TLA+ 2024 survey: A report

Motivations, Advantages, and Challenges in TLA+ Usage

1. Top motivations for TLA+ usage were:

   - **Interest** in formal methods and TLA+ as a starting point (53.7%).

   - **Difficulty** in bug **detection** with traditional methods; attracted to TLA+'s error-finding capabilities (25%).

   - Introduction to TLA+ via **research** or academic **exposure**, fascinated by its capacity to model complex systems (36.1%).

   - **Curiosity** sparked by positive feedback from friends or colleagues who had prior TLA+ experience (25%).

2. The prevailing opinion among the responses emphasises several key **advantages of** using **TLA+** over other formal methods:

   - **Simplicity and Ease of Use**: Many respondents highlight TLA+'s simplicity and as its most significant benefit. They appreciate its approachability, intuitive nature, and suitability for engineers who may not have extensive experience with formal methods.

   - **Expressiveness and Clarity:** TLA+ is praised for its ability to express complex concepts clearly and concisely.

   - **Practicality and Applicability**: TLA+ is seen as a practical choice, particularly in industry settings. Its widespread usage in industry, integration into workflows, and effectiveness for architectural verification in distributed systems are cited as important advantages.

   - **Tooling and Support:** The availability of robust tooling, documentation, and stable support for TLA+ are noted as significant benefits.

   - **Temporal Capabilities:** The temporal component of TLA+ is highlighted as a valuable feature, particularly for modelling concurrent reactive systems and identifying concurrency bugs like deadlocks.

3. The primary advantage reported by respondents regarding TLA+ is enhanced **system comprehension**, with **90%** of users selecting this option.

4. Drawing from the responses provided, the **challenges** encountered while **learning** and using **TLA+** can be summarised as follows:

   - **Steep Learning Curve**: The complexity of TLA+ and its concepts contribute to a steep learning curve for newcomers. Understanding advanced specifications, distributed systems, and concurrency issues pose significant challenges.

- **Tooling and Syntax**: Issues with tooling, including the TLA+ Toolbox GUI, TLC documentation, and ASCII/Unicode dichotomy, impact the learning experience.

- **Modelling and Abstraction**: Difficulty in modelling systems, finding mathematical concepts to describe systems precisely, and transitioning from programming languages to TLA+ abstraction are noted challenges.

- **Debugging and Visualisation**: Limited debugging capabilities, unclear error messages, and high disk space usage during visualisation of states impede the learning process.

- **Integration and Accessibility**: Challenges related to integrating TLA+ with other tools, lack of modern learning materials, and difficulties in accessing comprehensive and searchable documentation hinder the learning experience.

Tooling preference in TLA+

5. **TLA+ Toolbox** is **preferred** by a larger portion of users compared to **Visual Studio Code**, with **50.9%** of respondents utilising the Toolbox and **38.7%** opting for Visual Studio Code.

6. The majority of users choose to **encode** their TLA+ specifications using **ASCII (49%)**, while **Unicode** is favoured by **19.2%** of respondents. The remaining respondents did not express a preference.

TLA+ Documentation

How helpful do you find the TLA+ documentation and resources?

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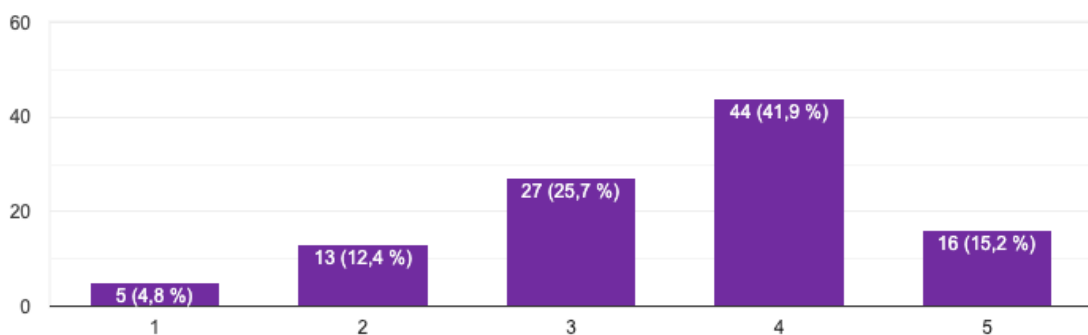
7. In general, a significant majority of survey respondents find the TLA+ **documentation** to be **beneficial**. This trend mirrors also the responses in the question concerning community **support** and **learning**.

8. The resources deemed **most helpful** for learning and using TLA+ included:

- **Online tutorials and documentation** (77,8%)

- **Reading existing specifications** (63,9%)

- **Hands-on learning** (57,4%)

It might come as a surprise that **training sessions and courses** weren't as popular, with only **20.4%** of respondents finding this mode of learning helpful.

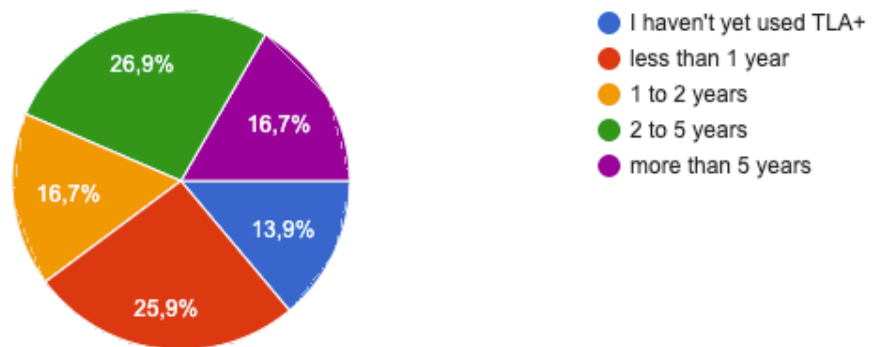What resources do you find most helpful when learning and using TLA+?
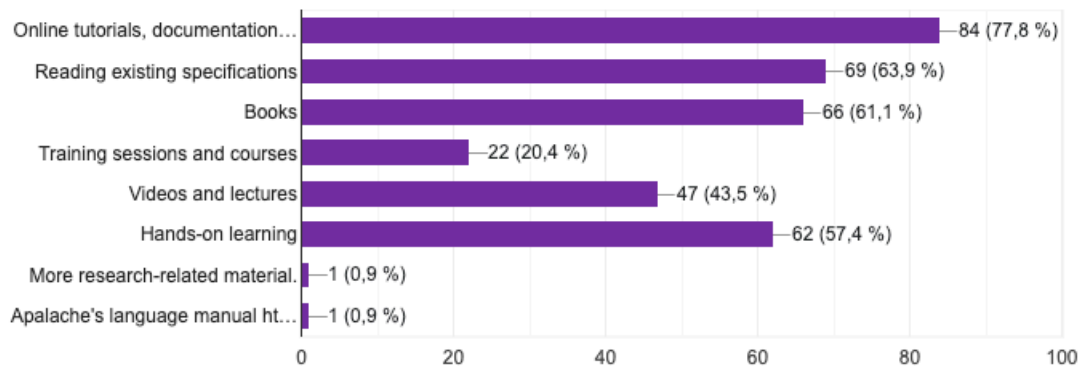
TLA+ Community

9. According to the responses to the question "*How long have you been using TLA+?*" a **quarter** of the respondents reported using TLA+ for **less than a year**.

How long have you been using TLA+?

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I haven't yet used TLA+
less than 1 year
1 to 2 years
2 to 5 years
more than 5 years

10. The proportion of TLA+ users utilising it in a **professional setting** stands at **60%** compared to 40% who use it outside of a professional context.
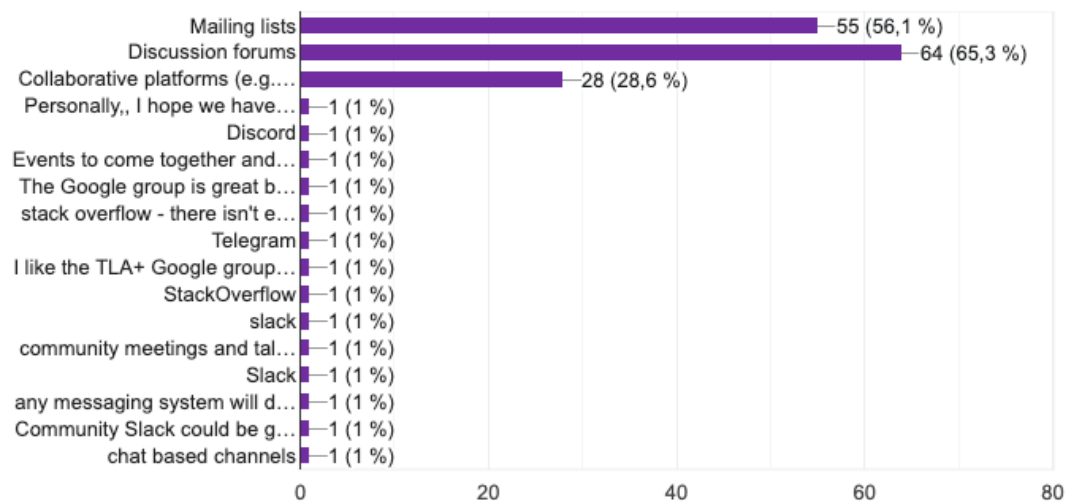
11. A substantial **65.4%** of respondents have yet to contribute to the community in any capacity.

12. The challenges perceived by respondents for new contributors include:

   - **Difficulty Understanding Existing Codebase and Documentation:** Respondents note challenges in comprehending the existing codebase and documentation. The lack of clear structure and architecture documentation, as well as the complexity of the Java codebase, pose significant obstacles for newcomers.

   - **Limited Resources and Expertise:** Limited resources, both in terms of time and expertise, are cited as challenges for new contributors. Some express concerns about the lack of familiarity with formal methods in modern computer science education, while others highlight constraints on available time for learning and contributing to the project.

   - **Tooling and Language Complexity:** The complexity of the TLA+ language and tooling is mentioned as a challenge, with some newcomers finding the syntax and tooling difficult to grasp. Additionally, the presence of two languages, TLA+ and PlusCal, is seen as confusing and may deter potential contributors.

   - **Navigation and Documentation:** Navigating the various TLA+ resources and finding relevant documentation is identified as a challenge. Respondents note scattered and sometimes non-existent documentation, making it difficult to find the most relevant resources and assistance.

   - **Perception of Complexity and Mathematical Nature:** There is a perception among some potential contributors that TLA+ is complicated and too mathematical, which may discourage participation. Additionally, the coexistence of TLA+ and PlusCal, along with the prevalence of PlusCal in online materials, is seen as confusing and may deter newcomers.

What would be your preferred way to engage with the TLA+ community in the future?

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Mailing lists	55 (56,1 %)
Discussion forums	64 (65,3 %)
Collaborative platforms (e.g....	28 (28,6 %)
Personally,, I hope we have...	1 (1 %)
Discord	1 (1 %)
Events to come together and...	1 (1 %)
The Google group is great b...	1 (1 %)
stack overflow - there isn't e...	1 (1 %)
Telegram	1 (1 %)
I like the TLA+ Google group...	1 (1 %)
StackOverflow	1 (1 %)
slack	1 (1 %)
community meetings and tal...	1 (1 %)
Slack	1 (1 %)
any messaging system will d...	1 (1 %)
Community Slack could be g...	1 (1 %)
chat based channels	1 (1 %)

13. Responses to the question "*What would be your preferred way to engage with the TLA+ community in the future?*" reveal that the majority of users prefer the traditional **mailing list** and **discussion forum** format over more modern **collaborative platforms** such as Slack, Discord, or other chat-based channels.

14. Regarding desired **improvements or new features** in TLA+, a couple of themes emerged from the survey responses:

   - **Documentation and Tooling**: There is a strong consensus on the need for improved documentation, particularly in the form of better organised and comprehensive resources. This includes better documentation for the entire project, better release cycles for all TLA+ tools, and centralised documentation on a website rather than PDFs.

   - **IDE Improvements:** Many respondents call for enhancements to the IDE, including improvements in usability, better integration with modern tools like Visual Studio Code, and the addition of features such as visualisation tools, and refactoring support.

   - **Visualisation Tools:** There is a recurring request for visualisation tools to aid in understanding complex specifications, particularly for visualising large state spaces and trace visualisation.

   - **Unicode Support:** A number of respondents express a desire for Unicode support.

Key takeaways:

A. **Streamlining Documentation:** There's a clear demand for better-organised documentation and centralised resources with a more modern interface to cater to users' preferences for accessible and comprehensive guidance.

B. **Community Communication Preferences:** The majority of community users favour traditional mailing lists and discussion forums over modern platforms like Slack or Discord, indicating a preference for established communication channels for engaging with the TLA+ community.

C. **Enhancing Visualisation and Tooling:** Respondents emphasised the need for enhanced visualisation tools within TLA+ tooling to aid in comprehending complex specifications and system behaviour, highlighting the importance of integrating features that facilitate better understanding and debugging processes.