

# The Long Road Ahead: Ongoing Challenges in Contributing to Large OSS Organizations and What to Do (Supplemental Materials)

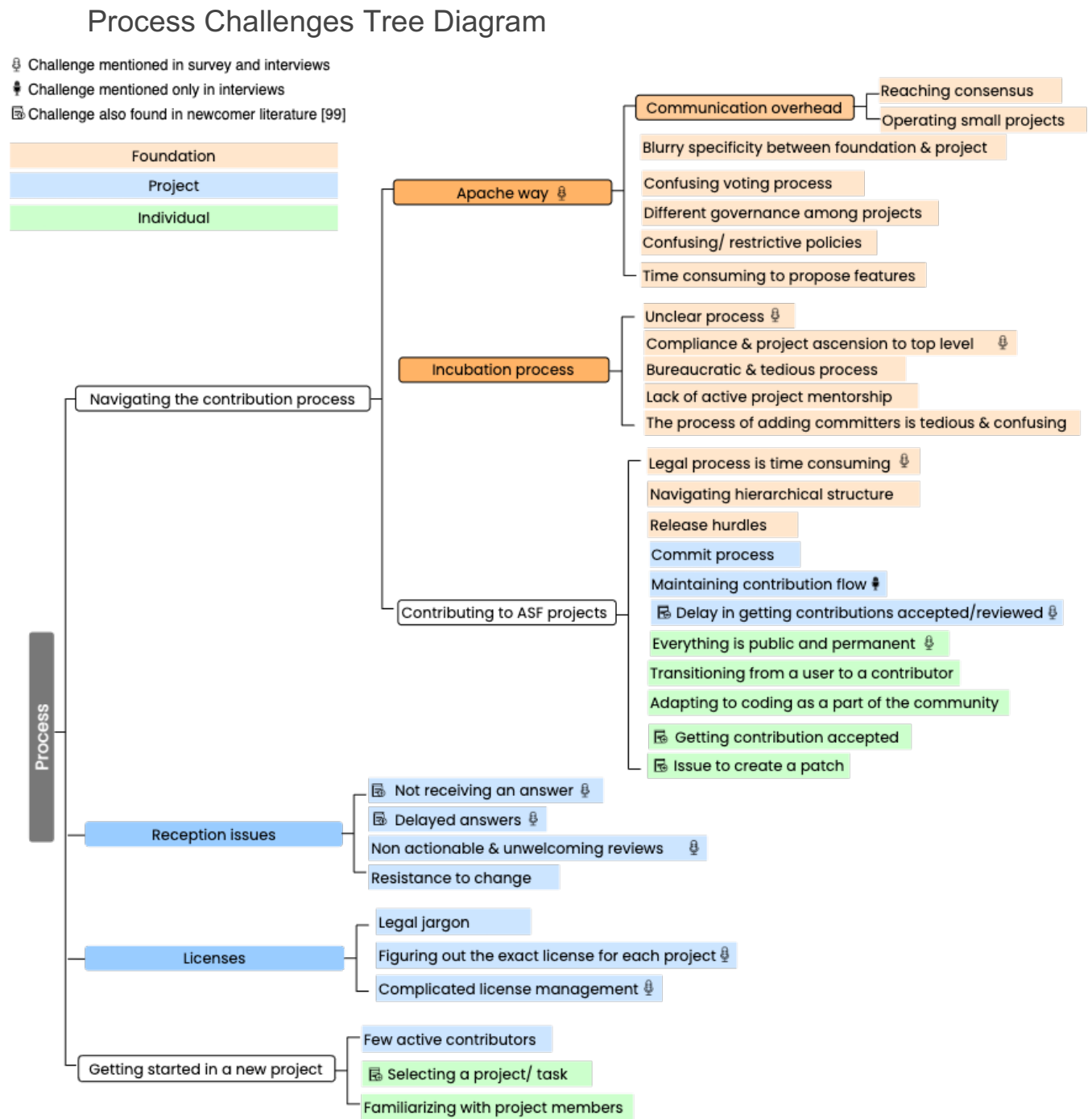
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# Results supplemental materials

## Process:









**Figure 1** presents the challenges related to the Process at three levels: Foundation (orange), Project (blue) and Individual (green).

Table 1a. Process Challenges Table

Challenge Level 1	Challenge Level 2	Challenge Level 3	Challenge Level 4 (leaf)	Description of challenge	Example Quote
Navigating the contribution process	 Apache Way	Communication overhead	Reaching consensus	During discussions (e.g, decision making) reaching agreement can be challenging	“Without a management structure, achieving consensus is too difficult and causes people to drop out and discourages people from joining.” [S-398]
			Operating small projects	Multiple communication media can be overwhelming for small projects	“a lot involved to just simply participate ... (mailing list, setup, conversation, chat etc...) while great for big projects, for smaller more recent one, it was exhausting.” [S-102]
			Blurry specificity between foundation and project	It can be difficult to differentiate between policies and rules which apply to ASF as a whole and those that are project specific.	“sometimes it's hard to understand what things apply to the ASF, and what applies to only a single project. Sometimes the borders are blurred.” [S-665]
			Confusing voting process	The voting process can be confusing especially in cases where consensus cannot be reached.	“It's also not super clear how the idea of "rough consensus" works with regards to coming to consensus on changes within the project (new features, designs, libraries, etc) and how to proceed if "rough consensus" cannot be reached.” [S-404]
			Different governance among projects	Even within the same Foundation philosophy, different project can have different governance this can be particularly challenging for people involved in different ASF projects	“different projects have different cultures (some radically so).” [S-157]
			Confusing/ restrictive policies	Policies can be restrictive for certain projects	“ASF policies for contributing, hosting, backwards compatibility were too restrictive. “ [S-550]
			Time consuming to propose features	Proposing features can be time consuming and costly especially when the discussion does not happen at the early stages	“the idea was then discussed and rejected rather when I proposed the idea.” [S-409]
	Incubation Process		 Unclear process	The incubation process can be unclear and open for interpretation which can makes it difficult and time consuming	“Well, what the incubator...meant at the time was just a certain number...it's not well defined... now






				to determine the next steps.	looking at what I spent a couple of months reading everything that is written at Apache...there is no definition in the research of vendor neutrality. It's not there, it doesn't exist. Um, and so, trying to figure out for my research, trying to figure out like, what people really mean by that"[I-3]
			🔗 Compliance & project ascension to top level	The procedure of integrating a project into ASF and making sure it's in compliance	"the single most difficult aspect was bringing an existing open source project into apache and adhering to the guidelines hardest ongoing challenge...making sure we're in compliance." [S-642]
			Bureaucratic & tedious process	The incubation process can be seen as bureaucratic and tedious	"joining the incubator...have to label your project as "not ready yet" literally everywhere (-incubating in releases version, repositories, websites, etc) independently of the prior maturity of your project outside the incubator...with bureaucratic processes." [S-615]
			Lack of active project mentorship	The unavailability of active mentorship can be challenging for podling projects who are left with their own interpretation of the resources they can gather.	"lack of active mentorship during poddling incubation process. having to assemble an understanding of "the Apache Way" from myriad (sometimes contradictory) sources." [S-342]
			The process of adding committers is tedious & confusing	The process of adding a committer can be challenging and confusing	"When our project was in incubation, the process of adding committers involved several steps ...The process itself was confusing, and at times our mentor was unavailable so things stalled. I got so I hated adding committers."[S-451]
	Contributing to ASF projects		🔗 Legal process is time consuming	Legal work includes wait periods, which makes the process time consuming	"in [project name], the challenge [is] bringing the [code] from the [name of the company] corporation into Apache Software Foundation, there's a lot of legality involved. And that requires a wait period ... So that requires quite a lot of hand holding." [I-6]
			Navigating the hierarchical structure	There is no clear roadmap to navigating the hierarchical structure. It is not clear what the next steps for transitioning	"It was also not completely clear what extra tasks I had to do to complete my transition to becoming a committer as well as becoming a





				to a new role	PMC member later down the line. I.e. once the community has nominated you, it's not super clear what else you have to do to fully transition." [404]
			Release hurdles	The release process itself can be tedious	"process for cutting a release is very tedious" [S-442]
			Commit process	The commit process can be challenging especially when it is different from other projects.	"I found a "git" culture clash when going from non-Apache projects...to Apache projects where...commits are pulled directly into the final git history." [S-832]
			🔧 Maintaining contribution flow	Retaining contributors and maintaining a consistent rate of contribution can be challenging	"Oh, the main challenge for all of the Apache project that I know is to keep the community up and running. Yes, because people come, they come, they fix their bug and they go away. But if you don't have a strong core group of people that move the project forward they They keep the project alive. The project is as low down." [I-11]
			🕒 Delay in getting contributions accepted/reviewed	Getting a contribution accepted or reviewed can take time and persistence from the contributors. Sometimes contributions are left unnoticed for long periods of time.	"Project was inactive - bug report / patch was ignored until I've pinged the PMCs." [S-480]
			🌐 Everything is public & permanent	All contributions and most communication in OSS are open for anyone to see and are permanently archived. This can be daunting for some.	"the knowledge that whatever you do is going to be public is a bit daunting" [I-20]
			Transitioning from a user to a contributor	The transition from being a user to becoming a contributor can be challenges	"needed to find a way from reading mailing list as a user to file jiras and contribute" [S-370]
			Adapting to coding as a part of the community	Coding as part of the community can be challenging for some and can requires a paradigm shift	"switching from one-man coding to a community approach is sometimes hard" [S-655]
			📝 Getting contribution accepted	Convincing the project to accept your contribution is not trivial	"It was hard to convince the project committers in my decisions and why they should have accepted my code." [S-326]
			📝 Issue to create a patch	Creating a patch is not straightforward especially when it's the first time.	"I had never created a patch file. But they helped me" [S-218]

<b>Reception issues</b>			 Not receiving an answer	Not getting any responses from the community	"I have submitted patches, but it never got anywhere. I didn't get any. Like, I didn't really see anything back....means that community is not active" [I-1]
			 Delayed answers	Delayed responses	"there will be no response or no acknowledgement until four days, five days, 10 days...feels demotivated, seeing your PR just lying down and no actions on it." [I-20]
			 Nonactionable & unwelcoming reviews	Unwelcoming and non-constructive code reviews	"the experience of getting code reviewed...is so negative." [I-5]
			Resistance to change	Resistance can arise when making changes within a project	"when you change it, you can get people coming out of the woodwork angry about the change." [S-73]
<b>Licenses</b>			Legal jargon	The legal documents can be hard to understand.	"to understand ASF license and related law affairs is a challenge." [S-191]
			 Figuring out the exact license for each project	Identifying the exact the license to use for each project	"The process of figuring out what licenses were compatible for use in an apache project was a bit difficult" [S-404]
			 Complicated license management	License management especially when dealing with third party dependencies	"Licensing questions are still among the hardest and I think are done wrong very often. A step-by-step guide for checking and adding a third party dependency would help." [S-576]
<b>Getting started in a new project</b>			Few active contributors	Absence of active contributors	"There are not much active contributors to the project. I had to find out a lot by myself." [S-215]
			 Selecting a project/ task	Selecting the next project or task can be challenging	"Picking a simple task was a uphill"[S-137]
			Familiarizing with project members	Getting to know project members and becoming part of the community can be challenging for some	"challenge was to getting familiar with the project members." [S-115]





**Table 1a** presents the challenges related to process. Challenge Level 1 represents the Process top-level category and challenge level 2,3 and 4 represents refinements of the previous level categories in the respective order.

Table 1b: Process Strategies Table

Challenge Level 1	Challenge Level 2	Strategy	Description of strategy	Example Quote
Navigating the contribution process	Contributing to ASF projects	 Provide training and best practices tools for reviewers	Provide training/ best practices on how to provide welcoming actionable reviews	"it's mostly that they [reviewers] don't know how to be better...so I think if we if we could somehow give them tools... not like software tools, but like, the, like personal tools to be more approachable and friendly reviewers. I think that would be really good." [I-5]
		 Improve the code review process	Ease the review process, provide a template walkthrough script that prompts questions	"some tooling so that people can just make a pull request, and answer sort of like a template set of question...they have a little script that walk someone through everything for their project...also kind of makes the review process easier" [I-5]
		 Provide training on contributing to ASF projects	Hand over contribution process and guidelines about both github and non github projects through videos, provide templates and instructions to fill issues and pull-requests and publish troubleshooting pages	"The support that I would like to see from the foundation is a set of tools and artifacts that we can use to improve the experience...For example, templates" [I-18]
		 Encourage knowledge transfer	Enable between projects knowledge transfer	"I suggest trying to survey and learn from other projects and organizations about their process" [S-813]
		Democratizing open source licensing	Making OSS licensing more accessible to everyone and provide guidance on when to use the different licenses	"more guidance on how to figure out if a particular project's license means it can be legally used... and the difference between licenses that can be vendored and used in a project" [S-404]
	Apache Way	Modernize introduction to Apache	Provide a welcome pack, ASF movie, videos, and presentations	"We need a video guideline on Youtube or somewhere else to introduce the process of the basic principle of ASF." [S-147]
		Provide regular training on ASF	Provide trainings and workshops about ASF principles, community building, and project funding	"it'd be nice if there is a training to help contributors fund the projects, or aid in building the community." [S-429]
		 Provide clear guidance on the governance process	Provide information about the voting and about how consensus is reached, publish the hierarchical structure	"More guidance on the voting process and how the process of rough consensus is supposed to be reached and what to do in cases where it cannot be reached" [S404].

		Give projects more agency	Standardize ASF general policies but give projects more agency to deviate from the ASF guidelines and adjust them to the project's members' way of working – provide the flexibility to accommodate different ways of working.	"The policies are ...very strict with little room to maneuver. (some policies are good in this Form, but some do not make sense to be this strict." [S-186]
		Make becoming a reviewer equitable	Ease the process of becoming a reviewer and provide automatic setup system for new contributors	"Make it easier for developers to become reviewers" [S-645]
	Incubation Process	Remove negative stigma involved with "incubation" status	Recognize the project merit during the incubation process and have mentors take on the guiding hat instead of the assessment hat	"Avoiding using the label "-incubating" as synonymous to "not worthy yet" [S-615]
		 Provide sample success paths to guide through incubation	Provide prescriptive guidelines and example success pathways for new project to follow	"[I] made the incubator be a little bit more prescriptive... prescriptive in the sense of here's one successful path"[I-2]
<b>Reception Issues</b>		 Provide mechanisms to help with PR reception and acknowledgment	PR reception acknowledgement bots, automate pre-check and small merges, be able to change the status of ticket under review and implement an availability dashboard to help with PR assignment. Establish a project policy to review and triage all tickets (e.g, Jira tickets) and have some contributors rotate on this task	"Automatic verification is important because it's something that is automatic and it immediately answer to the response to the contributor... if I contribute a patch now, maybe no one is, has free time to check my patch and to answer... but if there is something that validates automatically a patch and answers with the adds comments...it also gives an immediate response." [I-11]
<b>Getting started in a new project</b>		 Increase ASF mentorship mechanisms	Add ASF mentorship programs for newcomers focused on learning the Apache Way and OSS contribution, provide more mentors, broadcast and ease the process of reaching out to them and provide the option of regular mentorship office hours, involve inactive senior contributors in knowledge transfer and recognize the participating mentors (e.g, mentor of the month)	"1.Create a team of mentors for new contributors; have regular office hours (f2f at conferences and online) 2. Advertise how to get in touch with mentors for contributing to tech docs, code, events, helping the infrastructure organization; 3. Make it easy for schedule an online 30 minute session with a mentor after initial intake process for contributing" [S-843]
		 Have dedicated process enablers	Each project should have an enabler dedicated to help with process, formal issues and pedantic policies. Enablers are non official mentors that help unblock contributors, give them context and point them to the right resources	"I will say that I think like this term that we use, the enabler, it's very necessary. And you can do it with more than one person. I have seen that role for me... And basically what it is, is pay attention to new people who come to your community, and make sure that the energy and effort that they bring to the project is well invested." [I-18]



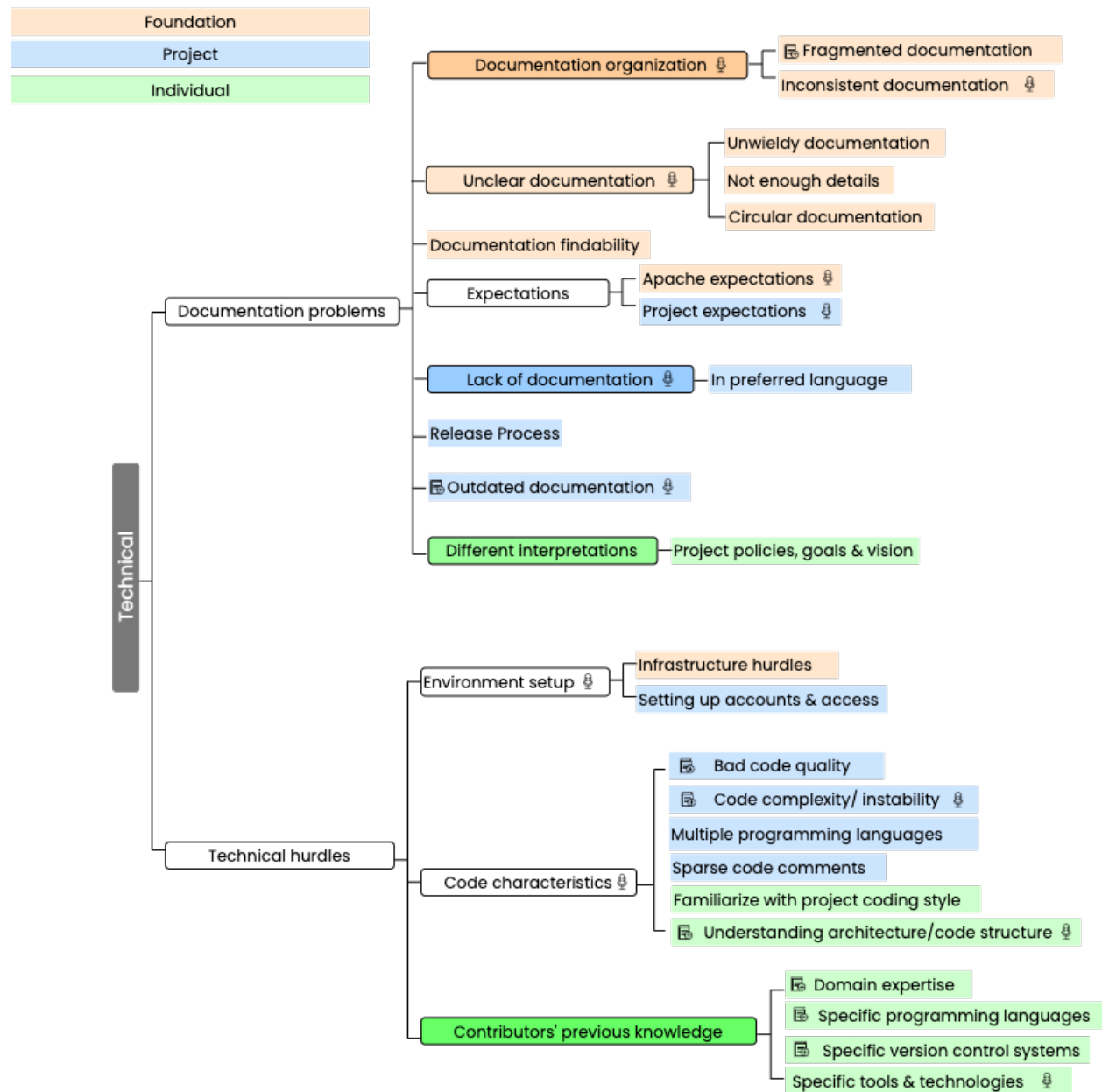
		 Invest in events and hackathons	Organize more events, meetups and hackathon	"Hackathons are great because often if you can get them over the first hurdle for the first change, they are then hooked and will make more changes." [S-73]
		 Ease the process of choosing a project	Publish a list of ASF project organized by activeness and newcomer friendliness; Create project maps that provide an overview of the type of contributions each project needs	"I guess if we can list sort the projects giving a score based on the activeness, it will be easy to get a decision." [S-115]
		 Have a formal internship program	Start an internship program inside of Apache and provide pair programming options, provide authoritative documentation about the internship process and have a recognition mechanism in place (e.g, mentee of the month); Have students contribute to open source project in university	"have at least some rough agenda around that saying, Okay, if the mentor and the mentee for three months of internship, then here is the rough agenda, they can follow week one to do x y z. two, three expected outcome, some blog posts from mentor and some from mente on how did the entire process go." [S-20]
		 Start with documentation changes	Start with documentation changes to get familiar with the project's contribution flow	"start with at least documentation changes to get used to the process of contributing, reviewing, getting feedback, and then the prs getting merged." [I-20]

**Table 1b** presents strategies for overcoming the process challenges mentioned in Table 1a. Challenge Level 1 represents the Process top-level category and challenge level 2: represents a refinement of the top-level categories. See Fig. 1 for the meaning of the icons.

# Technical







## Technical Challenges Tree Diagram









📋 Challenge mentioned in survey and interviews  
 👤 Challenge mentioned only in interviews  
 📖 Challenge also found in newcomer literature [99]








**Figure 2** presents the Technical challenges at three levels: Foundation (orange), Project (blue) and Individual (green).

Table 2a: Technical Challenges Table






Challenge Level 1	Challenge Level 2	Challenge Level 3	Challenge Level 4 (leaf)	Description of challenge	Example Quote
<b>Documentation Problems</b>	 Documentation organization		 Fragmented documentation	Documentation is unorganized and scattered	"The ASF documentation is spread all over the place and poorly organized." [S-212]
			 Inconsistent documentation	Some documentation sources contain different sometime contradicting documentation	"often felt undocumented and many with a lot of differencing opinions about things like what goes in license files, what constitutes a release, etc." [S-426]
	 Unclear documentation		Unwieldy documentation	Wordy and confusing documentation	"Much of the documentation reads like it was written by lawyers, not engineers. Which is why I find it frustrating to read; too wordy and indirect when a simple example would suffice." [212]
			Not enough details	Documentations do not include ample explanations and details	"The ASF documentation...none of which actually provide sufficient detail" [S-212]
			Circular documentation	Documentation is hard to navigate and redirects users to multiple documents in a circular manner	"The web pages sometimes link to each other in such a way that I'm going in a loop trying to find information...It's hard to suggest how to prevent that "endless loop" feel." [S-600]
			Documentation Findability	Documentation can be buried in information and not easy to find	"Quite simply information is very hard to find on the Apache website. Search _may_ turn up a page which appears to be close to what you're looking for, but navigation is non-existent, so one cannot then _browse_ from there." [S-618]
	Expectations		 Apache Expectations	There is a lot of expectation around the knowledge you should have as part of the foundation but those expectation are not explicitly documented	"I will say like, all these challenges around the Apache way come from that perception of tribal knowledge and in belonging that you are expected to have" [I-18]
			 Project Expectations	Vaguely documented project expectations	"the main challenge is figuring out how a project likes to accept contributions and what their expectations and tooling is around that. I don't think that this challenge is unique to ASF projects" [S-488]




	 Lack of documentation		In preferred language	There can be little or no documentation in contributor's preferred language	"Not enough information for contribution or ASF Activities in my language(Korean)." [S-528]
			Release Process	Absence of clear, easy to find guidelines about the release process	"The process for cutting a release is very tedious. The documentation is not very clear (and is hard to find), so it seems that each product does its own documentation." [S-442]
			  Outdated Documentation	Documentation can be outdated	outdated project "sites", documentation. [S542]
	Different interpretations		Project policies, goals, & vision	Multiple interpretations of project policies, goals, or visions can lead to conflict	"Sometimes ASF documentation is confusing... When policies are confusing, this has sometimes resulted in conflict in our communities due to people interpreting policies in different ways" [S-821]
<b>Technical Hurdles</b>	 Environment setup		Infrastructure hurdles	The ASF infrastructure itself can be challenging	"ASF infrastructure (e.g., for web hosting) can be more limiting and presents more challenges to work with than public cloud offerings." [S-753]
			Setting up accounts & access	Difficulties setting up accounts or gaining access	"I have had recurring problems getting my login credentials to work. This slowed almost to a halt my contributions. " [S-494]
	 Code characteristics		 Bad code quality	Undocumented and poorly designed code	"mostly technical challenges due to an ageing (and sometimes in my opinion, poorly designed) code base, with lack of internal documentation." [S-701]
			  Code complexity/ instability	The code structure can be complex and hard to understand.	"Main challenge was to understand a complex project enough to make a significant contribution." [S-733]
			Multiple programming languages	Multiple programming languages can be challenging in maintaining a good quality code base.	"Found that committers might commit patches that had serious flaws due to unfamiliarity with a given language or lack of expertise. This is a hard problem...due to the wide range of languages supported" [S-80]
			Sparse code comments	Code may have little to no comments	"The biggest barrier is that the code is often the only reliable documentation, and the comments in the code can be very sparse" [S-387]

			Familiarize with project coding style	Adapting to a projects coding style can be difficult for some especially for contributor that contribute to multiple projects	"Adopting to the coding style of the project...there are some substantial differences to the style I have to use at my job, so it took some effort to switch between the styles." [S-240]
			 Understanding architecture/ code structure	Understanding the dependencies and architecture of the code can be challenging for some contributors	"understanding what the architecture of the project is what dependencies you need to be aware of" [I-18]
	Contributors' previous knowledge		 Domain expertise	A lack of domain expertise can be challenging when contributing or participating in discussions	"Everybody spoke about applications or programs or websites ...I felt like I was illiterate." [S-48]
			 Specific programming languages	The lack of knowledges in a specific programing language can be challenging	"Being an experienced Java developer, I wanted to contribute to Apache [project], which is written entirely in C...first challenge was learning C...never became a fluent language for me." [S-656]
			 Specific version control systems	Challenges related to knowledge on the version control system used by a specific project	"Understanding the git process more than anything else especially around cleaning up history before merging in a fix for instance." [S-585]
			 Specific tools & technologies	Contributors may have little or no experience with one or more specific tools the project uses	"not familiar with a lot of the tools and systems that Apache projects use" [I-18]

**Table 2a** presents the Technical challenges. Challenge Level 1 represents the Technical challenge top-level category and challenge level 2,3 and 4 represents refinements of the previous level categories in the respective order. See Fig. 1 for the meaning of the icons.

Table 2b: Technical Strategies Table

Challenge Level 1	Challenge Level 2	Strategy	Description of strategy	Example quote
Documentation		 Provide a comprehensive contribution documentation	More explicit and informative commit process, internal API, project architecture, Jira tickets and a basic FAQ for the project	"And the other mechanism that I think every single project should have is a contribution path that helps people progress through the project. And a contribution path has two things. Basic FAQ...Like what is architecture What system do we use to file bugs? How often do we release code etc. And the other is perhaps an introduction to all the systems that Apache uses like Maven and so on." [I-18]
		Clearly document the ecosystem expectations	Provide explicit overview of the projects' expectations and the Apache expectations	"The projects ought to be more explicit about the expectations for admissible code changes, including code quality and style guidelines enforced by automatic checks." [S-487]
		Provide recipe type and example driven guidelines	Provide standardized and step by step onboarding documentation and online tutorials, and example driven community cookbook	"Better onboarding documentation, with step by step processes for how to contribute in different ways." [S-359]
		 Make documentation easier to find and provide a single entry point for all Apache resources	Making process, policies and guideline easy to find through a google search, centralize all policies in an policies.apache.org and provide a policy search system, implement a single entry point for all apache resources	"Make them [policies, processes, and guidelines] easy to find using Google search." [S-382]
		 Leverage information architecture	Leverage information architecture strategies to restructure (organization structure) and reorganize (task/ topic organization scheme) the projects and foundation websites	"We need to get an information architect to help us restructure the main website (and possibly pull in additional material elsewhere such as svn, wiki etc.) so navigation is much more intuitive than it is currently." [S-42]
		 Promote accessibility	Involve designers and build accessible websites	"Building accessible websites is a really good example. I think that to build accessible websites, you need to have people with the right knowledge set like designers that have experience with people who are who have like week vision or can't hear" [I-18]
		Run interviews to get feedback	Run interviews and get recent onboards feedback	"Interviews with recent onboards and incremental improvement of docs based on their experiences" [S-340]
		 Concise, practical, and visual	More concise and readable, less text and more figures, provide examples, simpler structure, more details (purpose and goal of each step and policy) and streamline	"Make them easier to understand in simple words and summarized. It is difficult to find time to read a long, boring, technical document. " [S-334]

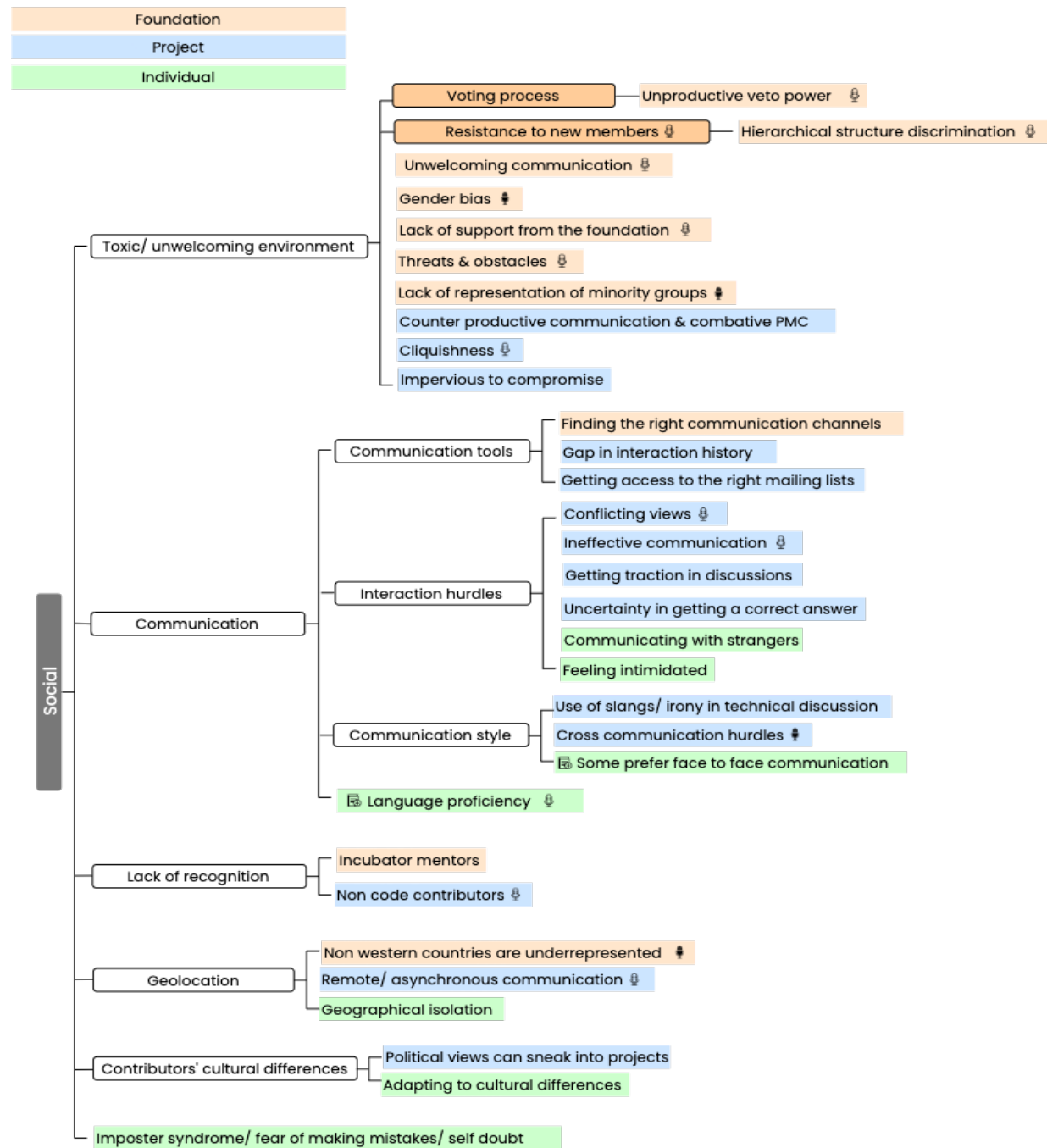
		documentation style	information per concept. Provide prescriptive documentation and create a clear distinction between authoritative and opinion-based statements	
		 Multi-language documentation	Provide translated versions of the documentation and regularize machine translation	"Most of ASF policies, processes, or guidelines is English. Although most of the content can be understood, there are a little detail information may be misunderstood if not translated accurately. So, I think it will be better if these policies, processes, or guidelines can translated by ASF official." [S-192]
<b>Technical Hurdles</b>		 Use automated tools, widely used tools and leverage upcoming technology	Use tools that are already familiar to contributors and provide guidance on incorporating upcoming technologies. Provide an automated credential resetting system, leverage automatic code formatting, use single sign on systems, provide integrated, secure, up to date and easy to use tools.	"Using modern tools like the push that happened for the past year is great: slack, github and gitbox makes the experience so much easier for contributors and committers so keeping up the pace there would be ideal" [S-317]
		 Be proactive and start the communication	Don't hesitate to reach out to committers about the yet to be reviewed PRs	"We are encouraging them to ping us [committers], nag us, multiple times, if not five times a day, at least they can ping us one time a day if the PR is not reviewed." [I-20]

**Table 2b** presents the recommended strategies for overcoming the Technical challenges. Challenge Level 1 represents the Technical top-level category and challenge level 2: represents a refinement of the top-level categories. See Fig. 1 for the meaning of the icons.

# Social

## Social Challenges Tree Diagram









- Challenge mentioned in survey and interviews  
 Challenge mentioned only in interviews  
 Challenge also found in newcomer literature [99]






**Figure 3** presents the Social challenges at three levels: Foundation (orange), Project (blue) and Individual (green).





Table 3a: Social Challenges Table

Challenge Level 1	Challenge Level 2	Challenge Level 3	Challenge Level 4 (leaf)	Description of challenge	Example Quote
<b>Toxic/unwelcoming environment</b>	Voting process		 Unproductive veto power	Consensus voting can delay decision making	"There are some very stubborn people who can delay decision-making for too long. When trying to vote in a committer, they would go on for days looking for reasons why that committer should not be voted in." [S-398]
	 Resistance to new members		 Hierarchical structure discrimination	Hierarchical structure can be seen as discriminating and unwelcoming	"no one with less than 10 years of experience is well regarded to lead anything at the Foundation." [I-18]
			 Unwelcoming communication	Communication can feel unwelcoming and overwhelming resulting in contributors refraining from participation	"I was happy being a committer but once I saw all the members discussion in the list I was overwhelmed...I have never commented on the members list for this reason." [S-62]
			 Gender bias	Bias towards non men contributors	"there are a number of male longtime members who are allowed to speak their mind pretty freely...But I noticed when I do it, I'm a.... Right?" [I-4]
			 Lack of support from the foundation	Not receiving any support or help from the foundation	"received no support from the foundation in correcting the situation. When I tried to correct the situation several ASF members came to me on the list and in person...contradicted each other, themselves, and me." [S-276]
			 Threats & obstacles	Encountering threats and obstacles in difficult situations where you expect the foundation's support	"When I tried to correct the situation several ASF members came to me...threatened to have the board remove me from my [current] role if I couldn't stop my former employer's misbehavior. I was unemployed at the time. The foundation was an obstacle and a threat, but at no time a support in the process." [S-276]
			 Lack of representation of minority groups	Lack of representation of minority groups within the foundation	"no one with less than 10 years of experience is well regarded to lead anything at the Foundation, which then imposes this chicken egg analogy into diversity and inclusion, you're never really going to have anyone with 10 more years of experience that....belong to a



					minority because these people haven't been at the foundation." [I-18]
			Counter productive communication & combative PMC	Communication at the PMC level can be counter productive making it hard to participate	Also I always felt the PMC was very opaque, exclusive, and the demeanor was not conducive. [S-794]
			 Cliquishness	Groups forms within the project and can result in it becoming exclusive and resistant to other contributors	"Another big hindrance on other projects was the company-oriented cliquishness where certain companies tried to exclude outsiders from committer and PMC status regardless of level of contribution." [S-299]
			Impervious to compromise	Some members are unwilling to compromise	"There are people who "can't be wrong". They are 100% sure their view of the world is correct when it isn't. They make assumptions about other people and lack the ability to see the world from other people's perspective...These people also require a lot of energy at times and causes people to drop out and discourages others from joining." [S-398].
<b>Communication</b>	Communication tools		Finding the right communication channels	Challenges relating to finding the best ways tools communicate in a particular situation	"Find the right communications channels, which depends not only on hard facts, but also on people." [S-407]
			Gap in interaction history	It is hard understand previous conversations if there is no history or context	"Communication mediums were hard to follow...If you get offline and come back few hours later, there is no history of what happened." [S-317]
			Getting access to the right mailing lists	Not automatically getting access to the right mailing list can result in missing out on certain communication media	"not automatically invited to the private@ list so I never knew about it until a long time after I became part of the PMC!" [S-468]
	Interaction hurdles		 Conflicting views	Some contributors have different or conflicting views. This can be challenging for decision making.	"some mentors or Apache members have differing views on some things, where information perhaps is contradictory...can be hard to decide...as it relates to a new project and PMC." [S-553]
			 Ineffective communication	Challenges from ineffective communication between contributors	"Difficult to have effective communication with contributors" [S-815]







			Getting traction in discussions	It can be difficult to be heard in discussions	"The biggest problem is to get enough traction for a discussion." [S-409]
			Uncertainty in getting a correct answer	The community does not always give you the answer or the right answers	"There's no clear pathway...you ask around and you may or may not get a correct answer" [S-184]
			Communicating with strangers	It can be difficult for some contributors to communicate with strangers	"Sending an email (on the mailing lists) to unknown people is nerve-racking" [S-382]
			Feeling Intimidated	Contributors can feel intimidated by more experienced or long term contributors/groups.	"Aligning with a long standing community felt a bit intimidating" [S-444]
	Communication style		Use of slangs/irony in technical discussion	Using slang, irony, or idiomatic expressions in technical discussions can be challenging especially for non-native English speakers	"it is still hard to understand phrases, slangs or irony from native speakers on operational lists." [S-259]
			🗣️ Cross communication hurdles	Not having a canonical language and using multiple different languages in communication can make it hard to communicate between teams	"problem is that you lose a lot of your cross-communication as soon as you step away from one canonical language." [I-4]
			🗣️ Some prefer face to face communication	Some contributors prefer to communicate in person rather than online	"communication online is hard and having a discussion online could be tougher than in person." [S-334]
			🗣️ Language proficiency	The language barrier can be challenging for non-native english speakers	"As a non-native speaker, one has to get used to the domain language, tone and discussion culture." [S-275]
<b>Lack of recognition</b>			Incubator mentors	Incubator mentors are not acknowledged and appreciated enough for their effort	"mentors who get scolded for "not contributing enough", when the incubator is the institution requiring rubber stamping and taking their limited mentoring time away" [S-615]
			🗣️ Non code contributors	Non code contributors do not get enough recognition	"So like doc writers or event organizers, and what have you, I don't think they're getting the kind of recognition that they should be getting" [I-3].
<b>Geolocation</b>			🗣️ Non western countries are underrepresented	Not enough representation from non western countries	"it has been remarkably ineffective at encouraging women, people from Sub Saharan Africa, you







					know, they're just big populations that are not there." [I-2]
			 Remote/asynchronous communication	Time Zone differences relating to contributor's locations can delay communication	"The delay in code reviews because of timezone difference between the contributor and the reviewer." [S-536]
			Geographical isolation	Can be hard to meet with others when geographically far from local contributors.	"Geographical isolation, difficult to meet local experts" [S-761]
<b>Contributors' Cultural differences</b>			Political views can sneak into projects	Political views can sneak into projects causing conflicts	"Political challenge: some projects wants sometimes to promote political views...My way was to abandon project such unwelcoming PMC who don't understand local interests." [S-840]
			Adapting to cultural differences	Cultural differences such as the way people address each other or the tone of voice used can be challenging to adapt to	"Culturally people address others difference (polite vs direct) and it causes harsh reactions." [S-789]
			 Imposter syndrome / fear of making mistakes / self doubt	Contributors feel that they are not good enough or are afraid to make a mistake.	"people would laugh at me or people would think that he is not a good developer...you are cautious...you have an imposter syndrome where you feel that you don't know anything." [I-20]

**Table 3a** presents the social challenges. Challenge Level 1 represents the Social challenge top-level category and challenge level 2,3 and 4 represents refinements of the previous level categories in the respective order. See Fig. 1 for the meaning of the icons.

Table 3b: Social Strategies Table

Challenge Level 1	Challenge Level 2	Strategy	Description of strategy	Example quote
<b>Communication</b>		 Create communication best practices with suggestions	Create communication guidelines with suggestion and encourage summarizing and avoiding the use of jargon and complicated English	"I would suggest making it clearer for native english speakers that mailing lists are not where they'll win the next literary prize." [I-270]
		 Transition from tacit to explicit	Document best practices, tools for communication and provide a process for conflict resolution	"Perhaps apache sites should document that the best way to do email interaction is through web site and gmail is flaky. " [S-442]

		 Leverage both public and private channels and disclose their visibility	Praise in public, coach and critique in private and disclose the visibility of each communication mailing list	"often helpful to coach them in private...then the person can have a more successful first interaction or ongoing interaction, and they can be then valued more highly by the community...back channels are a very valuable way to do that....much easier to resolve that in private...it's easier to speak to one person than speak to 100." [I-2]
		Automate a role-based sign up to mailing lists	Provide a better alternative to signing up on a mailing list where people with different roles are automatically signed up to the right mailing lists	"we should find other alternatives to mailing lists, that will maintain "thread conversation" but people outside will already in without the need to signup, so be more easy for them to start talking with community" [S-305]
		Create a list of helpful contacts	Provide a list of helpful contacts, a communication group and a help hotline for contributors who face communication difficulties	"A list of friendly and helpful contacts who are familiar with the different projects that new comers can reach out to. Better onboarding documentation, with step by step processes for how to contribute in different ways." [S-359]
		 Leverage real time communication	Incorporate real time communication tools to foster connection and a sense of belonging and create guideline on how and when to use real time communication	"I will say that things like slack and more real time communication help too. Because mailing list I know it's the preferred official way for ASF and it will definitely continue to be, but I think like to drive connections especially in an early stage, the slack and chat help a lot." [I-18]
		 Use productivity management strategies	Give yourself time to adapt, set a goal for yourself, seek help when needed and leverage grammar tool to help with english	"you want to contribute something, right? If you're just being asked most of the time, and you just want to contribute your time, you don't really [contribute]. So you want to have a goal." [I-14]
<b>Toxic/ unwelcoming environment</b>		 Provide guidelines and active support toward an inclusive environment	Provide guidelines for a safe and inclusive communication space and provide active support especially to those contributing in difficult circumstances	"we need to create an inclusive space for people of different backgrounds, communication styles, and approaches to design and problem-solving." [S-622]
		 Include minority groups in the D&I discussion	Involve the minority groups in the D&I discussion and decision, provide a trusting environment for them to voice their opinions	"And we're going to need to listen to these people, and we're going to need to trust them." [I-18]
		 Provide means to keep the community active and healthy	Rethinking unconditional lifetime participation by providing a retiring policy for inactive/ misbehaving contributors at any level and a resumption policy for returning contributors. Implement a way to deal with misbehaving individual in a gradual manner	"So if PMC members are not that active, removing them removing those PMC member actively instead of letting the active PMC members have a vote on it. So, I would say ASF should have some kind of policy that if you have not contributed in last three years, then you should be removed because yeah, you want your current community to be healthy and active." [I-20].

		 Rethink the voting system	Remove veto power and find a better conflict management system	"Remove veto, coach PMC and contributors on conflict management." [S-794]
		 Promote minority focused online meetings	Encourage women involvement by starting a women in apache online meetings	"Have a "Women in Apache" online meeting once a month for women contributors to get more involved in the Apache projects" [S-843]
Lack of recognition		 Value all types of contributions	Create best practices to values all contribution and explicitly incentivize non code contributions (e.g, documentarians) and mention that these are valuable first class contribution that can lead to committership and election as a PMC member, create a central system to monitor these contributions and provide guidelines about how to assess impact.	"Value ALL contributions." [S-32]
		 Invest in mentorship	Create mentoring training and certification to encourage more contributors to take on the mentor hat	"A mentoring program will be always great." [S-824]
Geolocation		 Invest in growing the international community	Provide toolkit on how to launch and build a community in a new country, dedicate funds/ events to enlarging the community in other regions and have local meetup groups	"One idea I had was to create local communities in the local language...they had like local language talks as well. So I think this is a good step...if they are aware about it, they know about it, they'll start going to such talks, they will get inspired, or at least they would get a map on how they could do it, then they will start towards it." [I-20]
		Diversify the ASF events location	Host ASF forums/ events in diverse location: Work on being less US centrics and organizing forums outside the US	"it would be to welcome the ASF to China to host the forum" [S-527]
Contributor s cultural differences		Provide the option of offline training when possible	Organize offline training to help those who prefer face to face interactions	"Organize more offline training and meetings." [S-203]
		 Encourage awareness and acceptance	Provide an optional profile information platform where contributors can input their preferred language (and indicate if english is their first, second or third language), their preferred means of communication, their background, etc... to encourage awareness of the cultural differences and provide more equitable resources	"In [company name], [company program name] program which was international. Created a Directory where [employees] provide profile to help interaction (put in context) - who they are, which language they speak." [I-18]

**Table 3b** presents the recommended strategies for mitigating social challenges. Challenge Level 1 represents the Social top-level category and challenge level 2: represents a refinement of the top-level categories. See Fig. 1 for the meaning of the icons.

# Methodology supplemental materials

## Interview script

### Startup script

Thank you for chatting with us. I am \_\_\_\_\_ and \_\_\_\_\_. In this interview, we want to know more about your experiences in ASF. The interview will be 30 - 60 min long and will be audio-recorded to help us with the analysis. All information will be anonymized and raw data will not be shared with ASF. After analysis the recording will be destroyed. This part of the study will be guided by the protocols set by the Humans Research review board (IRB) at

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As an appreciation for your time we are happy to offer you a \$50 Gift Card or make a \$50 donation to your open source project of choice.

Here is the informed consent required about the study, could you please read it over [share screen with consent form].

We are going to start the audio recording now [start recording]

### Profile

- ☐ Tell us a bit about your current work at ASF

### Challenges and suggestions

- ☐ What were your main “challenges” you face with the project?
- ☐ What are the mechanisms that can support the contribution process in ASF?

## Summary of survey modification post community feedback

Note: To all of you providing feedback, big thank you for your time. We prefer to indicate here how much we appreciate your time and effort in this task than in each of the comments (this would be too noisy). Thanks!!

### How long have you been involved with the ASF?

Answer Choices (pick one)
Less than 3 years
3 to 5 years
5 to 10 years
Over 10 years
Prefer not to say

**Comments regarding the feedback provided:** *With these questions we are trying to understand for how long someone has been involved in the ASF. We changed the age ranges as per feedback.*

### In general, do you contribute to the ASF as a volunteer or as part of your paid work?

- Volunteer only
- Paid work only
- A mix but mostly volunteering
- A mix but mostly paid
- No answer

**Comments regarding the feedback provided:** This question was reworded taking into account the recommendations. With this question we intended to understand how much time would a person invest in ASF activities, considering those paid, unpaid or a mix of both. We changed the wording as per feedback switching “volunteering” to “unpaid” and added “an equal mix of paid and unpaid”.



**Do you face any barriers when participating in ASF (e.g., language differences, technical expertise, cultural differences, etc)?**

- No barriers
- Few barriers
- Several barriers
- Many barriers

**Comments regarding the feedback provided:** This question was reworded taking into account the recommendations. Changing the word “barriers” to “challenges”.

**If you have experienced barriers in participating in the ASF, describe an example for when you experienced the barrier, how it affected you, and how, if at all, you overcame the barrier.**

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**Comments regarding the feedback provided:** This question was reworded taking into account the recommendations. Changing the word “barriers” to “challenges” to match the previous question.

**What suggestions do you have for improving the ASF policies, processes, or guidelines available to new contributors?**

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**Please choose your country of residence.**

[v] Dropdown of Countries |

**Comments regarding the feedback provided:** the drop downs menus have been changed to a list of options of all the countries to choose from

**How confident are you in your ability to read, write & speak in English when performing the following activities...**

	Uncomfortable	Not confident (can speak, but difficult)	Average	Confident	Very confident (fluent)
Performing reviews					
Participating in non-technical discussion					
Participating in technical					

discussions					
Speaking with others (face to face)					

**Thinking about your childhood, which socio-economic status did you identify with?**

- Lower
- Working
- Middle
- Upper middle
- Upper
- Prefer to identify as \_\_\_\_
- Prefer not to say

**Comments regarding the feedback provided:** the keyword 'class' seemed to be confusing. So, we removed this word and instead we ask for the perception of the contributor with respect to their socio-economic status. This question does not intend to work on understanding individuals' incomes, but their perceptions of with respect to others in their country/community..

**Thinking about your current situation, which socio-economic status do you identify with?**

- Lower
- Working
- Middle
- Upper middle
- Upper
- Prefer to identify as \_\_\_\_
- Prefer not to say

**Comments regarding the feedback provided:** This question has been rephrased to match the previous question wording.

**Comments regarding further discussion:** The two questions above about the socio-economic status have been removed after further discussion as they were perceived to be sensitive.

**How do you identify yourself as. Check all that apply.**

<b>Answer Choices</b>
Man

Woman
Non-binary
Prefer to not disclose
Prefer to self-describe

**Do you consider yourself to be transgender?**

- ☐ Yes
- ☐ No
- ☐ Questioning
- ☐ Prefer not to disclose

**Comments regarding feedback provided:** there has been a really good discussion around this topic. Thanks for all of the feedback. We combined these two questions by adding tran-man and tran-women to the option list and rewording “non-binary” to “gender variant/ non conforming/ non-binary”.

**What is your education level (or equivalent)?**

- No formal education
- High school
- Technical training
- Undergraduate degree
- Master's degree
- Ph.D

**Comments regarding feedback provided:** there has been a really good discussion around this topic. Thanks for all of the feedback. The main issue here is about nomenclature and how to name the different levels. Specific keywords such as college seemed to be confusing. In order to keep this simple, it was decided to go for a broader definition and reduce the number of options (situations where people have completed certain parts of a degree are not considered now, for instance).

**Thank you for thoughtfully completing the survey! Your response has been recorded.**

If you would like to participate in Gift Card raffle (we are giving out fifteen 75 USD gift cards) please provide us your email address below.

**Participate in raffle (yes/no)**

**Comment regarding feedback provided:** the raffle question has been removed from the survey. This was decided after discussing the legality involved with equally providing this option in all the different countries.

If you would like to volunteer for a follow-up video conference interview to help us explore the survey results in more detail, please provide us your email address below.

- Volunteer for follow-up interview (yes/no)

**Email address:**\_\_\_\_\_

## Survey questions

The following pages present the survey questions and consent form



**The ASF is researching the state of our community through this survey. It will prompt you to provide basic information on your contributor role, your experiences with, and perceptions of, the Apache community, as well as some demographic information. The Apache Software Foundation (ASF) promotes open, community-focused projects that are welcoming to all. Your survey responses will help us understand to what extent we are meeting our equality, diversity, and inclusion objectives.**

**The survey is estimated to take approximately 15 minutes of your time and is voluntary. Data will be aggregated and anonymized to help us understand the experiences of different groups. Your responses will be anonymous unless you want to share your email address for follow-up questions. No IP addresses will be recorded.**

**See our [REDACTED] for more information about this survey. If you have further questions, please contact the administrators of this survey: [REDACTED]**

**[REDACTED]**

**For collected data, we are following the Apache Privacy Policy.**

**By clicking "next", you acknowledge to participate voluntarily and to have read the text on this page.**



## Section A: Main questions

### A1. How long have you been involved with the ASF?

Less than 1 year ☐

1 to 2 years ☐

3 to 5 years ☐

6 to 10 years ☐

Over 10 years ☐

### A2. In general, do you contribute to the ASF as paid or unpaid work?

Paid work only ☐

Unpaid only ☐

An equal mix of paid and unpaid ☐

A mix, but mostly paid ☐

A mix, but mostly unpaid ☐

### A3. What is your education level (or equivalent)?

No formal education ☐

High school ☐

Technical training ☐

Undergraduate degree ☐

Master's degree ☐

Ph.D ☐

### A4. Did you face any challenges when you started to participate in the ASF (e.g., language differences, technical expertise, cultural differences, etc)?

No challenges ☐

A Few challenges ☐

Several challenges ☐

Many challenges ☐



**A5. Describe an example for when you experienced the challenge, how it affected you, and how, if at all, you overcame the challenge.**

**A6. What suggestions do you have for improving the ASF policies, processes, or guidelines available to new contributors?**

**A7. Please choose your country of residence.**

Afghanistan ☐

Albania ☐

Algeria ☐

Andorra ☐

Angola ☐

Antigua & Deps ☐

Argentina ☐

Armenia ☐

Australia ☐

Austria ☐

Azerbaijan ☐

Bahamas ☐

Bahrain ☐

Bangladesh ☐

Barbados ☐

Belarus ☐

Belgium ☐





- Belize
- Benin
- Bhutan
- Bolivia
- Bosnia Herzegovina
- Botswana
- Brazil
- Brunei
- Bulgaria
- Burkina
- Burundi
- Cambodia
- Cameroon
- Canada
- Cape Verde
- Central African Rep
- Chad
- Chile
- China
- Colombia
- Comoros
- Congo
- Congo {Democratic Rep}
- Costa Rica
- Croatia
- Cuba
- Cyprus
- Czech Republic
- Denmark







- Djibouti ☐
- Dominica ☐
- Dominican Republic ☐
- East Timor ☐
- Ecuador ☐
- Egypt ☐
- El Salvador ☐
- Equatorial Guinea ☐
- Eritrea ☐
- Estonia ☐
- Ethiopia ☐
- Fiji ☐
- Finland ☐
- France ☐
- Gabon ☐
- Gambia ☐
- Georgia ☐
- Germany ☐
- Ghana ☐
- Greece ☐
- Grenada ☐
- Guatemala ☐
- Guinea ☐
- Guinea-Bissau ☐
- Guyana ☐
- Haiti ☐
- Honduras ☐
- Hungary ☐
- Iceland ☐





- India
- Indonesia
- Iran
- Iraq
- Ireland {Republic}
- Israel
- Italy
- Ivory Coast
- Jamaica
- Japan
- Jordan
- Kazakhstan
- Kenya
- Kiribati
- Korea North
- Korea South
- Kosovo
- Kuwait
- Kyrgyzstan
- Laos
- Latvia
- Lebanon
- Lesotho
- Liberia
- Libya
- Liechtenstein
- Lithuania
- Luxembourg
- Macedonia





- Madagascar
- Malawi
- Malaysia
- Maldives
- Mali
- Malta
- Marshall Islands
- Mauritania
- Mauritius
- Mexico
- Micronesia
- Moldova
- Monaco
- Mongolia
- Montenegro
- Morocco
- Mozambique
- Myanmar, { Burma }
- Namibia
- Nauru
- Nepal
- Netherlands
- New Zealand
- Nicaragua
- Niger
- Nigeria
- Norway
- Oman
- Pakistan





- Palau ☐
- Panama ☐
- Papua New Guinea ☐
- Paraguay ☐
- Peru ☐
- Philippines ☐
- Poland ☐
- Portugal ☐
- Qatar ☐
- Romania ☐
- Russian Federation ☐
- Rwanda ☐
- St Kitts & Nevis ☐
- St Lucia ☐
- Saint Vincent & the Grenadines ☐
- Samoa ☐
- San Marino ☐
- Sao Tome & Principe ☐
- Saudi Arabia ☐
- Senegal ☐
- Serbia ☐
- Seychelles ☐
- Sierra Leone ☐
- Singapore ☐
- Slovakia ☐
- Slovenia ☐
- Solomon Islands ☐
- Somalia ☐
- South Africa ☐





- South Sudan
- Spain
- Sri Lanka
- Sudan
- Suriname
- Swaziland
- Sweden
- Switzerland
- Syria
- Taiwan
- Tajikistan
- Tanzania
- Thailand
- Togo
- Tonga
- Trinidad & Tobago
- Tunisia
- Turkey
- Turkmenistan
- Tuvalu
- Uganda
- Ukraine
- United Arab Emirates
- United Kingdom
- United States
- Uruguay
- Uzbekistan
- Vanuatu
- Vatican City





Venezuela ☐

Vietnam ☐

Yemen ☐

Zambia ☐

Zimbabwe ☐

**A8. How confident are you in your ability to read, write and speak in English when performing the following activities?**

	Uncomfortable	Not confident (can speak, but difficult)	Average	Confident	Very confident (fluent)
Performing reviews	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Participating in a non-technical discussion on the email list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Participating in technical discussions on the email list	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Speaking with others (face to face)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**A9. How do you identify yourself?**

Woman ☐

Man ☐

Trans Woman ☐

Trans Man ☐

Gender varian / Non-conforming / Non-binary ☐

Prefer not to say ☐

Prefer to self-describe (please answer as comment) ☐

**Section B: Wrap up**

**B1. Would you like to volunteer for a follow-up interview to help us explore the survey results in more detail?**

Yes ☐

No ☐



**B2. If you would like to volunteer for a follow-up video conference interview to help us explore the survey results in more detail, please provide us your email address below.**

**Thank you for thoughtfully completing the survey! Your response has been recorded.**

**If you have any questions, please contact the administrators of this survey:**

[REDACTED]

[REDACTED]

[REDACTED]