

DEMOS

THE OPEN ROAD

HOW TO BUILD A
SUSTAINABLE OPEN
INFRASTRUCTURE SYSTEM

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This report sets out how philanthropic support can build sustainability in the open infrastructure ecosystem. It is an immense and important question, and we would be nowhere close to answering it without the enormous generosity and wisdom of the Open Source and Standards community. We would be delighted to continue these conversations.

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Alex Krasodonski

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INTRODUCTION

SUMMARY

This report sets out how philanthropic support can build sustainability in the open infrastructure ecosystem. The open infrastructure ecosystem spans open source software and standards, and is a shifting constellation of individuals, organisations and private and public bodies.

Over the past decades, open source and open standards have emerged as the de facto way digital technologies are created. From individual developers building a profile and skills to interoperability between multi-billion dollar companies, open source software and open standards are universal technological forces.

Despite this economic and industrial reliance on open infrastructure, the ecosystem as a whole faces a sustainability crisis. There is a major gap in funding, a gap felt most acutely at the foundations and by open source communities outside the digital limelight. For some developers, upskilling, economic security and a love for coding covers the costs of participation, but for many potential participants the barriers remain high. This includes non-code participants in an ecosystem where legal, management, governance and communications skills are in short supply. Where funding is available there remain gaps in tooling, governance and skills for OS communities to manage the money they receive and the responsibilities that come with it.

But money isn't everything. We need to defend the open infrastructure ecosystem from state and corporate capture, inadvertent or otherwise. We need to support its maintenance. We need to incentivise participation from a diverse group of participants. And we need to talk about why this all matters to a non-technical audience, be they corporate budget holders or government decision makers. These priorities should inform philanthropic decision-making.

NEXT STEPS FOR PHILANTHROPY

This report aims to support philanthropic efforts in three ways: first, by laying out a preliminary method for identifying the infrastructure to target: how do you decide? Second, it sets out a range of possible interventions worthy of philanthropic support: what should we do about it? Third, it identifies where the wider ecosystem might contribute: how can we encourage governments and the private sector to do more?

We believe this report will support an effective ITT process for philanthropic funders. Given the scale and diversity of the challenges, we are more hesitant to prescribe specific interventions. Nevertheless, here are our tentative suggestions.

First, **support ten Standards Disruptors** – social, political and legal experts trained in technology, or technologists trained in social, political and legal studies, to participate full-time in standards bodies.

Speak to Tobie Langel and Mehwish Ansari, a co-author on this report.

Second, **fund the roll-out of financial governance tools and methods** to support existing OS communities, starting with Open Collective. Speak to Pia Mancini and Ben Nickolls.

Third, **assess existing training and documentation** for developers in a company setting to make the internal case for funding the OS community and fund a pilot. Speak to Duane O'Brien and Mandy Grover about this.

Fourth, fund a policy-focused paper **assessing how software bills of materials (SBOMs) and changes to government procurement could be used as a lever on the OS ecosystem and the standards-to-implementation pipeline**, supported by a primer on OS as a feature of geopolitics and foreign policy.

Fifth, funding for a pilot and evaluation of a targeted **Philanthropic intervention** in a foundational piece of OSS infrastructure. Begin with the Minimalist package, identified to be at risk of inadvertently causing infrastructural problems down the line.

Sixth, fund a campaign **to help amplify the voices of those working on ethical licensing**, designed to target key stakeholders who could provide powerful support for the use of ethical licensing if it were better and more widely understood. Speak to Coraline Ada Ehmke about this.

Further recommendations are given in part three, ***What's Needed?***.

PART ONE

WHAT IS

OPENNESS?

WHAT IS THE OPEN INFRASTRUCTURE ECOSYSTEM?

The “open infrastructure ecosystem” is a term that encompasses two critical areas of digital infrastructure development: open source software (OSS) and open standards. It’s the code and the people who write, maintain and use that code, the communities that develop and support OSS and open standards, and even the governments and private companies who use or fund it. This report focuses on both of these areas.

OSS is software with code that anyone can legally inspect or change. GIMP is an open source graphic design tool, meaning anyone can use it for free, or add features. Photoshop is a closed source, paid alternative where functionality is controlled by Adobe.

Standards are documents that specify how particular protocols, architectures, and hardware should be designed or implemented. They are the bridges between projects, individuals and organisations: open standards allow anyone to build interoperable projects. Open standards are the reason why you can connect to WiFi to check your email in any coffee shop, regardless of whether Samsung or Apple manufactured your mobile phone or Asus or Netgear built the WiFi router.

OSS and open standards are not the same thing, and they are developed by different communities with distinct cultures. However, OSS and open standards can complement and reinforce each other to produce groundbreaking digital technologies, like the many of the networking protocols that make up today’s internet infrastructure.

While OSS projects focus on building and testing the code that makes up open technologies, open standardisation can improve their interoperability with other systems, increase their adoption among infrastructure developers, and normalise the assumptions and principles embedded in them. But the connections between these two parts of the ecosystem are not currently strong, and there is a need for building bridges between them.

WHAT IS ‘OPEN’?

‘Open’ is a value, and there’s a spectrum of openness in the development, access and use of both software and standards. The more open, the more likely it is that:

- Software and standards are developed in the open
 - Development processes are transparent and inclusive
 - Development processes balance competing interests
- Software and standards are able to be freely and openly accessed
 - Source code of open source projects or software is be accessible
 - Standard specifications are available under ‘fair terms’.

- The use of software and standards are neither mandated nor restricted
 - Licenses permit redistribution and modification without restriction or modification.
 - Standards are not enforced but adopted by choice within an open market

Openness in the design, access, and use of software and standards in turn facilitates the design, development, and deployment of open infrastructure technologies – technologies that can interconnect with other systems, have low and non-discriminatory barriers to adoption, enable anyone to build their own technologies on top, and give users a meaningful choice of which technologies they want to use.

WHY 'OPEN'?

Like an ethanol fire, the Internet is burning but we on the outside can't see the flames. In November 2021 the Log4Shell exploit was made public. Log4Shell is a so-called zero-day: for nearly ten years it was unknown to the security community. When it finally came to light, the fallout was catastrophic: hundreds of millions of systems were compromised in "the single biggest, most critical vulnerability ever".

Log4Shell was discovered on a Friday (of course it was). Immediately, the team behind it sprang into action. But crucially, this was a small group of volunteers: unpaid, underappreciated, who gave up their weekend under unbelievable pressure to fix the Internet, for free. "Please hurry up", wrote the engineer at Alibaba who discovered Log4Shell (Alibaba's yearly revenues are over 100 billion dollars). Parallels were drawn to the 2014 Heartbleed vulnerability that affected half a million websites: in a letter written after the bug was discovered, Steve Marquess describes the pressure on the team: it had one full-time employee and survived on donations and contract work.

It's now 2022, and smaller fires are cropping up. This month, two libraries underpinning thousands of projects stopped working, causing systems to endlessly print nonsense. This time, it was self-sabotage: "Respectfully, I am no longer going to support Fortune 500s (and other smaller sized companies) with my free work", wrote the developer on Github. "There isn't much else to say."

Decades of stratospheric growth have been built on the back of Open Source, and from the outside, the foundations often look rather shaky.

The examples of Log4Shell and Heartbleed give nightmares to anyone prone to worrying that the Internet itself isn't as permanent and stable a system

as we might hope. But it also plays into a specific kind of worry that understands OS unsustainability as a business or commercial risk. We believe there is more to it than that. Open is not just an effective way to build and maintain software - it should be a tool to promote principles and values of openness.

The open infrastructure ecosystem builds a better digital future by placing more value in individuals' ability to understand and shape its fundamental technologies. It allows smaller, less powerful stakeholders to advocate for ideas that don't align with the dominant interests. And it means that nations have common interests in maintaining the stability of global digital infrastructure that we rely on every day, like the internet.

We need this kind of openness in how we develop, access, and use software and standards because openness in these processes in turn strengthens the openness of their outcomes: the infrastructure technologies themselves. Open infrastructure technologies have low barriers to access, interconnection, and innovation; more transparency and scrutiny (and therefore fewer overlooked security vulnerabilities); and better user choice. As such, the impacts of protecting and promoting open digital infrastructure are more inclusiveness, resilience, stability, and respect for fundamental rights for the people that rely on this infrastructure every day, around the world. This is why we need to prioritise the open infrastructure ecosystem.

Digital technology's rapid development, however, building on the foundations of open infrastructure, has brought its own challenges. Chief among them is sustainability, a challenge that plays out in funding shortfalls, licensing disputes, inequality, burnout and exclusion. For instance, critical digital infrastructure that forms the foundations of the internet is left to be maintained by groups of volunteers, stretched to a breaking point while state dependency and corporate profit ratchets up.

Defending the open infrastructure ecosystem will require maintenance of these essential projects - but it cannot mean maintaining the status quo. Defending the principles and the people of the open infrastructure ecosystem will require much more radical and systemic change. Some would say these principles are worth little when in practice, maintainers suffer when projects and organisations remain exclusive and exclusionary, when companies reap enormous profits off the back of the work of volunteers. They'd have a point. But that doesn't mean these values aren't worth fighting for when determining the stewardship of the digital world, and we're not fighting hard enough.

If this ecosystem cannot be sustained, its death will be slow and imperceptible. Development will take place in ever more privatised spaces. Licensing will gradually become less permissive. Entry for new participants will get gradually more difficult. The ramifications of this would be enormous: a fractured web controlled by a handful of competing states and corporations under whom individual power and agency to shape the digital landscape will be a distant memory. A balkanised digital world, where decisions about the future of technology are made in boardrooms, and universal rights and liberties come second to state or corporate powers bent on raising the walls around their domains ever higher.

Preserving openness means transparency. Transparency of information, transparency of code, and transparency in governance. It means agency. Agency to learn, to teach and to participate in how the online world looks. It means access, lowering of barriers to new joiners and protecting them from exploitation. The tradition of OSS communities and open standards development provide a foundation for this: it's high time we built on them.

PART TWO

WHAT MATTERS?

When thinking about the open ecosystem as a whole, what ways are there to identify those areas most important to you and your organisation?

WHAT MATTERS?

Any philanthropic strategy needs two things: a strategic priority, and a means of identifying how to achieve that strategy through grantmaking and other interventions. Different funders will have different strategic priorities, from Ford's focus on social justice to Sloane's focus on science or the OSF's focus on democratic change.

INFRASTRUCTURAL IMPORTANCE AND THE RISK MODEL

The dominant framework for understanding OSS sustainability can be described as a 'risk model'. Major corporations and governments rely on OSS and standards, and unsustainability to them is a risk to be mitigated.

Whether a piece of open source software or an open standard constitutes foundationally important infrastructure is partly determined by a simple counterfactual: how much of the world's technology is affected if there is a vulnerability?. In these terms, the importance of an OSS project or open standard can be measured by the systems critically impacted by a change or crisis in that project or standard. `cURL`, relied upon by every human with a smartphone, is under this definition foundational infrastructure and in scope. The `HTTPS protocol`, which secures a fundamental part of internet

user's browsing traffic, is under this definition of foundational infrastructure. `cowsay` is not.

However, the Risk Model is an incomplete model. It's necessary but not sufficient. Alongside risk to the core functions of digital infrastructure, there are further strategic priorities best described as an Openness Model.

THE OPENNESS MODEL

We believe funders should engage with more than just a Risk Model.

Foundationally important infrastructure is subject to rapid change as technologies develop. Dominant technologies may not always be ones we wish to preserve. And although stability is important, the entrenched view of OSS unsustainability as a risk fails to capture the importance of the open infrastructure ecosystem to rights, liberties, working cultures and the health and diversity of its participants.

In compiling this report, we felt there was frequent confusion as to whether or not OSS sustainability should be prioritised on the grounds of risk-mitigation or on grounds of principle and values of openness.

Funders and members of the open infrastructure ecosystem should consider whether and how their interventions go beyond the risk model. They should question how their strategies can form part of a fight to sustain the principles of openness and give us the best chance of an internet which protects the rights of those who use it.

Usually, the two are symbiotic: foundational stability and openness are mutually reinforcing. However, there may be cases where they come into conflict: where a focus on risk alone is likely to overlook interventions that would benefit the open infrastructure ecosystem more holistically. For

instance, a world where all OSS developers are paid by one or two major corporations is likely sustainable and would help to mitigate the risk of critical collapse, but would seriously undermine the value that comes from foundational infrastructure being open.

Where such conflicts arise, we would urge funders to support interventions that acknowledge the risk model, but directly champion the openness model.

This support will be crucial to strengthening our shared digital future against capture by authoritarian visions of technology. Authoritarians may be able to offer a competitive alternative within the parameters of a risk model, but cannot meet the standards demanded by an openness model based in liberal democratic values.

Although conceptually challenging in principle, practical examples make the distinctions between these models clear, as shown below.

TABLE 1

INTERVENTION AIM	RISK MODEL	OPENNESS MODEL
Improved Licensing	Reducing inconsistency and confusion in the use of licenses by OSS projects improves scaling, cooperation and use of OSS.	Ethical licensing offers new routes for developers to exert control over their work being used for harm.
Multistakeholderism	Greater buy-in to the use of standards by different governments increases common interests in cyber stability and security.	Involving different groups in the development of standards protects the process from being captured by powerful actors in their own interests.
Improved Diversity	Greater access to a wider set of contributors and perspectives boosts resilience and increases talent pools, and ensures that technological development is appropriate to changing global contexts.	Equality of access is preserved, and underrepresented human experiences and needs are recognised so that software and standards are designed to meet a wide array of use cases.
Sustainable Funding	Ensuring maintainers of foundational digital infrastructure are funded reduces the risk of vulnerabilities being overlooked or unaddressed.	Small, non-profit, and alternative developers and implementers of digital technologies can regularly contribute their needs and perspectives to the design of foundational digital infrastructure.

OPEN STANDARDS AND PROTOCOLS: FOUNDATIONAL INFRASTRUCTURE

In the lifecycle of a technology, standardisation exists as a critical point of intervention after it has passed the proof of concept phase, but before it is deployed to the market.

While standardisation is a process that exists in myriad sectors, from automobile manufacturing to food and safety, it is uniquely important for the development of digital infrastructure because it facilitates interconnection between heterogeneous technologies - the fundamental principle of the internet. A protocol is a type of standard that sets rules for how data moves within technical systems and across technologies. Given that standardisation takes place before a technology enters the market, standards processes pose a rare opportunity for all stakeholders to influence technologies before they become ubiquitous.

Developers and implementers have an incentive to standardise their technologies. If you want your technology to become part of foundational infrastructure, publishing a standard through a process that involves a respected technical community is a way to signal that your

technology is legitimate and worthy of interoperating with others. Standardisation also normalises the assumptions, principles, and innovations that make up your technology, so that others can use and build on them.

For example, in the mid-1990s, Netscape Communications developed the Secure Socket Layer (SSL) protocol to improve the security of its browser, Netscape Navigator, for e-commerce. Even though SSL gave Navigator a competitive advantage in the browser market, the Netscape developers were willing to share the specifications of SSL; they bet that it would be more beneficial for websites to adopt support for SSL and improve interoperability with Navigator than to keep SSL technology proprietary. So, Netscape standardised the technology in the Internet Engineering Task Force (IETF). The subsequent ubiquity of SSL encryption enabled worldwide online financial transactions and fundamentally shaped how we use the internet today. It's safe to say that SSL is part of today's foundational infrastructure, and standardisation facilitated its foundational importance.

MEASURING INFRASTRUCTURAL IMPORTANCE

There are several ways for philanthropy to identify which OSS projects and open standards contribute to important foundational infrastructure. These methods can also serve to guide the planning of philanthropic interventions.

One: Ask the Community

Soliciting information through prizes or invitations to tender provide a route for OSS communities to present their efforts to funders. Community surveys, such as those run by **CHAOSS**, can give useful indications of where a community is struggling with motivation, burnout or other sustainability challenges. Informal coalitions such as the **Public Interest Technology Group (PITG)** can provide insight regarding the challenges and barriers facing non-commercial stakeholders in standards developing organisations (SDOs).

Two: Ask the Experts

SustainOSS brings together experts from across open source communities for events, podcasts and working groups. Open Source Foundations steward hundreds of critical digital infrastructure projects. Formal groups within SDOs such as the **Human Rights Protocol Considerations Research Group (HRPC)** in the Internet Research Task Force (IRTF) and the **Privacy Community Group (Privacy CG)** in the World Wide Web Consortium (W3C) convene the experts of these technical communities to address how standards relate to public interest values. Strong networks should guide philanthropic funding decisions.

Three: Scan the Horizon

What matters in five years' time may not matter now. The pace of change and development in the open infrastructure ecosystem is unrelenting, and a myopic focus on today's critical

infrastructure may obscure the foundations of tomorrow's digital world. This requires philanthropy to support spaces where technologists can work alongside wider civil society to evaluate how the changing face of digital infrastructure may create new opportunities for intervention.

Four: Analyse the Data

A range of datasets exist to evaluate open source projects and protocols and to better understand their centrality in the open infrastructure ecosystem. A common starting point is dependency analysis - looking at how many systems depend on a piece of code in order to work. [Libraries.io](#) provides a comprehensive dataset of software shared through common package managers, recording dependencies for each, along with varying indicators of code quality. In 2020, the Linux Foundation published '[Vulnerabilities in the core](#)', a census of software firms and providers. As this is based on real-life uses, it gives a good measure of software importance across industries. This kind of data can help organisations identify current and future projects that may be foundationally important. Finally, Google has been working with the Open Source Technology Improvement Fund (OSTIF) to publish a list of projects ranked [by criticality score](#), which attempts to measure project importance through public Github data.

While datasets related to standards development can be difficult to find, [BigBang](#), a tool maintained by the DATACTIVE Project, is a mailing list parsing software that supports statistical, network, and discursive analysis of standards processes and communities.

Planning Interventions

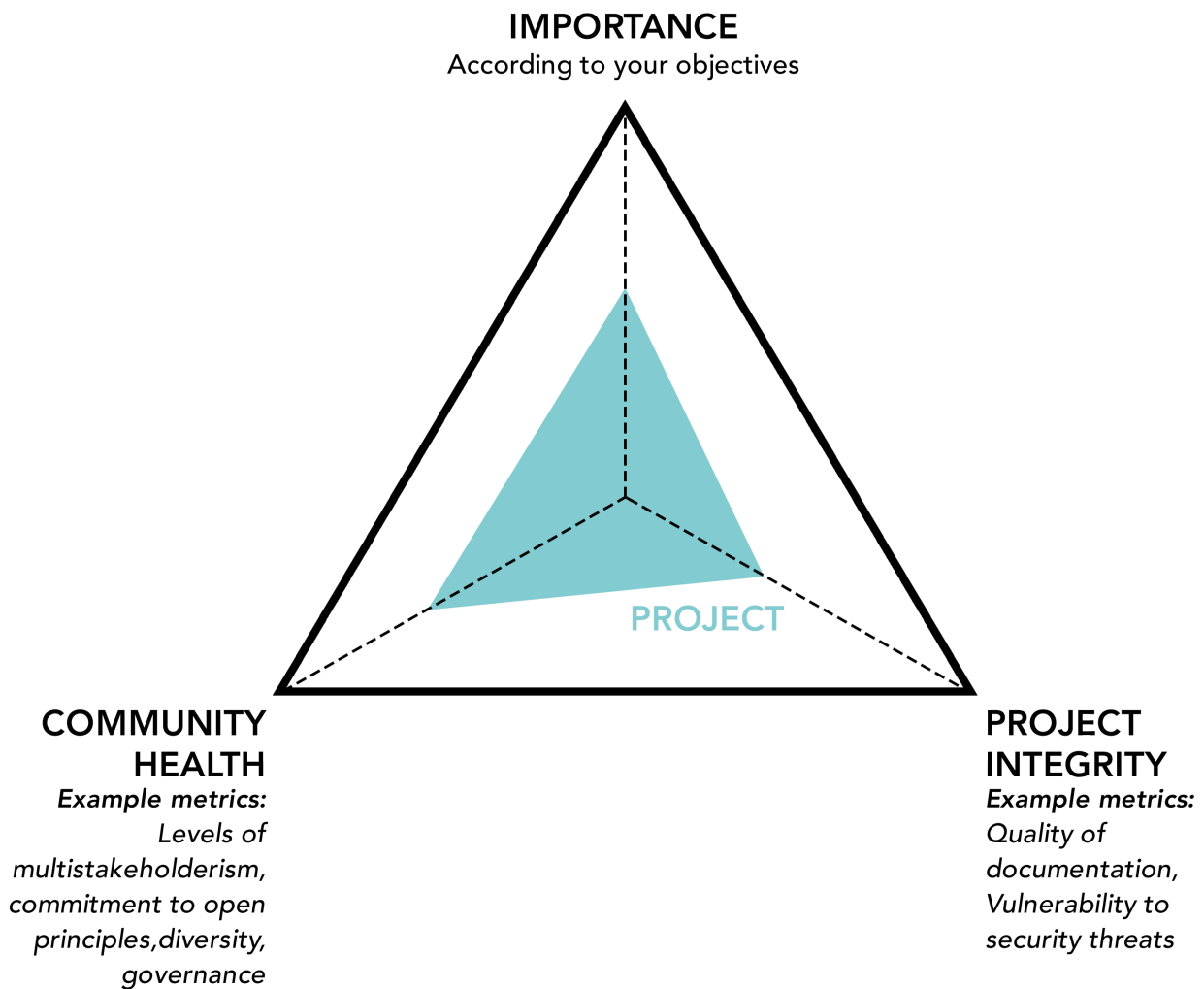
These methods can also be used to support planning for philanthropic support. At its most basic, speaking to the lead developer on an OSS project or the participants of an SDO working group to evaluate where support is most needed, or canvassing experts to understand where tools or training materials are most needed, should guide the deployment of resources.

Assessing Foundational Open Infrastructure Communities

Important projects - from a piece of software to a key standard - are indicators of important people. If we want to understand how to support more sustainable, more open, better-quality open source projects and standards, we need to

consider how we can better support the people and communities involved in their creation. To maximise impact, it's also key to decide which communities to focus on.

During the planning phase of an intervention, it can be helpful to evaluate the needs of communities based on the 'stable triangle' model sketched below. We use the term 'project' below in a broad sense - referring to the purpose and output of a community. While many of the metrics developed so far have been developed with OSS in mind, this model is intended to apply to standards, software, Github repos, support forums, etc.



The first step here is to determine a project's importance. For us, this is foundational importance, but this could be criticality to a certain sector, or importance to a given marginalised group, or whatever your organisation cares about sustaining.

This gives you the height of the triangle. The base is then determined by indicators of project health. On the right, we measure the strength of the community maintaining the project; metrics here could include the diversity of the contributing team, the support structures in place to help struggling maintainers, or a commitment to open source principles. On the left, we measure the quality and integrity of its outputs. Metrics here could include the quality of documentation or availability of information in different languages, alongside various measures specific to the project's type -such as vulnerability to security exploits.

The task of an intervention can then be seen as finding and stabilising 'tall triangles' most at risk of toppling, by helping to widen their base. Methods for identifying priority communities are detailed in [Appendix 2](#), but by way of example of a 'tall triangle' project highlighted by our approach, [Minimist](#), is

explored below.

[Minimist](#)

<https://github.com/substack/minimist>

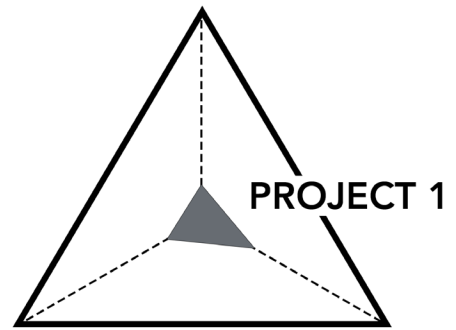
A good example of a project which does an unglamorous but important job, this JavaScript package essentially helps programs understand instructions they are being given from the command line.

It is **foundationally important**, with 13m dependencies on Github, and is included in software which underpins the modern web - including Facebook's React, Microsoft's TypeScript, and Ruby on Rails. However, it lacks a **healthy community**. The package has essentially been maintained by a single developer since 2015, with the last commit made in March 2020. There are also serious red flags around its **integrity** - the project has previously been shown to be insecure, with a vulnerability (since fixed) disclosed in 2020.

Compounding the community issues, the repository does not make it easy for new developers to get involved, lacking standard documentation files

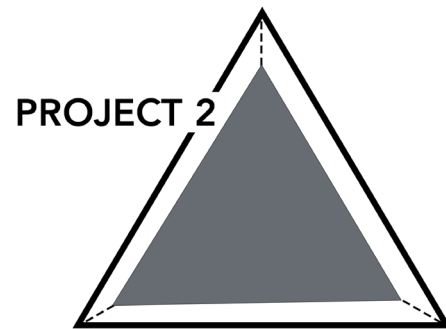
showing interested parties how to contribute to the project. Nevertheless, people are actively offering to contribute; the repo has 29 open pull requests suggesting alterations to the code, and there is an active discussion in the repo's 'Issues' page (the traditional entrypoint for offers of help or change requests) of developers discussing how to keep the project alive.

Crucially, none of the above should be construed as criticism of the developer behind Minimalist. Indeed, the implication that developers should be expected to work on maintaining code purely because it is being used by large commercial projects is a key driver of burnout in open source. Rather, we believe projects like Minimalist make good candidates for philanthropic triaging, and an offer of support.



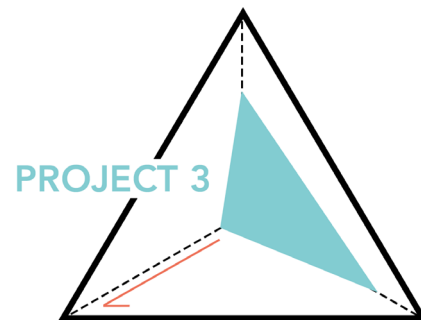
NOT A PRIORITY

Not of foundational importance



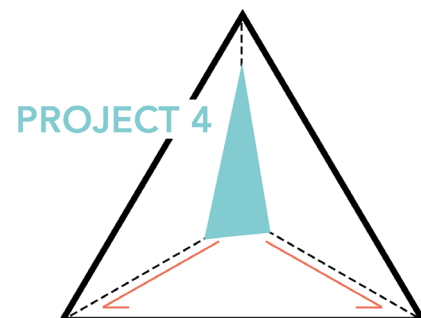
NOT A PRIORITY

Already well supported



PRIORITY

Community needs support



HIGH PRIORITY

Both community and integrity needs support

F

IDENTIFYING OPEN STANDARDS COMMUNITIES

Standards are not developed in one place. There is a constellation of standards developing organisations (SDOs) that have complementary, overlapping, and sometimes even competing mandates to develop standards for certain aspects of digital infrastructure. Because SDOs rely on widespread recognition to be effective, identifying them is significantly easier than identifying important OSS communities. There are four major SDOs that claim to develop some form of open standards and have mandates that address digital technologies of foundational importance:

Internet Engineering Task Force (IETF): The IETF is an industry-driven body that develops internet networking protocols. A staggering number of IETF protocols are of foundational importance to the global internet infrastructure, including the Hypertext Transfer Protocol Secure (HTTPS) and domain name system (DNS) protocols.

While the IETF claims to convene a technical community of independent individuals that are committed to upholding the common goal of engineering a better internet over any other interests, it is common for companies to sponsor the time and costs for their representatives to participate in the IETF and develop standards based on their technologies. There are a wide range of network technology vendors, from hardware to software, present. Representatives from the largest companies, such as Cisco and Google, tend to have the greatest presence in working groups and leadership positions. Governments do not participate at all in the IETF, which is hostile to any perception of government interference. All other stakeholders (including academics, small infrastructure providers, and civil society organisations) are welcome to participate in decision-making freely through mailing list discussions, or in meetings for the cost of registration.

IETF leadership is made up of volunteers chosen by the technical community, and positions are generally given on the basis of how long a member has been participating in the IETF. Document editors, working group chairs, area directors, and even the Internet Architecture Board (IAB) – the overarching governing body of the IETF – are all selected by the Nominating Committee, which itself is largely composed of volunteers from the IETF technical community.

Institute for Electrical and Electronics Engineers Standards Association (IEEE SA): The IEEE is an industry-driven body that develops hardware standards related to a wide range of information and communication technologies (ICTs). The IEEE 802 working groups alone develop physical-layer

standards that specify Wi-Fi networks, broadband cables, Bluetooth interconnection, and fibre optic connection.

Like the IETF, the IEEE technical community is largely composed of industry representatives – corporate members – and devoid of government participation. The IEEE's corporate membership includes a wide array of companies, mostly from the US and China, including telecommunication and internet hardware vendors, AI software companies, and aircraft manufacturers. Given the sheer breadth of work across IEEE working groups, it is difficult to pinpoint stakeholders that are dominant across the board of IEEE standardisation work.

While it is possible for academia, civil society, and other stakeholders to buy membership to the IEEE at-large, the inclusion of new members to working groups can be informally subject to the approval of the working group chairs; moreover, in certain working groups, members must clear strict participation requirements to be eligible for voting privileges in decision-making processes.

Above the working groups, the governance of the IEEE is largely carried out through the work of its committees, which are composed of volunteers from within the technical community. Any member of the IEEE can become part of a committee, but they must be nominated and then elected by their fellow voting members.

World Wide Web Consortium (W3C): The W3C is an industry-driven body that develops web standards, which largely support the applications and services that run over internet infrastructure. Important W3C standards include the HyperText Markup Language (HTML) for building web pages.

As in the IETF and IEEE, the W3C technical community is largely composed of industry actors, though the W3C boasts a greater presence of small companies and open source developers. Participating companies include web browsers, social media platforms, and content delivery networks. As such, representatives of giants like Facebook will sit in the same working groups as developers of the open source social network service Mastodon. While membership is required for W3C participation, academics, civil society, and other non-industry stakeholders are generally welcomed by the technical community to become members, and the W3C regularly provides concessions for organisations to lower the financial cost of membership. Once a stakeholder becomes a member, they are able to fully participate in any and all working group discussions.

Unlike other industry-driven bodies, the W3C is governed by a full-time, salaried staff of directors

and executives. It is the W3C Director, not the technical community, that appoints chairs for working groups.

International Telecommunication Union

(ITU): The ITU is a UN specialised agency that is mandated to develop standards for transnational telecommunication and ICT infrastructure technologies. In particular, the ITU's Technical Standardisation Sector (ITU-T) and Radiocommunication Sector (ITU-R) set standards that have foundational importance. One example is the Signaling System No. 7 (SS7) suite of standards developed in the ITU-T, which supports international telephone network switching. On the other hand, the ITU-R develops standards related to radio-frequency spectrum management that underpins most wireless services, including mobile communications.

Unlike the IETF, IEEE, and W3C, the ITU is an intergovernmental body – as such, the most powerful stakeholders in the ITU-T and ITU-R technical communities are Member States. While other stakeholders can also become ITU members, voting privileges are held solely by governments.

Does the open standards community need intervention?

In recent years, Chinese government and industry stakeholders have steadily increased their engagement across the ITU-T, and now largely dominate or heavily influence the standards development process in most consequential ITU-T study groups. Governments that seek to counter the growing dominance of Chinese technologies in the global market, such as the US, UK, and EU, also participate in ITU-T study groups, though their participation is often defensive, seeking to curb standardisation that normalises Chinese technologies. Global South governments are largely absent in ITU-T discussions, though those that are present often praise the ITU for being one of the few spaces that are open to the needs and interests of Global South industry.

While the ITU-R boasts more representation from Global South governments, discussions are still largely dominated by a few, mostly Global North, delegates that have participated in the ITU-R for decades. The ITU-R is the very definition of an “old boys’ club”.

In recent years, the ITU has heavily invested in growing industry participation to increase the legitimacy of its standards; today, the ITU's Sector Members include major global telecommunication network operators such as Orange, hardware vendors such as Ericsson and Huawei, and internet companies such as Facebook and Google. Civil society organisations can technically apply

to become a Sector Member; however, their participation is met with hostility by many Member States and it can be difficult to contribute effectively to decision-making processes.

While study group chairs are appointed by consensus from among the technical community, their selection is heavily mediated by the interests of the most dominant Member States in that group.

The openness of open standards

The spectrum of what constitutes an “open” standard is exemplified by the differences between these SDOs. While all of these SDOs claim to develop publicly available, non-proprietary standards, only IETF and W3C standards are free to access online; IEEE and ITU standards are only available behind membership or paywalls. Similarly, all four SDOs claim to develop standards through multistakeholder processes based on consensus. However, the power dynamics within each SDO demonstrate that the reality is not so straightforward. While consensus may be a guiding principle of decision-making, forum capture does exist in SDOs where there is less transparency, as in the IEEE and ITU. As a result, certain companies or governments can dominate a particular working group or take advantage of a leadership position and influence the direction of certain standards.

On the other hand, overlaps in mandates can lead to “forum shopping”, where ideas that are rejected by the technical community in one SDO may crop up again in another SDO. This can create a dangerous situation where a proposal that threatens the idea of open infrastructure can be rejected in the IETF, but still take hold as a draft standard in the ITU, where pushback may not be so strong.

Even in SDOs that are ostensibly more aligned with the principle of openness, it can be difficult for certain contributions to create an impact, particularly in cases where the profit incentive is not clear. For example, in recent years, public interest advocates in the IETF have sought to improve the security of the DNS so that it remains a robust aspect of the global internet infrastructure. However, this proposal has been met with an unwillingness to engage from major DNS service providers that are hesitant to invest the time and resources to update their existing products and services.

Identifying Interventions

Identifying which communities are in need of support will not identify specifically what kind of intervention they need. In Part Three, we set out common challenges facing open infrastructure projects, which provide criteria for assessing the sustainability of an open infrastructure community and identifying key areas of intervention, through discussions with those

in and outside of the specific community.

Communities can also be supported through interventions which seek to support a more open infrastructure ecosystem overall - for instance, diversity initiatives which benefit many different communities. These long-term holistic interventions are crucial for developing an open infrastructure ecosystem which is sustainable.

PART THREE

WHAT'S NEEDED?

Now that you have identified the targets of intervention you believe best meet your strategic objectives of improving the sustainability of open infrastructure, what kinds of interventions are needed, suitable, and create the greatest return on investment?

WHAT'S NEEDED?

There is no single intervention that can tackle the pressures facing an ecosystem as large and complex as that of open internet infrastructure: there is a demand for action from individual developers and communities through to governments and multi-billion dollar corporations. The open infrastructure ecosystem demands four overlapping categories of intervention.

MAINTAIN

The open infrastructure ecosystem relies in great part on volunteerism and charity. Pressure is mounting as support for time comes under pressure from changing corporate priorities, uncertain funding and infrastructural support, and a dearth of diverse skills.

See [Sustainable Funding, Project, Team and Community Management](#) and [Documentation and Technical Debt](#).

INCENTIVISE

The last decade has also seen radical changes to online business models, and shifts in the perception of the value of contributions. Interventions are required to incentivise participation in the open infrastructure ecosystem at its various strata, through recognition, competition, and philanthropic support.

See [Publicity and Prestige](#) and [Training and Education](#).

REINFORCE

There are growing threats to the open infrastructure ecosystem. Commercialisation, centralisation of skills, money and power within a handful of corporations, exclusion of developing economies, rising cybersecurity risks and the threat of authoritarian digital governance all demand a close eye in the years ahead.

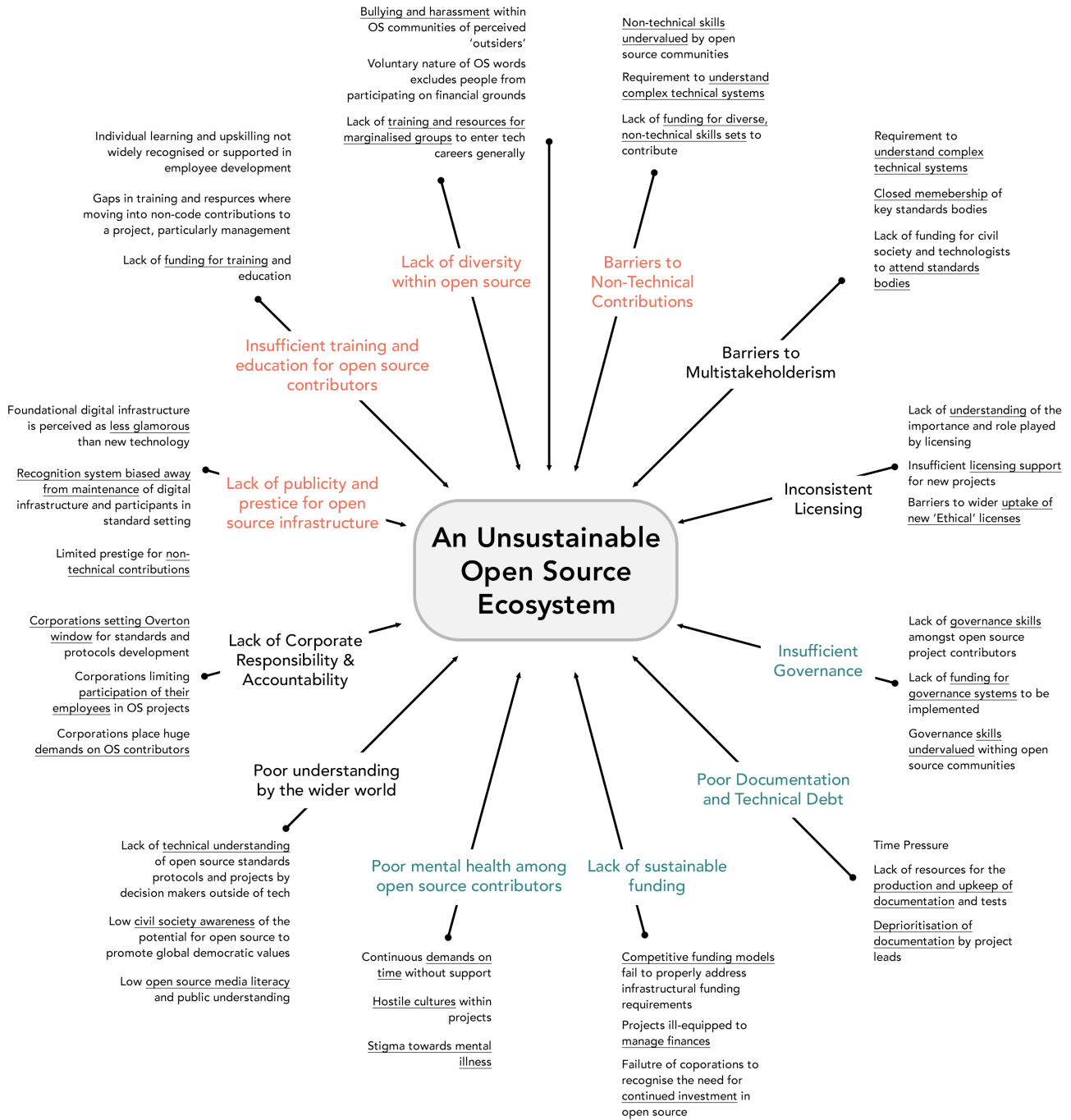
See [Governance and Multistakeholderism](#) and [Licensing Support](#).

EXPLAIN

Software and standards are highly technical subjects with enormous real-world ramifications. They tend to be poorly understood by stakeholders working outside the open infrastructure ecosystem who rely on and take decisions impacting this ecosystem. We need interventions to diversify the range of stakeholders, to better explain its role and requirements to governments, and to advocate on its behalf in terms that are accessible and clear to decision-makers.

See [Networking and Communication, Corporate Accountability](#) and [Government Communication & Procurement](#).

CAUSES OF UNSUSTAINABILITY IN THE OS ECOSYSTEM



Incentivise

Explain

Maintain

Defend



MAINTAIN

The open infrastructure ecosystem relies in great part on volunteerism and charity to develop and maintain itself. As time passes, and the web becomes increasingly commercialised, there is a growing risk that historical non-financial incentives are atrophying, putting crucial open source projects at risk of collapse and leaving open standards in the hands of the most powerful few.

If this ecosystem is to be maintained, it is vital that methods are found to ensure critical parts of it remain active, adaptable and secure, without capture by commercial interests or reliance on particular, skilled individuals.

This requires:

- Sustainable Funding
- Documentation and Resolving Technical Debt
- Mental Health Support

MAINTAIN: SUSTAINABLE FUNDING

“Open source has been such an incredible force for quality and community exactly because it’s not been defined in market terms”

Open source by its nature operates outside of traditional funding models. How to build sustainable funding without compromising on the fundamental principles of open source is both the most obvious and most controversial question about the open infrastructure ecosystem, but there is a clear requirement to increase it.

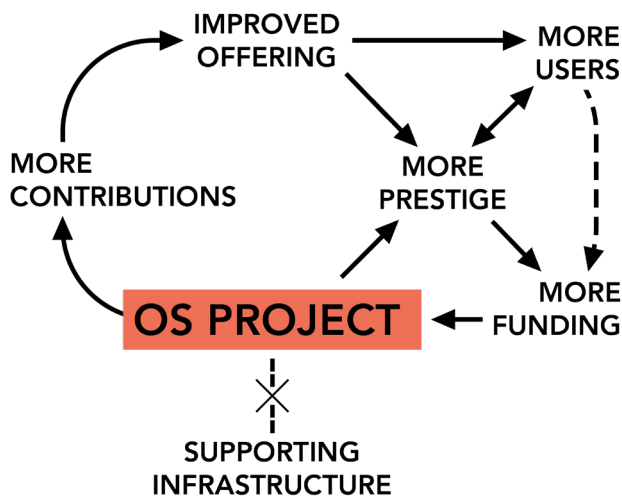
Distribution and decision-making systems for the allocation of funds across OSS communities remains an area with [an array of options](#). Funding individual OSS projects without the capacity to

extend that support to the projects they depend on perpetuates inequality and fails to build ecosystem-wide sustainability. This is further complicated by an international workforce as an OSS community can be made up of participants under dozens of income regimes.

Culturally there can be discomfort in open source communities about money, but care must be taken here: a lack of funding and a reliance on volunteerism excludes participants unable to participate in the ecosystem part-time. This new generation of maintainers are unlikely to share aversions to monetising their work.

Many solutions for funding projects and developers exist, from [GitHub Sponsors](#) to [Patreon](#). However, where possible, philanthropists should support and encourage the use of tools designed to distribute funding across a community equitably to avoid replicating market-like forces where prominent projects get more support while unseen, foundational frameworks continue to struggle. Cooperative tools, such as [OpenCollective](#), do this well. [Tidelift](#) is an enterprise solution focused on distributing funds to maintainers throughout the dependency chain. DAO and crypto solutions for community funding are growing: [GitCoin](#) and [stakes.social](#) are two, though care with cryptocurrencies is clearly required.

While there is a growing suite of tools for the collection and distribution of funds, there is a critical need for tools and training for OSS community members in spending that money (See: Training and Education)



Feast and famine in the competitive funding model

There is an enormous shortfall in funding from major software companies. Rectifying this through outreach and campaigning is worth doing. Additionally, supporting in-house software teams to successfully make the internal case for funding OSS to non-technical budget holders would create a lot of value.

Lack of sustainable funding is also a barrier to participation in open standards development. It can take over two years and thousands of dollars in membership or registration fees to see the development of a single standard from start to finish. Over that time, stakeholders in this process not only need to participate regularly in multiple meetings a year that are held all over the world and last a week or more, but also feed into the ongoing mailing list discussions. Leadership and power in an SDO is gained not by demonstrating the sharpest technical expertise, but by being recognised as a long-time member of the technical community.

Generally, technical communities do not compensate participants for their time, and leadership positions are filled by volunteers. Large companies often invest significant staff time and resources to send their engineers to IETF, IEEE, W3C, and ITU meetings. Some companies have entire teams dedicated solely to standardisation work. But small companies, OSS community developers, and civil society organisations don't have the same capacities. Often, representatives of these groups attend standards meetings as volunteers in their individual capacities, or on top of their required projects or deliverables.

The costs are disproportionately higher for organisations and individuals from the Global South. Since technical communities are largely composed of representatives of Global North stakeholders, standards meetings are typically held in North America and Western Europe. This often means that people from the Global South often have to

pay for longer, more expensive flights and deal with exorbitant exchange rates to cover the costs of lodging and sustenance during meeting weeks.

As a result, non-commercial interests, including public interest values, are not well-represented and the open infrastructure ecosystem can be threatened by unchecked proprietary interests.

OSS communities, civil society organisations, and other non-commercial stakeholders that protect and promote public interest values can be champions for the Open Model in standardisation processes through the support of good grantmaking. Good grantmaking recognises that there is a need to support not just the costs of meeting participation (i.e. flights, lodging, sustenance) but also sufficient staff time to conduct technical research, build knowledge, engage in intersessional discussions, and form relationships with others in their technical community. Good grantmaking also recognises that it can often take over a year of regular participation for new entrants to become fully integrated into a technical community, even with support and guidance; at the same time, projects and grant budgets must be designed to reflect that standardisation activities require multi-year strategies and yield medium-term outcomes, not short-term ones. Standardisation is a long game.

Current efforts

Open Collective lead the way in project-based funding for Open Source communities.

Tidelift and **Ruby Together** are leading the way in channeling money from corporations that depend on OS to the contributors maintaining OS infrastructure.

Github's Open Source Guides are useful primers for communities looking to raise funds.

Funders such as **Ford Foundation**, **MacArthur Foundation**, **Open Society Foundations**, and the **US Department of State** have committed funding to public interest standards projects.

PITG's Travel Fund provides stipends to individuals that are interested in attending an SDO meeting.

ARTICLE 19's **Internet of Rights Fellowship** selects a cohort of individuals and organisations that are new entrants to SDOs to participate in standards processes, providing stipends for 12 to 24 months.

Philanthropic funding recommendations

Generally speaking, funding by philanthropic organisations to date has focused on digital infrastructure research rather than direct support. This includes funds from Mozilla, Ford, Sloan, OSF.

Microsoft has provided small amounts (\$10k) of direct funding to OS infrastructure projects, and Google has similarly provided direct funding with a security focus.

Where individual projects are supported, funders should ensure that proportionate distribution to project dependencies is included in the grant-making process.

Fund the creation and roll-out of financial governance tools and methods to support existing organisations, starting with Open Collective.

Fund grants for civil society and individuals that cover both core and activities costs and allow for long-term strategic engagement in standards development.

Ensure that funding goes not only to “shepherds” that protect and support specific open standards, but also “advocates” that are advocating for structural changes in the governance and operation of SDOs to make them more open.

Fund under-represented groups to attend and participate in open standards bodies. These groups include indigenous community network operators, Global South civil society organisations, and feminist infrastructure collectives.

Ecosystem recommendations

There is a chronic imbalance between enterprise users of OSS and its maintainers. Businesses built on OSS must now pay their way. O'Brien and Grover provide [a useful primer](#) for this.

There is an important multilateral debate to be hosted on how to publicly fund digital infrastructure. MOSS are partners here, and current efforts by Luminate and BBC Media action to build a \$1bn International Fund for Public Interest Media is a useful model.

MAINTAIN: DOCUMENTATION AND TECHNICAL DEBT

“When people have easy wins, they will feel incentivized to do more”

A crucial part of ensuring a project has a productive maintainer base or a standard has a robust working group is in signposting - showing those who are interested in a project how they can usefully get involved through clear documentation.

At a code level, this documentation might describe what the project is designed to do, and what each part of it does. At a project level, it could detail a roadmap for planned future development of

the project, outline good ‘first issues’ suitable for less experienced developers who want to help, or provide contributing guidelines which outline preferred formats for new code.

In OSS projects, missing documentation is one form of technical debt - the outstanding balance of things which should really be done in order to make a project secure, but aren't immediately critical to making it work; similar to the way your washing machine will continue functioning even if you haven't recently cleaned its filter. As projects age, and quick fixes are made, this technical debt can build up to a critical level, making it harder to recover when something eventually breaks.

Another key indicator of technical debt in software is a lack of tests; small pieces of code which run on the main codebase and check that it's doing what it's expected to do. Like producing documentation, writing tests can be good standalone tasks for low-skilled contributors, or those new to a complex project.

In SDOs, the development of a standard is usually subject to rigorous documentation. As such, the documentation problem in open standards is not so much that it's missing, but that it's either difficult or impossible for people on the outside of these technical communities to find and retrieve it. In the ITU and IEEE, documentation of standards under development are only accessible to members. In the IETF or W3C, the documentation is freely available online, but difficult to parse for those who aren't familiar with the organisations' documentation practises. Even stakeholders that are experts in one organisation may find it difficult to navigate the byzantine systems of another.

There's therefore an important need for long-term members of these technical communities to develop signposting resources that are designed to help OSS developers, community and non-profit operators, civil society organisations, and other non-commercial champions of the Open Model that are new or potential entrants to these spaces.

Documentation that explains how certain standards processes impact open infrastructure technologies, how to engage in the SDOs that are responsible for them, and where to find more information about their latest drafts is a critical yet unfulfilled need at present.

Current efforts

[Github's opensource.guide](#) is a good introduction for maintainers wishing to [produce documentation](#), or outsource this production to others. The company also publishes [standard templates](#) for files detailing contributing guidelines, how to help fund a project,

how to report bugs, etc.

OpenCollective [documentation](#) is best in class.

ARTICLE 19's publications, including: [How The Internet Really Works](#), which includes a section on SDOs and how they relate to a public interest internet; "[Navigating the ITU](#)" briefing series; and [Media Development in the Digital Age: Five Ways to Engage in Internet Governance](#).

Informational standards developed by groups within SDOs can support stakeholders seeking to make public interest or even non-technical contributions, such as HRPC's standard on [Research into Human Rights Protocol Considerations \(RFC 8280\)](#) and draft standard on [Guidelines for Human Rights Protocol and Architecture Considerations](#) in the IETF.

Google's [Season of Docs](#) matches technical writers with open source projects so that they can give support on documentation.

Philanthropic funding recommendations

OSS projects lacking documentation should be seen as being at-risk in the long term; funding supplied to a community should include resources for the production and upkeep of documentation and tests.

For scientific research-focused software, resources could include the [Software Sustainability Institute](#), which will assess the long-term sustainability of projects. [The Chan Zuckerberg Initiative](#) could provide a model for how philanthropic funding can specifically target improving documentation of OSS.

Funding should support the development of resources made by experts of SDO technical communities that are specifically designed to support new entrants and non-experts in OSS and public interest communities.

Funding should also support software tools such as BigBang that can be used to build datasets and research that can demystify the discussions and outcomes within particular standardisation processes.

Ecosystem recommendations

Redouble generalised efforts to get those with a diverse skillsets, beyond technical coding skills, interested in maintaining open source projects and participating in open standards development, and empowered to do so (see also: *non-technical contributions to SDOs* recommendations below).

MAINTAIN: MENTAL HEALTH

"If we continue as we are, who will maintain the maintainers?"

Poor mental health and burnout are already commonplace amongst those working in tech: according to OSMI data, 51% of tech professionals have had a diagnosed mental health condition, with 83% of software developers surveyed during the Covid-19 pandemic in the UK reporting burnout, linked to overwork, a mentality of prioritising outcomes over people, and persistent stigma around mental illness. In particular, Team CommUNITY's 2020 Community Health Report shows that OSS technologists, civil society advocates, privacy and security researchers, and others in the digital rights community are currently facing unprecedented levels of stress that are contributing to mental health decline, an inability to work, and toxic community dynamics.

This is a particular concern for the future of the open infrastructure ecosystem. As OSS projects gain increasing dependencies and draft standards undergo the development process toward publication, those working on them face continuous demands on their time and skills to maintain projects and respond to requests. In the absence of employment infrastructure to support people (paid leave, access to healthcare &c) burnout is all too common.

Moreover, the toxicity and negativity of some key OSS platforms can be at best, demotivating, and at worst, lead to widespread harassment and abuse. Weaponisation of moderation tools, bullying, and poor governance by companies running these platforms, such as Stack Overflow, has led to hostile environments within these spaces that are a crucial source of support for people working in open source. A 2017 GitHub survey found that '21% of those who say they witnessed rude behavior in an open source project say they stopped contributing to it afterward.'

At the same time, given that most open SDOs are dominated by white, male representatives of Global North companies, standards processes can become spaces where women and people of color feel alienated in discussions that have sociopolitical implications; a recent example is the ongoing backlash in the IETF to a proposal to remove offensive technical terminology such as "master" and "slave" from use in standardisation.

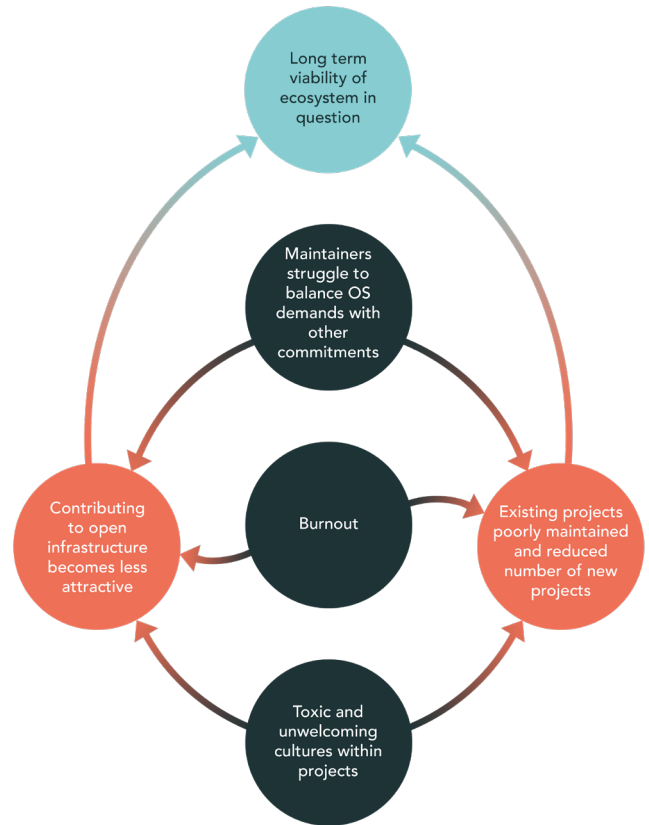
This collective health crisis poses a significant threat to the viability of the open infrastructure ecosystem. Experienced open source maintainers are driven out of the community as they struggle to balance the demand of open source with other commitments,

SDO participants representing minority and marginalised communities are disillusioned from speaking up, and this toxic burnout culture alienates new people from entering the ecosystem altogether. This in turn affects how well existing projects are maintained, reduces the number of new projects being developed, and undermines the attractiveness of contributing to the development of open technologies.

Current efforts

The CHAOSS metrics developed to measure the health of OSS communities include 'project burnout' and 'psychological safety'. Online communities themselves are also trying to work towards safer spaces, such as through codes of conduct and guides to community-building.

Team CommUNITY launched the Community Health Program, which publishes the Community Health Report and provides psychosocial services and tools to support the global digital rights community, including OSS developers, public interest technologists, and others within the open infrastructure ecosystem.



Philanthropic funding recommendations

Funding can be directed towards initiatives dedicated to challenging mental health stigma in tech more widely, such as Open Sourcing Mental Illness and Prompt. Mental health support and awareness within OSS communities can also be improved through the presence of trained mental health first aiders, who could be funded on an individual basis or through a collective supporting OSS projects.

Funding to individuals and organisations for medium- and long-term projects should include budgetary support for staff healthcare benefits, as well as supplementary wellness benefits like professional coaching and counseling services.

Funding should be directed to enhance support to organisations and programs like Team CommUNITY, which provide psychosocial care to communities engaged in the open infrastructure ecosystem.

INCENTIVISE

As the internet has expanded, OSS projects and open standards have gained a huge potential audience of contributors. However, this expansion has also seen radical changes to online business models, and shifts in the perception of the value of contributions.

We anticipate a need to find ways to incentivise participation in the open infrastructure ecosystem at its various strata, through recognition, competition, and philanthropic support.

This requires:

- Non-Technical Contributions & Governance
- Training and Education
- Pathways to Diversity
- Publicity and Prestige

INCENTIVISE: NON-TECHNICAL CONTRIBUTIONS TO OPEN INFRASTRUCTURE

'[The IETF] can be a confusing place, considering its use of specialized jargon, unique procedures, and technical subject matter.'

Open infrastructure is more than code. There is plenty of testimony from developers struggling with the management, governance, documentation and public engagement demands that a growing project or developing standard might bring. One way to alleviate this stress is to open up OSS and technical standards communities to other, complementary competencies. For instance, having a multidisciplinary contributor pool on board would take the pressure off of OSS maintainers and enable them to focus on the work that they are interested in. The problem is that, although community

and cooperation are the cornerstone of open infrastructure work, participants tend to be coders.

Basically, protecting and promoting the openness of digital infrastructure can be done by bringing in people that are looking at the same technologies through different lenses. Non-code contributions and non-code skills are more poorly represented, even though they are essential to the success of a project and health of a community. (See also *Licensing Support*). Therefore, the sustainability for the open infrastructure ecosystem depends on building on-ramps for a wider variety of skills.

For OSS communities, these on-ramps includes managers that are able to ensure a project is healthy, manage finances, spot and mitigate risks, and support team members when needed. It includes communications specialists able to bridge the gap between the project, its needs, and the outside world, particularly when fundraising or training potential maintainers.

SDOs are spaces where technical considerations and technocratic jargon dominate, but non-technical contributions are absolutely essential. Standards bodies are political bodies. The decision to encrypt more or less web traffic data in networking protocols, for instance, has ramifications for security, surveillance and freedom of expression.

While these kinds of adverse implications may be embedded in standards by design, to satisfy the interests of authoritarian or anti-competitive actors, often these consequences arise because developers just hadn't fully considered how their technology could be used (or misused) before standardisation. Given that the technical communities of the IETF, IEEE, and W3C are overwhelmingly made up of white and male technologists from the Global North, the perspectives of the use cases and deployment conditions of a particular technology are limited compared to the reality.

Regardless of the intention, without the meaningful involvement of communities, activists and experts who understand the political ramifications of

different proposals, these bodies risk normalising technologies that can enable centralisation, repression, and closed systems – dynamics that the Open Model guards against. On the other hand, robust involvement from non-technical communities, activists, and experts can lead to the standardisation of technologies that actually improve the resilience of digital infrastructure against authoritarian and undemocratic interests. Lowering the barriers to non-technical participation presents a case for philanthropic support.

In addition to the high financial barriers facing non-technical contributors in SDOs (see also *Sustainable Funding*), there are high knowledge barriers. Standards processes are extremely technical and highly specialised; veteran technologists have a tough time keeping up in working groups that are not squarely in their expertise. It can be difficult for non-technical contributors to digest the technical details of a particular standard to match the speed of meeting and mailing list discussions.

Unfortunately, even in SDOs such as the ITU-R and those with strong multistakeholder values such as the IETF, technical communities can balk at the idea that their outputs are political, and instead claim that standards are objective processes where the best engineering prevails. As such, even when non-technical contributors are present, others in the community can dismiss these interventions as out of scope and irrelevant. This can create yet another invisible barrier that undermines and demoralises non-technical contributors.

Current efforts

Several civil society organisations participate in SDOs to bridge the gap between technical and non-technical considerations:

In the IETF, the Center for Democracy & Technology (CDT), American Civil Liberties Union (ACLU), ARTICLE 19, CIS India, and Derechos Digitales regularly participate.

In the IEEE, CDT, ACLU, and ARTICLE 19 regularly participate.

In the W3C, the Electronic Frontier Foundation (EFF) and ARTICLE 19 regularly participate.

In the ITU, Global Partners Digital (GPD), ARTICLE 19, the Association for Progressive Communications (APC), Derechos Digitales, and Asociacion por los Derechos Civiles (ADC) regularly participate.

Philanthropic funding recommendations

Fund ten 0.6-1.0 FTE in civil society organisations to participate in standards bodies who are able to participate in SDOs effectively. In particular, participants should be capable of bridging technical discussions and non-technical analysis.

Funding should not only be given to organisations to directly engage in standards development, but also to support informal coalitions such as PITG and the individuals that volunteer to lead SDO research and working groups, such as HRPC, that act to preserve the public interest and other considerations that align with and reinforce the Open Model.

Ecosystem recommendations

In addition to supporting the inclusion of non-technical contributions in the development of specific standards, it is important that civil society organisations advocate for structural changes in SDOs that improve multi-stakeholder inclusion and the recognition of public interest values.

INCENTIVISE: TRAINING AND EDUCATION

'A maintainer keeps the project running, but where should that project go?'

A key hindrance to creating sustainable OSS projects built around healthy communities is the lack of leadership and strategy training among maintainers. Often, maintainers start off as authors or developers of OSS projects, contributing code and doing more of the innovative work. Eventually, as projects grow and attract more users, responsibilities are compounded, making it hard for maintainers to effectively govern projects. Their work also morphs from actively writing new code to more maintenance work like answering questions and merging pull requests.

As “core developers”, the future of OSS projects is dependent on maintainers’ ability to lead. Yet, a common complaint among maintainers is being thrust into a management role, often without training. This problem is magnified in open source, as training and support for this kind of ‘promotion’ cannot be provided externally, as maintainers are the ones aware of all the intricacies of OSS projects. This challenge shows the need for decentralisation of responsibility.

In a **2020 survey** of 1,200 OSS developers, respondents identified *enjoyment of learning and the need for creative expression* as among their primary motivations for participating in the open

infrastructure ecosystem. Diversity of skills in OSS communities should be presented in these terms: as an opportunity to learn and build skills beyond just coding.

Current efforts

The [Open Source Security Foundation](#) has produced free courses on securitising software, applicable to a wide range of OSS projects. These courses are certifiable. Expanding the certification of independently-produced training and learning materials by funders, foundations or corporates could strengthen this part of the ecosystem further.

[First Timers Only](#) provide support for new entrants to OS.

Philanthropic funding recommendations

Fund training programmes targeted at upskilling maintainers in leadership and strategy specifically, similar to the [Linux Foundation's Open Source Management and Strategy course](#) or young-person focused [Commonwealth100's Open Source Leadership project](#).

Ecosystem recommendations

Private sector management and employee development training should recognise individual learning in career development and management.

INCENTIVISE: DIVERSITY

'If you agree with me that "open" is fundamentally about access, empowerment and participation of all people, then you'll agree we are failing miserably in that endeavor.'

While OSS and open standards underpin most of global digital infrastructure, the developer and technical communities driving open infrastructure development hardly mirror its diverse user base. Currently, OSS communities and the technical communities of the IETF, IEEE, and W3C are made up overwhelmingly of male and white developers from the Global North.

In 2020, [Github reported](#) that 34% of its users were from North America, while 26% were from Europe. Projects and documentation are also mostly in English, locking out participants from other language blocs: even the syntax of most programming languages uses English words.

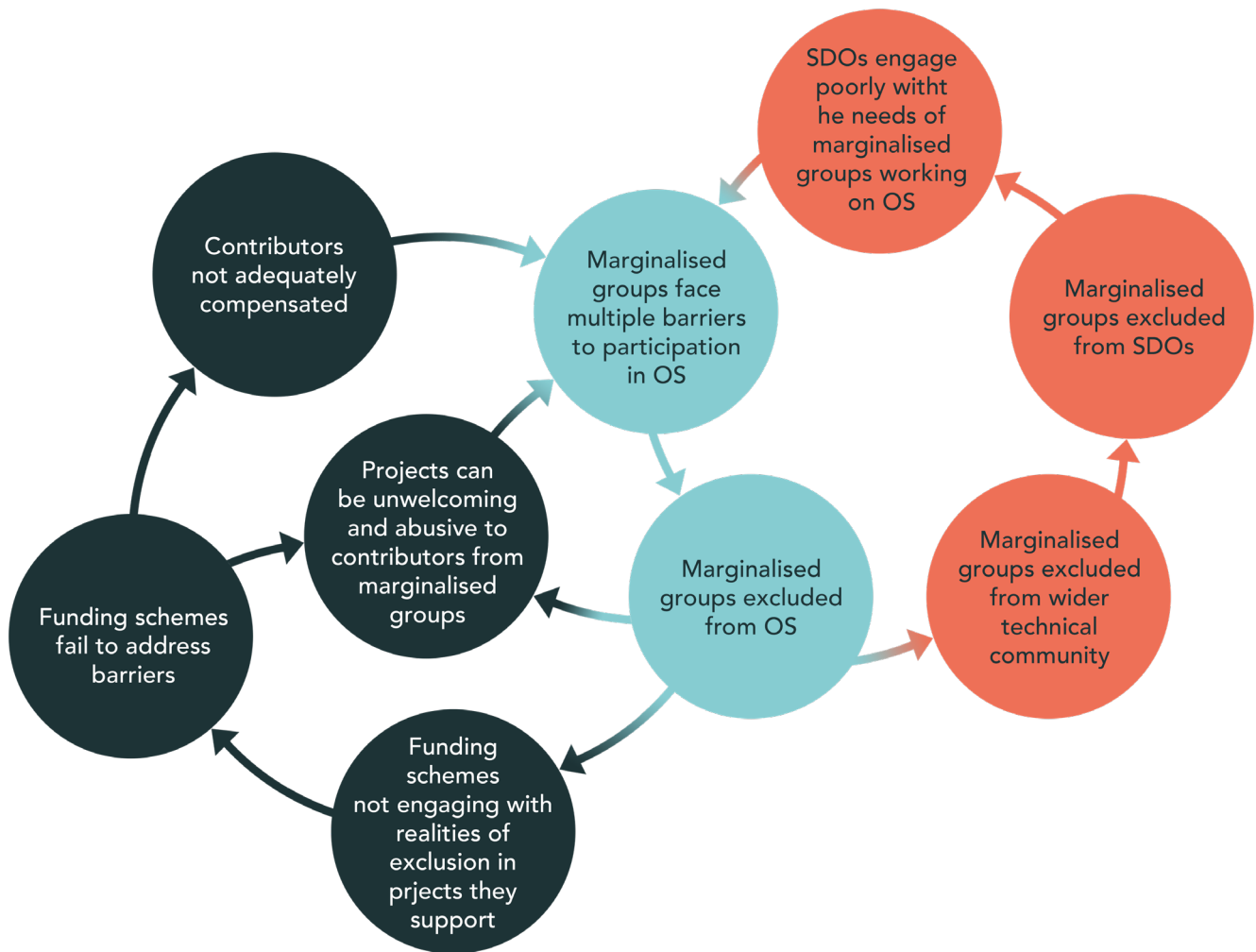
In a [2017 survey](#) of 5500 OSS developers, only 3% of the respondents identified as female while 1% identified as non-binary. The gender imbalance in OSS has been attributed to unwelcoming developer communities where women are often targeted with abuse, looked down on and subjected to sexual harassment. Many women hide their gender behind a pseudonym to avoid this abuse.

These issues are compounded by the voluntary nature of much work in the ecosystem, which disproportionately excludes those from marginalised groups.

With open source being a career ladder into tech corporations for many developers, the lack of diversity in this space should be alarming as it directly contributes to the lack of representation in the tech community overall. This also reflects and compounds the lack of diversity that exists within the key SDOs.

This lack of diversity in standardisation has had far-reaching consequences on the design, development, and deployment of digital infrastructure, particularly the internet. For example, the historic lack of standards promoting users' access to internationalised domain names has meant that the default language of the internet is English. This alienates non-English speakers, predominantly in the Global South, from registering domain names and developing websites for their communities, in their native languages. Simply, it results in a web that further marginalises communities that are often already at the margins.

Today, while civil society representation is steadily growing across SDOs, there remain three major gaps in representation. First, Global South civil society organisations still make up a very small percentage of contributors. Second, all civil society organisations that currently contribute – whether from the Global North or Global South – exist at the level of national, regional, or international policy and advocacy; there are virtually no grassroots or community-oriented civil society organisations participating in SDOs, although these are often the organisations that are directly building and supporting infrastructure. Third, while a small yet robust global community of feminist hackers and infrastructure providers is growing, there is no bridge between these collectives and SDOs, and public interest expertise on gender and sexuality is largely missing in standardisation discussions.



Current efforts

The CHAOSS [Diversity, Equity, and Inclusion Working Group](#) works to define and share metrics to measure diversity in OSS projects.

[Open Source Diversity](#) is a platform that brings together advice, resources, networks and events to help OSS projects be more diverse.

Communities are working to make their contributor pool more diverse. The [Pyladies Global Council](#) made a rule that no more than a third of its members could be from one country. This council is the governing body for Pyladies, a community for women Python contributors. Others like Red Hat are promoting inclusion through culture change like the use of more inclusive language.

Communities are increasingly looking to improve and strengthen their guidelines to better protect women and minoritised people. The [Contributor Covenant](#) is a pledge that OS communities can adopt a step in creating harassment-free for contributors of all walks of life.

There are ongoing diversity efforts at Drupal (community management), Red Hat (inclusion of

women, inclusivity), Apache (D&I), *Write, Speak, Code and Outspoken Women*. The Software Freedom Conservancy also funds projects to make OS more inclusive.

Some SDOs have made efforts to improve diversity and inclusion in standards development. For example, the [IETF Systems Program](#) provides an informal space for women developers to meet and network. The ITU-R has its [Network of Women \(NOW\)](#) program, which provides mentorship and other support to onboard and retain women delegates in ITU-R discussions.

ARTICLE 19's Internet of Rights Fellowship specifically invites applicants from Global South and other underrepresented communities.

Philanthropic funding recommendations

Diversity and inclusion experts and existing communities need to be included in funder conversations: work to increase diversity by funders can be well intentioned but fails to have impact, without experts such as [Coraline Ada Ehmke](#) involved from the beginning to help flesh out what interventions will work.

Funders could provide targeted grants or training scholarships for people from underrepresented backgrounds to be involved in OSS projects and SDOs. Examples of schemes already operating successfully and seeking funding include [Rails Girls Summer of Code](#) and [Outreachy](#).

Funders should not only prioritise projects that focus on direct engagement in the development of specific standards, but also on efforts to create structural change within technical communities to break down the financial and knowledge barriers that disproportionately impact underrepresented communities from participating, while also promoting diversity and inclusion trainings for the leadership of these SDOs.

Ecosystem recommendations

Increasing diversity also means developing a wider understanding of how people can face multiple barriers to participation: financial, social, technical. This means that all interventions in the open infrastructure ecosystem need to take diversity considerations into account.

Community leaders also need to actively work towards promoting diversity by ensuring that they recruit more people from underrepresented groups. This also means developing initiatives for people who can not join communities in the conventional way. [The Pyladies Remote](#) chapter can be credited for being useful to many women who wanted to become Python contributors but could not make it to in-person Pyladies meetings.

INCENTIVISE: PUBLICITY AND PRESTIGE

[When it comes to hiring, I'll take a Github commit log over a resume any day.](#)

One driver of developer participation in the open infrastructure ecosystem is to build an eye-catching resume in a competitive market, proving a developer's skills or familiarity with whatever is in vogue. Standards and foundational software are rarely glamorous. Critical open source frameworks - with dependencies running into the tens of thousands - can often be a decade old. Infrastructural projects require security, triage and maintenance. This is work [notoriously disliked](#) by many developers. These frameworks face barriers to attracting new maintainers where "shinier" projects that do not meet the threshold for digital infrastructure do not.

Although funding is a critical pathway to ensuring these foundational projects are maintained, we should be open to imagining new routes to recognition for developers maintaining and securitising critical open digital infrastructure, or taking part in standards setting.

Critically, prestige should be expanded to non-coding participants. It should be common knowledge within the open infrastructure ecosystem who to turn to when a project needs better management, communication or human support. This is particularly important when considering the importance of learning and innovation as a driver in OS development. This means recognition from the ecosystem that fundraising, documentation, communications, and community management are critical skills worth learning, and can be done so in the service of foundational infrastructure projects.



Current efforts

GitHub's *Trending Developers* shows a leaderboard of repositories and developers, updated daily.

Pantheon runs the '[Gift of Open Source](#)', a prize competition which actively encourages people to participate in giving both technical and non-technical contributions to open source projects.

Philanthropic funding recommendations

Bring together high-profile industry voices to support awards for code and non-code contributions to digital infrastructure, such as OpenUK's honours list, which includes people who have contributed to [open source software, hardware and open data](#) in a variety of ways, both technical and non-technical. Awards such as the [Mozilla Open Source Support Awards](#) are also available to OSS projects which encompass a variety of technical and non-technical elements.

Ecosystem recommendations

UK & US governments should platform OS developers working on foundational infrastructure and publicly promote the work of their ambassadors to SDOs.

DEFEND

There are growing threats to the open infrastructure ecosystem that require a response. Commercialisation, centralisation of skills, money and power within a handful of corporations, rising cybersecurity risks and the threat of authoritarian digital governance all demand a close eye in the years ahead.

The open infrastructure ecosystem must undergo a threat assessment of sorts to understand where interventions to secure it against these dangers can be most impactful.

This requires:

- Licensing Support
- Multistakeholderism

DEFEND: LICENSING SUPPORT

“Can I stop “evil people” from using my program?”

No.

It is probable that a sea change in licensing would have the single greatest impact on the sustainability of the open infrastructure ecosystem as a whole.

One of the core values and key strengths of OSS is that software developed should be distributed under an open license, allowing people to use and modify it as they wish - supporting innovation and promoting equality of access. But this permissiveness also comes with serious risks to the sustainability of the open infrastructure ecosystem. It allows software developed openly to be exploited and used to consolidate corporate power, or to be weaponised to facilitate abuses (such as [promoting extremism](#), or developing invasive surveillance technologies).

We need licenses which retain the freedoms for others to use and adapt, but constrain uses that damage the very openness that OSS protects.

However, the uptake and normalisation of new licenses takes significant time and social capital.

Where philanthropic funding is dedicated to changing licensing norms, we strongly recommend **forming partnerships with existing efforts and organisations working towards similar long-term strategic objectives.**

The Organization for Ethical Source presents a range of licenses that place greater centrality on ethics and the protection of rights, but to date ethical licenses have not been widely adopted. There is, however, a **growing awareness of the ethical implications of OSS use and misuse that should be supported.**

Linked to *Non-Technical Contributions*, there remains a gap in the uptake of open licensing across the ecosystem of OS development. The range of possible licenses and a reluctance of new developers to worry about licensing leaves space for an organisation to work with OSS projects to ensure they are licensed appropriately and to encourage strong and ethical open licenses. Moving just one piece of infrastructure onto an ethical license could have enormous ramifications for the ecosystem as a whole.

There is also a principled argument which needs more vocal support: staunch defenders of OSS may revolt against the idea of any constraints on use as antithetical to openness. There is a need for funders to be strongly articulating the argument from openness for the use of ethical licensing.

While some may assume that the very idea of “open standards” would preclude any licensing requirements for use, SDOs have developed differing approaches to licensing. The W3C stipulates that any standards requiring the use of patents must be granted under a royalty-free license. On the other hand, the IETF and ITU-T provide some leeway for patent holders who standardise their technologies to stipulate licensing fee requirements that are “reasonable

and non-discriminatory”.

These approaches demonstrate the potential for open standards to lower the costs for implementation and adoption and therefore improve interoperability, particularly in the case of technologies developed by large and powerful companies. For these companies, the cost-benefit analysis may indicate that the legitimacy and normalisation that standardisation brings outweighs the profits from high licensing fees.

Current efforts

[Resources](#) produced by [GitHub](#) and the [OSI](#) support developers in choosing a license.

Omidyar-funded [EthicalOS](#) and [OES](#) encourage use of ethical licensing. The [Corporate Accountability Lab](#) has worked with the OES to develop licenses that embed values.

[Unity offers a license](#) which seeks to promote more sustainable funding of OS by adding a license fee for users generating revenues over £100,000.

Kat Marchan has written a [provocative guide](#) to licensing-led sustainability.

Philanthropic funding recommendations

Examine licensing of future foundational digital infrastructure and encourage open, permissive and ethical licensing.

Organisations working in this space may include [Creative Commons](#), the [Open Source Initiative](#), the [Free Software Foundation](#) or the [Software Freedom Conservancy](#). CC in particular offer a useful lesson in spreading the use of licenses into areas with an express mission of lowering barriers to entry, such as encouraging educational texts to be released under a commons license.

Funding could target convenors, such as the [Organization for Ethical Source](#) which is working to develop understanding of and collaboration around [ethical licenses](#).

Ecosystem recommendations

Where reasonable, companies and governments should embrace ethical licensing where they are able to.

DEFEND: MULTISTAKEHOLDERISM

“The Internet isn’t value-neutral, and neither is the IETF.”

The future of OSS projects which serve people from all over the world depends on adequate representation of users’ interests in SDOs at the global level. However, in standardisation, the most powerful stakeholders are either companies or governments, depending on the SDO. Across the board, academics, civil society organisations, and community and non-profit developers are a minority of the technical community – and, in some cases, they can be non-existent.

Historically, more multistakeholder SDOs like the IETF and W3C have taken public interest considerations into account in standards development, though neither perfectly nor consistently. In particular, cases where a public interest contribution that aligns with the principles of the Open Model comes into conflict with profit models or even fails to create sufficient business incentive is usually met with entropy and a lack of community support. Because these processes are consensus-based, lack of enthusiasm is essentially a death knell for any proposal.

Effective multistakeholderism therefore requires persistent effort from underrepresented stakeholders to resist forum capture by powerful parties with vested interests, who might thereby exert undue influence on the development of standards. Even SDOs that claim to be multistakeholder should be seen as under continuous threat from governments, powerful technology providers, and any other powerful actors - even where these actors see themselves as contributing with good intentions.

Other SDOs, crucial to the development of standards for digital infrastructure, explicitly resist the multistakeholder model: meaning civil society organisations have an uphill battle even for a seat to simply observe the table. In the ITU, only Member States have voting powers. It is easier for national governments, many of whom are [likely to prefer](#) a tightly regulated internet, to influence the development of standards, which they can in turn normalise within their own borders through regulation and procurement practises and subject other nations to market and diplomatic pressure to adopt them.

With access to SDOs already hindered by barriers, including a lack of expertise and high costs of participation, OSS communities, civil society, and other champions of the Open Model are not reaping the full benefits of multistakeholderism. The shift pushed by certain governments to multilateral institutions like the ITU only entrenches this exclusion, and further threatens the open internet. As a countermeasure, there is a need to defend multistakeholderism and increase the diversity of voices represented at all SDOs that make up the open standards landscape.

Current efforts

The ITU Civil Society Coalition works to bring public interest perspectives to ITU decision-making conferences; one of its standing positions is the need to improve multistakeholderism at the ITU by opening its membership to civil society.

The HRPC in the IRTF invites academics, civil society researchers, and other stakeholders to come and speak on issues relating to internet infrastructure, human rights, and standardisation.

Some governments have set up multistakeholder initiatives to support knowledge sharing and collaborations in SDOs. For example, the UK convenes its Multistakeholder Advisory Group on Internet Governance every month.

Philanthropic funding recommendations

A programme that trains a small number of expert, policy-aware technologists that represent public interest values that align with the Open Model and funds their ongoing participation in the long-term, detailed development of standards at SDOs, could have significant impact on the future of the open infrastructure ecosystem.

Funders should use their convening power to bring together civil society groups and bring them in conversation with companies and governments to support better multistakeholder collaboration in advance of participation at SDOs.

Funding should support the participation of individuals in SDO leadership positions that are committed to championing multistakeholderism from within and creating structural changes that improve inclusiveness, whether by removing membership barriers, reducing registration or participation fees, or conducting outreach to communities.

Ecosystem recommendations

Create strong and mutually beneficial links between SDO participants and maintainers of OSS projects. SDOs need input from communities at the sharp end of development; OSS projects need input from people who know how to write protocols.

EXPLAIN

Software and standards are highly technical subjects with enormous real-world ramifications. They tend to be poorly understood by stakeholders working outside the ecosystem who nevertheless rely on, and take decisions impacting, the open infrastructure ecosystem.

Going forward, we anticipate a requirement to open up the open infrastructure ecosystem, to diversify the range of stakeholders, to better explain its role and requirements to government, and to advocate on its behalf in terms that are accessible and clear to decision-makers.

This requires:

- Corporate Accountability
- Wider Understanding

EXPLAIN: CORPORATE ACCOUNTABILITY

“Imo, open source as a community endeavor is falling apart right before our eyes, and being replaced by open source as Big Corp entrenchment strategy.”

The origins of open source were rooted in subverting power structures and freeing code from proprietary control. Ironically, decades later, corporate predation of open source is rife, with corporations raking in profits from products built on open infrastructure and giving back minimally to developers and communities. Corporations also rely on open source for their hiring pipelines as they sometimes offer jobs to consistent open source contributors.

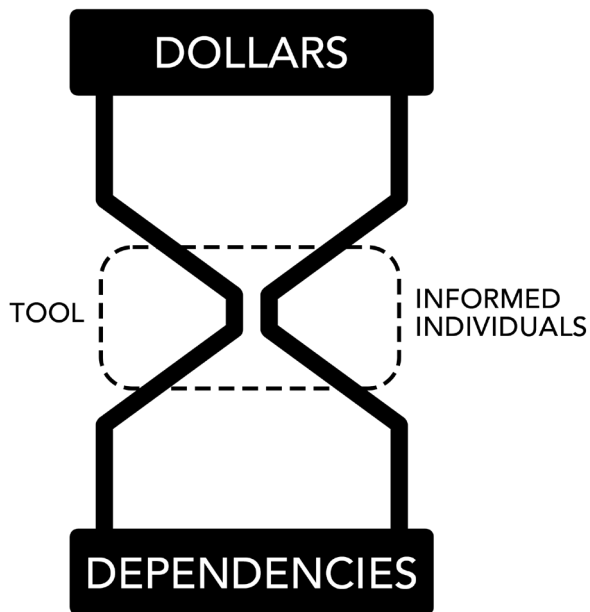
With the increase in open source reliance, the challenge to keep up with new developments and corporate demands for updates is overwhelming already overworked maintainers. As a result, while technology is developing at an exponential rate, the supporting infrastructure is lagging behind. Although

corporate support through funding communities to hire more support is a possible solution, maintainers shy away from this because companies expect their needs to be prioritised when they fund projects. This form of support is also not sustainable as it is hinged on the whims of corporations.

Corporations may also hire employees out of the OSS community and then directly or indirectly restrict the time they can still spend on their existing projects. On the other side, [maintainers face increasing requests from corporate employees](#) relying on their software.

Corporations need to start contributing meaningfully and unconditionally to OSS projects, or they put themselves at risk when crucial parts of digital infrastructure inevitably collapse. One barrier to this is the choke on information flow from dependencies to budget-holders in corporate settings (see diagram).

Open source communities are also starting to question the limits to freedom 0. While licensing agreements do not mandate that users share how they use OSS projects, developers are increasingly concerned about how corporations and governments are using their creations to inflict harm on people and the environment, and violate human rights.



Potential funding cannot reach the large number of dependencies due to a choke on the tools and individuals able to identify who or want funding should be spent on.

Current efforts

Many efforts turn on licensing changes to better protect the open infrastructure ecosystem from exploitation (see: *licensing*). For instance, the [Anti 996 Licence](#) is an attempt at preventing worker exploitation as it requires that corporations relying on open infrastructure using this license respect local labour laws and International Labour Organization standards. The [Hippocratic Licence](#) brings in human rights standards to OSS codes of conduct, while the [Atmosphere Software Licenses](#) restrict companies powering extractive industries from relying on open infrastructure licensed under them.

Philanthropic funding recommendations

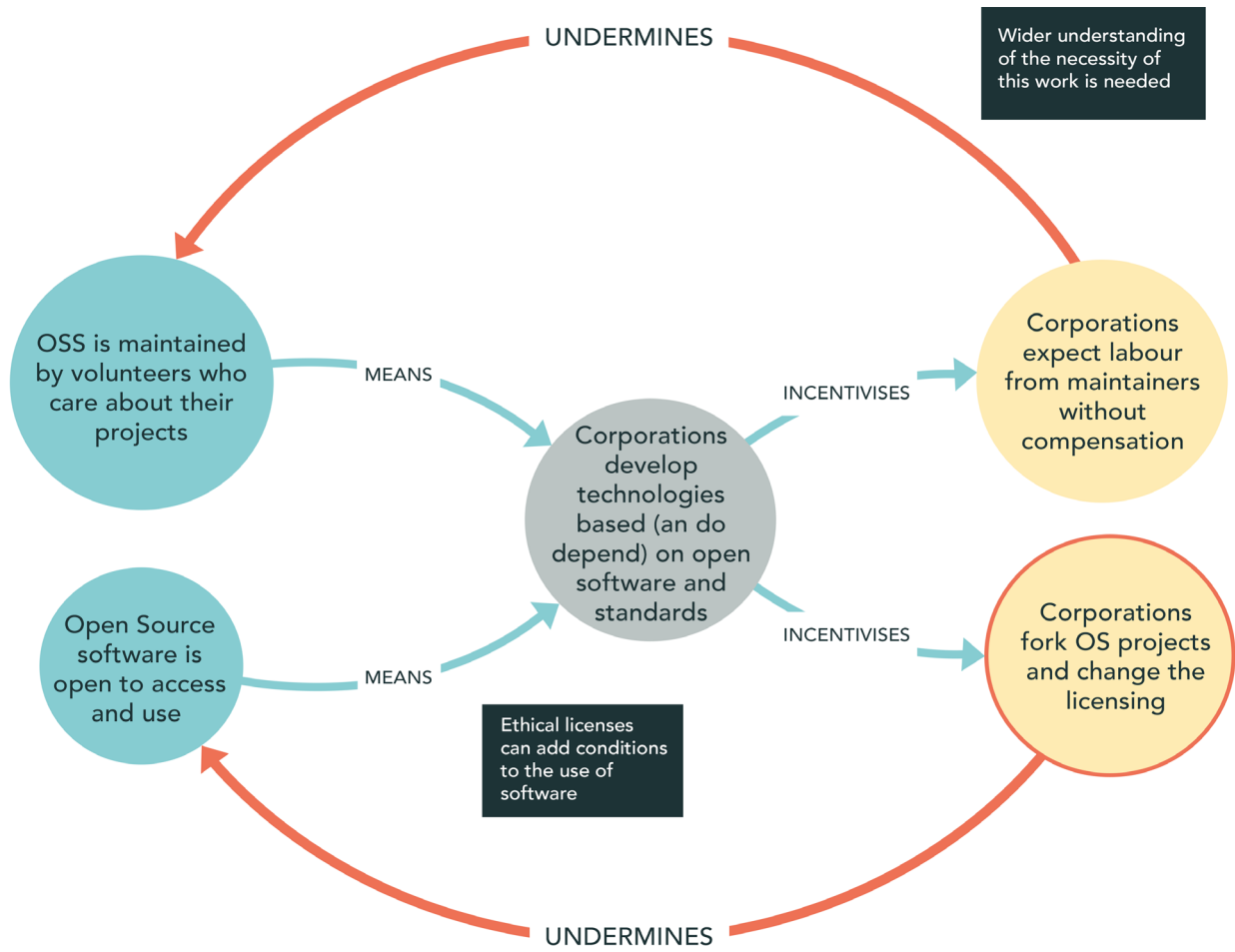
Fund a training and documentation toolkit for developers in a company setting to make the internal case for funding the OSS community.

Identify and support a position on Freedom 0, and look to build consensus within the OS community.

Ecosystem recommendations

Corporations should allow new hires to continue to contribute under the terms of an existing GPL or MIT license.

The open infrastructure ecosystem needs to be more accepting of conversations around the limits of Freedom 0. This includes creating safe spaces for these discussions as contributors have experienced harassment for expressing interests in the need to limit the kind of projects and companies that depend on their creations. As the custodians of the open source definition, the [Open Source Initiative](#) can lead these efforts on building consensus around these growing concerns.



APPENDIX ONE: THE OS ECOSYSTEM



APPENDIX TWO: HOW DO WE FIND OPEN INFRASTRUCTURE COMMUNITIES AND APPLY THIS METHOD TO THEM?

There have been a number of serious attempts to quantify these aspects of open source software projects in particular.

This comes with a warning, however: there is a danger that over-reliance on these quantitative measures (such as the number of dependencies a project has) could lead to a solely risk-based approach to intervention. While this might be justified for some targeted interventions - if your aim, say, is solely to help identify security holes in software - we contend that funding project integrity alone is not enough. Indeed, given a choice between improving the code and fostering an active community, committed to openness, we recommend concentrating on the latter.

Is a project foundationally important?

Perhaps the clearest metrics are available on the importance of a project to the open infrastructure ecosystem. The gold standard for these is 'Census II: Vulnerabilities in the Core', conducted by the Linux Foundation's **Core Infrastructure Initiative** - a wide-ranging census of applications designed to establish which OS modules are most heavily used, and whether they might be vulnerable to attack. The **OSSF's** criticality score project lists and assesses 'critical projects that the open source community depends on,' using public Github data to build indicators such as the frequency of code edits and the number of organisations from which the maintainer base is drawn.¹

Does a project need intervention?

For metrics of community health, the Linux Foundation's CHAOSS project has developed a detailed series of metrics for measuring the health of the community behind a given OSS project, designed to help measure contributions which often feel intangible.² On a per-project basis, Github provide a measure of each repository's community health, which provides a checklist of the minimum recommended documentation a project needs to provide in order to help contributors work on it.

Project integrity can be measured in a few ways. In assessing security, a global database of common vulnerabilities and exposures (CVEs) is maintained

by the MITRE project, and searchable at CVE. report. An absence of known vulnerabilities doesn't indicate code is secure - it could just be that no-one is looking hard enough to find them.³ However, packages with long-open issues, or which are well used but lack any reported bugs, should raise a red flag. For more general code quality, Libraries.io provide a 'SourceRank' measure for packages which can help assess the quality of the code and identify weaknesses, including the absence of basic documentation, and the date of the most recent release.

Each of the metrics above has its blind spots. For example, measuring the level of activity on a Github page can be useful in identifying important projects, but ignores projects which are not on Github, or are 'dead' but still in use.

A solution to this issue is being explored by the OSSF, which maintains a list of vulnerable projects based on a combination of metrics, including ranking in Census II, popularity gained through featuring on Google and Microsoft's 'open source' pages, and recommendations from the OS community. While this is in itself an imperfect measure, and a work in progress, this combinatory approach makes their recommended list of 103 critical projects a good place to start; though some of them are already well funded and supported.

1 https://github.com/ossf/criticality_score

2 The CHAOSS homepage, along with detailed documentation on the metrics they have developed, can be found at <https://chaoss.community/>

3 There are people proactively providing this scrutiny - the Open Source Technology Improvement Fund has been providing expert vulnerability audits of at-risk OSS projects - see <https://ostif.org/google-is-partnering-with-open-source-technology-improvement-fund-inc-to-sponsor-security-reviews-of-critical-open-source-software/>

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