify as open-source software. While there have been requests to make DPI open source, it is unlikely that it will happen for various reasons, such as: - Since the government maintains and hosts the infrastructure, it sees no reason or benefit from making it open source. A BHIM app might be made open source as it can serve as a reference implementation, but not the UPI framework. - A government-government sharing of the source might still be a possibility - The government machinery is not suited to maintain open-source code. This includes lacking technical capacity and a top-down bureaucracy's ability to deal with the maintenance of a code base.
1.1	Rushubh Mehta	Software Recommendations: Platforms and Cloud	My main problem with this document is that it does not cover any new ground. The way most of us consume state services is via software platforms. We should include a section on software platforms / cloud platforms with a recommendation that governments should be publishing only standards and maintaining registries, not running entire platforms. We should also make it clear that existing platforms like CoWIN and BHIM app are not open source and caution against using "open source" for these terms because it is incorrect.

Version	Contributor	Topic	Comments
1.1	Kailash Nadh	Software Recommendations: Platforms and Cloud	A serious gap that needs to be addressed is tech-on-cloud and cloud procurement. When significant amounts of tech deployments and procurement are moving to cloud services, the conventional model of FOSS adoption may be insufficient. What strategy or suggestions can address this?
1.1	Rahul Matthan	General	The tradeoffs involved in adopting open source could be articulated in more detail. Open source avoids the pitfalls of vendor/technology lock-in. However, it is sometimes fragile, as a small developer community maintains critical code.
1.1	Rahul Matthan	General	The report focuses only on the tech aspect. It should also consider the entire market and regulatory ecosystem, especially in the context of DPI. How to align the incentives of the different stakeholders and how it should be governed should be included.
1.1	Mihir Mahajan	General: Procurement	Restricting to open-source only can be problematic in spaces where Open Source is unavailable or lacks support and vibrant community. GoI shouldn't start using a project that may turn into a dead end. Hence, Open Source preferred (and a factor into evaluation along with quality, TCO, paid support guarantees, etc.) is a good approach.
1.1	Mihir Mahajan	General: Future Focus	Our research/product focus should to be build future Open Source tech - e.g., how to make Government of India cloud work purely with open source (reduces reliance on foreign, unreliable cloud players)? Building open source libraries for various India-specific purposes - language transliteration, machine translation (incl. speech to speech) for arbitrary Indian language pairs, OCR for Indian languages, and so on.
1.1	Mihir Mahajan	General: Patents	Open tech should embrace innovation and not worry about pre-existing IP rights.
1.1	Rushubh Mehta	General: Dissemination	An (full) editable version of this document should be make available for comments and editing
1.1	Nilesh TR	Open Hardware	In the open hardware section, I did not see any mention of the Right to Repair. I think this will be much more crucial because it goes beyond “computing” devices and would cover things like vehicles, mfg tools and a lot more.
1.1	Nilesh TR	Patents	Would also have liked to see recommendation on patent and copyrights law. Software and source code gets the unique privilege of being locked up under both of these, while still keeping the knowhow proprietary
1.1	Akshay S Dinesh	Software Recommendations: Procurement	“Adopt an open-source first policy in government procurement” Policy should build on previous policies. Refer to the previous open source policy here and say something like “Implement/extend the open-source policies for government procurement”
1.1	Akshay S Dinesh	Software Recommendations: OSPO	“Establish an open source programme office to coordinate policies, use and contribution of open source software (OSS) across government bodies” With ICFOSS, We have seen how this can be the most counterproductive thing to do. This recommendation, if being made, should be after a case study on ICFOSS and how another organisation can be built without the weaknesses of ICFOSS. Otherwise, this recommendation leads to a national level ICFOSS - a national level waste. Please remove this recommendation.

Version	Contributor	Topic	Comments
1.1	Akshay S Dinesh	Software Recommendations: Education	“Inculcate OSS skills in the education curriculum” This is good, but I think it can be made better by referring to existing examples like IT@school. But that maybe optional. Also, please give examples of what an “OSS skill” is.
1.1	Akshay S Dinesh	Software Recommendations: Funding	“Fund existing open-source projects of interest to the government and public” Better phrased as “Make budget allocations for open-source” because the phrase “interest to the government” needs to be defined.
1.1	Akshay S Dinesh	Software Recommendations: Community building	“Nurture a sustainable OSS community” Refer to the point 3 above. Nurturing an open source community is not something government can do. Please remove this point.
1.1	Akshay S Dinesh	Software Recommendations: Acknowledgement of OSS Use	Mandate acknowledgement of OSS Use Rephrase this to “Proactively bring transparency into technology stacks used by the government through RTI” which will cover OSS and proprietary and everything and brings RTI into the picture.

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 contact us at research@takshashila.org.in or raise it on the GitHub repository (github.com/TakshashilaInst/open-tech-strategy-for-india.git)