TLA+ 2023-2024 Survey

Results

Scope of the Survey

- 2023/2024: 110 Responses
  - 2022: 195
- Released: November 2023
- Results: March 2024

Special thanks to Martin Hornáček

for updating the survey and compiling results

Motivations to Start Using TLA+

- 53%: Interested in learning about formal methods
- 36%: Introduced through a research project or academic course
- 26%: Struggling to find bugs
- 25%: Curious after hearing about it from a colleague
- 15%: Other

Note: Multiple answers accepted. 109 responses with 170 answers.

Types of Systems for TLA+

- 64%: Distributed Systems
- 39%: Concurrent, Multi-threaded
- 33%: Communication systems
- 11%: Real-time, safety critical
- 9%: Network Protocols
- 5%: Security

Note: 100 responses, 177 answers.

Advantages of TLA+

- **Simplicity and Ease of Use**
  - Many respondents highlight simplicity of TLA+ as its most significant benefit. 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.

Benefits of TLA+

- 91%: Better system understanding
- 58%: Improved system reliability
- 52%: Improved system design
- 17%: Reduced cost and effort
- 10%: Increased development velocity

Note: 100 responses with 232 answers. On average people had at least two benefits.

Challenges of TLA+

- **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.
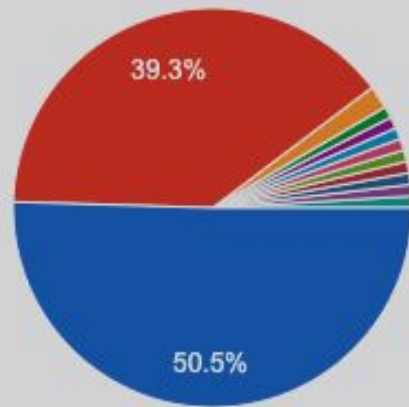
Tooling

Tooling

Which IDE do you primarily use to work with TLA+?

107 responses

Copy

- TLA+ Toolbox (50.5%)
- Visual Studio Code (with the TLA+ ext... (39.3%)
- emacs
- Sublime Text
- Vim/Neovim
- Neovim
- Emacs
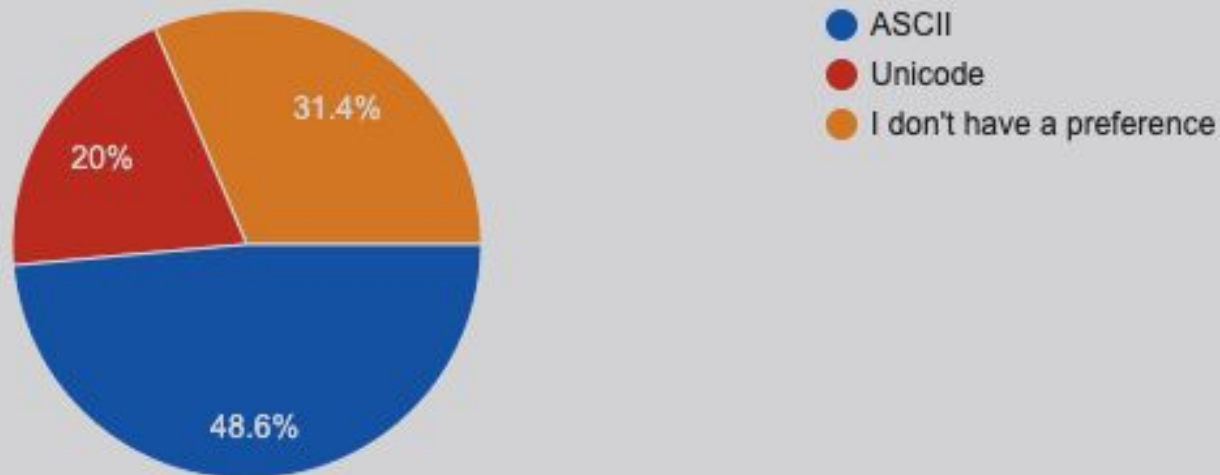- CLI + text editor

39.3%

50.5%

1/2

Tooling

- 93%: TLC
- 40%: PlusCal
- 28%: TLAPS
- 15%: Apalache

Note: 100 responses. 178 answers.

Encoding

How do you typically prefer to encode TLA+ spec files?

105 responses

- ASCII
- Unicode
- I don't have a preference

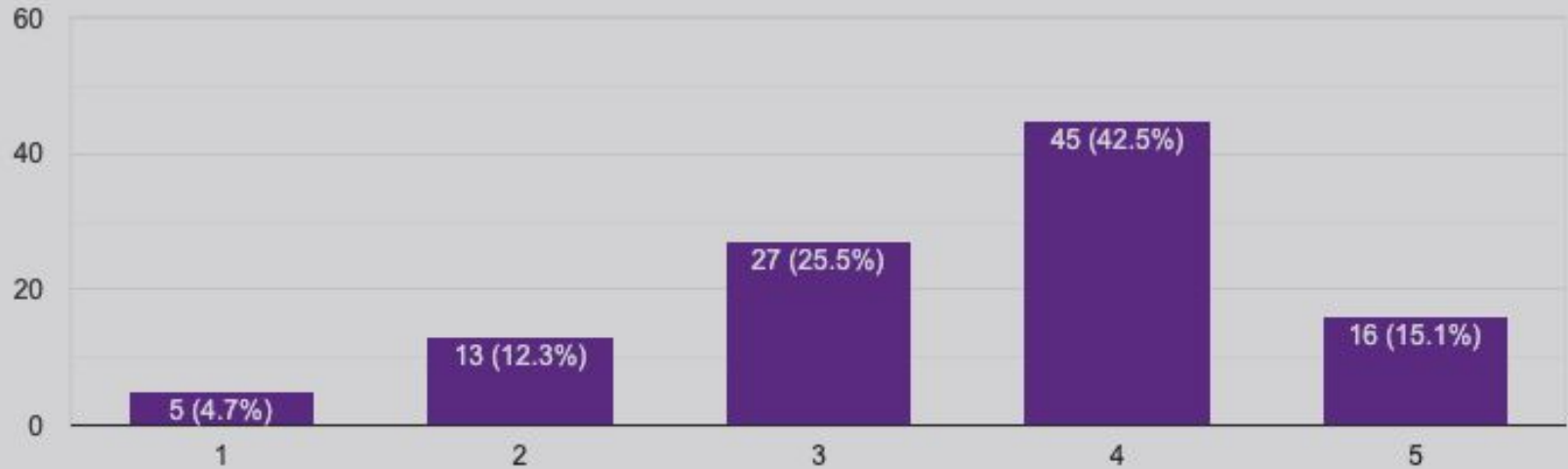48.6% ASCII, 31.4% I don't have a preference, 20% Unicode

Documentation

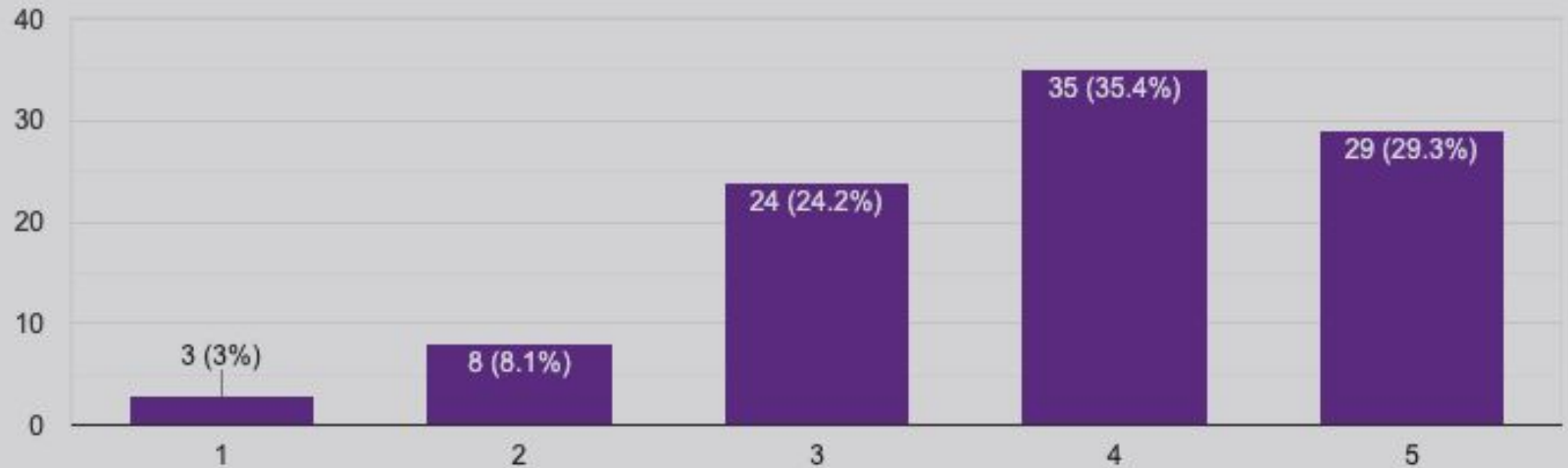How helpful do you find the TLA+ documentation and resources?

106 responses

How supportive is the Community for learning?

How have you found the TLA+ community in terms of learning and support?

99 responses

Copy

- 1: 3 (3%)
- 2: 8 (8.1%)
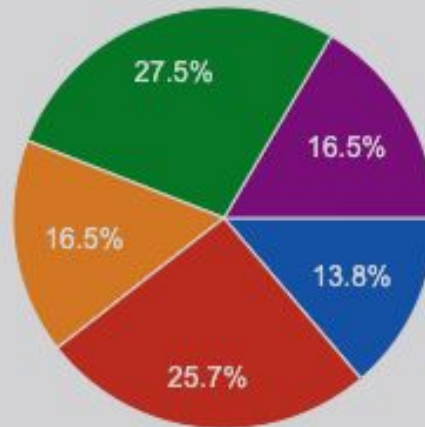- 3: 24 (24.2%)
- 4: 35 (35.4%)
- 5: 29 (29.3%)

Helpful Resources for Learning TLA+

- **78%: Online tutorials and docs**
- **64%: Reading existing specifications**
- **57%: Hands-on learning**
- **20%: Training sessions and courses**

Community - How Long Using

How long have you been using TLA+?
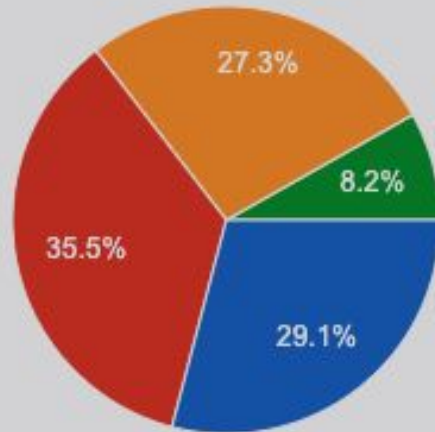
109 responses

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

27.5%
16.5%
16.5%
13.8%
25.7%

Community - Level of Expertise

What is your current level of expertise with TLA+?

110 responses

Copy

- Beginner. I am a novice or I am still learning.
- Intermediate. I can write simple specifications.
- Advanced. I can write complex specifications without guidance.
- Expert. I consider myself as an expert.

27.3%

8.2%

35.5%

29.1%

Community - Professional Users

Have you ever used TLA+ in a professional context?

109 responses

- Yes
- No

40.4%

59.6%
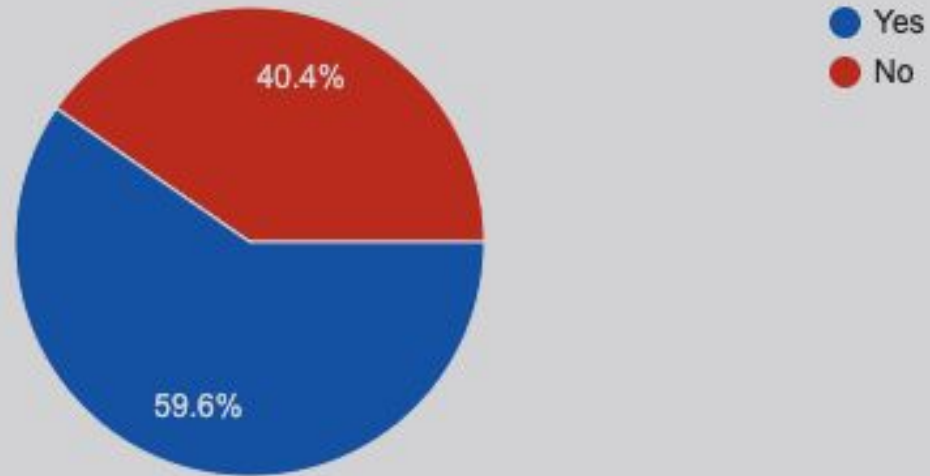
Community - Contributor

Have you ever contributed to the TLA+ community?

108 responses

- Yes
- No

65.7%

34.3%
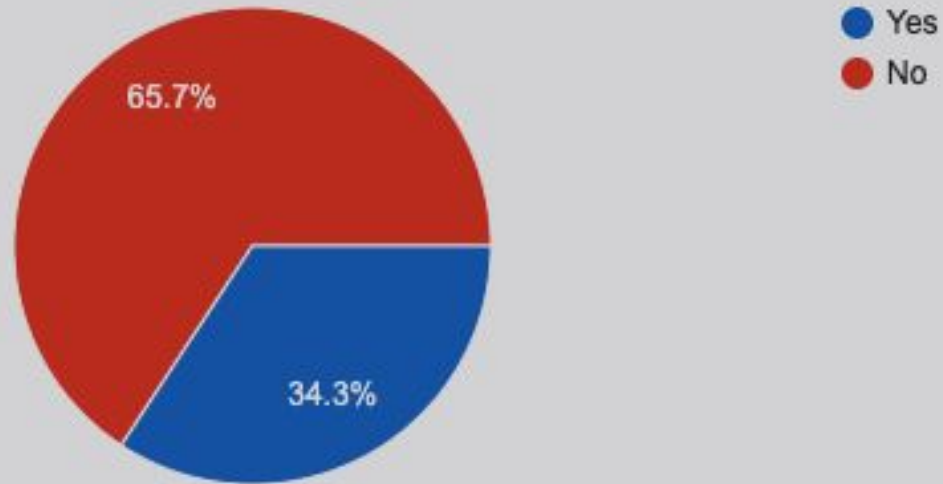
Challenges of Contributing

- **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.

Community - Communication

- 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.

Community - New Features

- **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.

Takeaways

- 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.
- 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.
- 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.
- Professional Contributor Gap
  - Majority of users are professional, while only a minority of users are contributors

Thank you!