



Arduino

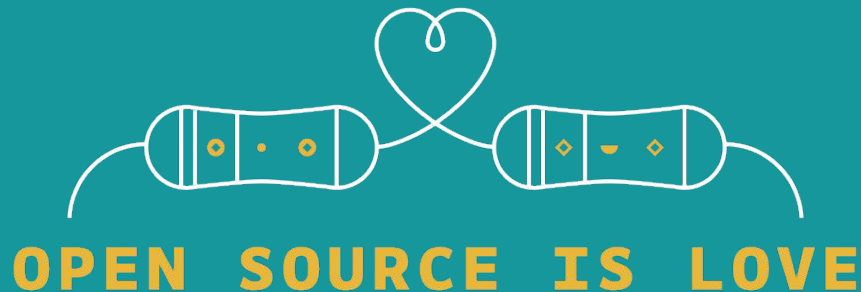
Open Source Report 2021

The Arduino Team

December 2021

As we approach the end of the year, it's time to do a **retrospective** on the development of the Arduino open source ecosystem. In this report you'll learn about the activities of the Arduino team from the past year, focusing on the hard work of employees, contractors, volunteers and most importantly the passionate and vibrant community that contributes every day to our mission.

This report is a snapshot of the community as of December 16th, 2021.





Introduction

A busy year

2021 has been by far one of the busiest and most productive years in Arduino history in terms of **open source development**. During this year we had many achievements, both in terms of **new releases** and in terms of **maintenance of the existing assets**.

On one hand, a significant amount of new open-source hardware products, new software tools and new libraries were released, while on the other hand we heavily **refactored some core pillars** of the Arduino framework (IDE, library index and more) to make them more robust and appropriate to the current size and relevance of the Arduino community. Our community has expanded to include not only makers, creators, hackers, educators, but also companies, industries and professional developers: serving our mission to **democratize access to technology** is more important now than ever, as we are called to **keep things simple yet powerful while making the foundations and the tools robust, secure and reliable**.



Serving a mission

Arduino was born as an open-source project and has grown over the years thanks to a vibrant community that has contributed in many ways; making it an open framework that is the de facto standard for thousands of Arduino and non-Arduino hardware products.

We believe in **open knowledge, standardization** and **interoperability** - an incredibly large amount of people from all over the world who share these principles have worked over these 16 years on code contributions, translations, documentation, tutorials, third-party libraries and cores.

Supporting this ecosystem is our top priority.

To comment on this report, join us in the [Arduino Forum](#).



Project sustainability

Moving onto the critical points, in 2021 we have been still observing a **significant amount of counterfeits** and illegal uses of the Arduino name, logo and open-source code.

We believe in open source because it's centered around **collaboration**: whenever the open-source hardware designs of Arduino boards are used and remixed to make more innovative projects, or to spread knowledge, we all win. But whenever this translates to just plain copies of low quality being placed on the market with no innovation, without giving anything back to the community, and even illegally using the official Arduino logo or other subtle techniques to deceive buyers, there's no innovation and no contribution to the community.

Open source and commercial usage are good friends, and **growing a business-oriented ecosystem of players is one of the goals of the Arduino project**, but this shall not be detrimental to the sustainability of the project itself: when open-source hardware and open-source software are tightly coupled, counterfeiters benefit from unfair competition as the development of the software stack and all the costs related to growing the ecosystem (including community, advocacy, support and brand awareness) are **only borne upon the shoulders of the original organization and the other active contributors**.

We strongly believe in the open-source hardware paradigm, and this distortion is a hot topic that needs a wider discussion because it can put the survival of an open source project in danger. For this reason, **we invest significant effort** in fighting illegal counterfeits and educating companies and individuals about correctly making derivative products respecting open source licenses and trademark rules.

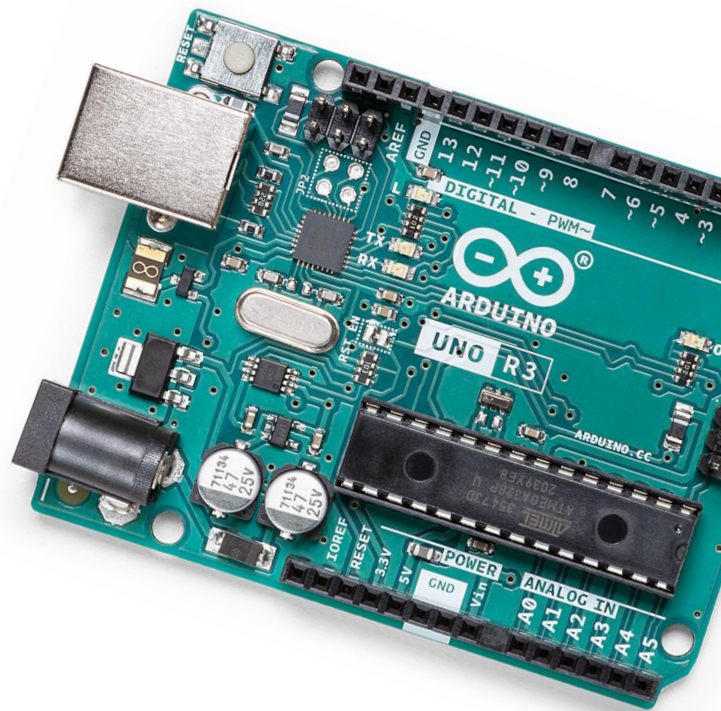


Credits

Everything you see here was made possible by all the people who are **buying original Arduino boards or making donations.**

Arduino products are fully certified, respect all the environmental and conflict minerals regulations and are manufactured in Europe respecting labour standards, plus **their revenues also support the development of the software ecosystem that everyone gets for free.**

A big thank you also goes to all the people and companies out there who have contributed in other ways to the ecosystem. This includes code, documentation, libraries, cores, community involvement, and derivative or complementary hardware products.





Activities carried out by the Arduino team

In this section we'll go through the main
projects delivered directly by the Arduino team.

New Open-Source Hardware boards

During this year we released **FOUR** new open-source hardware boards:

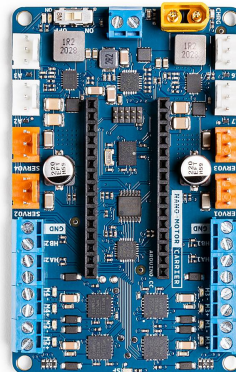
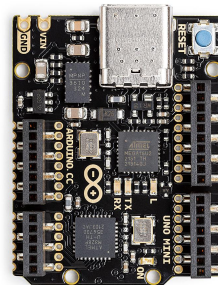
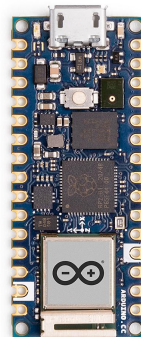
[Nano RP2040 Connect](#)
[UNO Mini Limited Edition](#)
[MKR IoT Carrier](#)
[Nano Motor Carrier](#)

For each of them, the full schematics and CAD files are available on the docs.arduino.cc website. We also added informative **web-based interactive viewers** that let users see the 3D models and click on individual components to browse the BoM interactively and see part numbers and other details.



HOW TO GET INVOLVED:

- Remix these boards, innovate and share your builds!



Arduino IDE 2.0

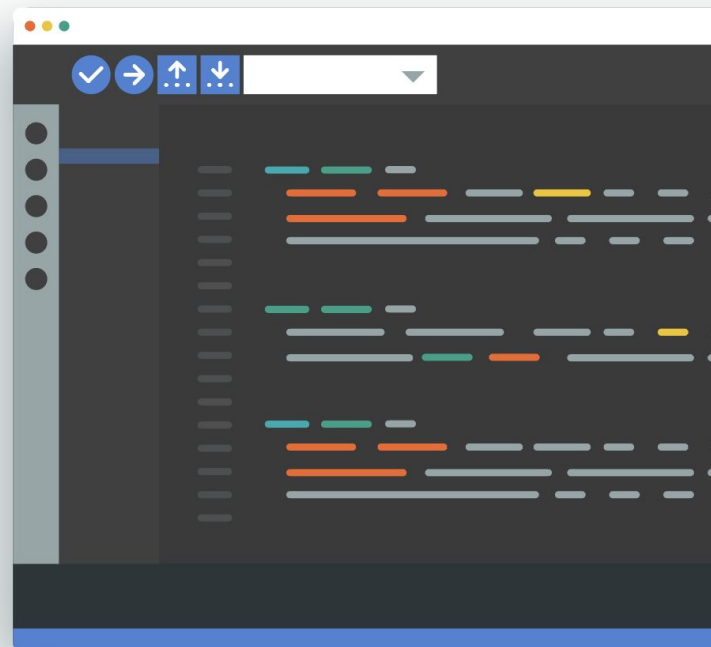
Rewriting the Arduino IDE from scratch is probably the most complex project we have been working on. A dedicated team has been working on this full-time for more than two years, representing a massive investment on our side to **improve the user experience**, moving away from Java, and bringing new features such as **autocompletion**, **code navigation** and **debugging** as well as a much improved **serial plotter** and far more.

In March we [announced](#) the transition from alpha to beta and during this year we released [twelve \(12!\) beta versions](#), plus the first [Release Candidate for the stable 2.0](#).



HOW TO GET INVOLVED:

- [Test the IDE 2.0](#) to spot issues and bugs
- [Contribute the translation](#) in your language
- [Join the development](#) and help testing bugs, fixing them and developing new features!



Arduino IDE 1.x

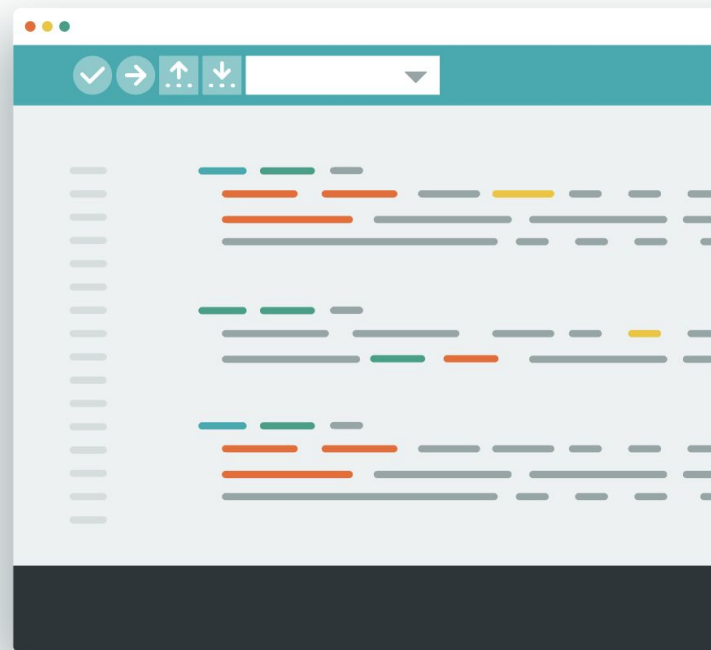
No, our commitment on the development of the IDE 2.0 doesn't mean we have abandoned the Arduino 1.x IDE that most users are familiar with.

During this year we released [five new versions](#) carrying many **bug fixes and improvements**.



HOW TO GET INVOLVED:

- Help us go through the [IDE 1.x issues](#) and test them against the IDE 2.0 to understand if they're still pending or they're fixed in the new version.



Arduino CLI

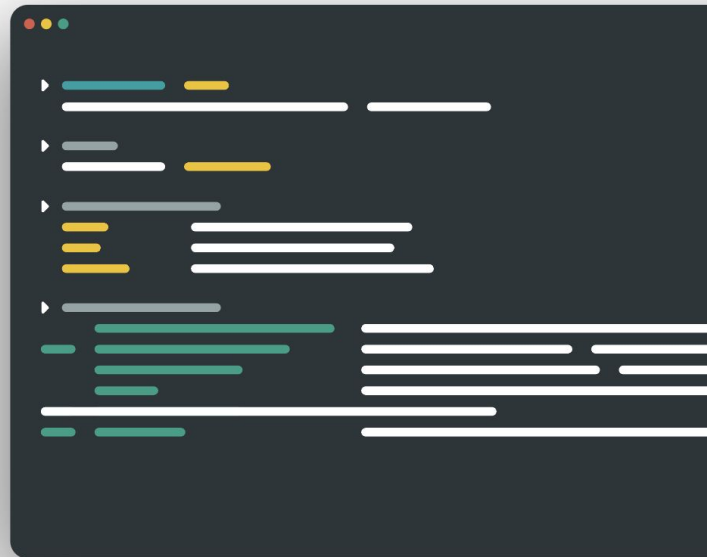
The open-source [Arduino CLI command line tool](#) provides access to all the features of the IDE, including compilation, upload to boards, library management and more. This tool allows you to manage your Arduino sketches without leaving your editor of choice, as well as integrate it in your scripts and custom applications.

We have been working on this tool on a daily basis, and during this year we released [18 new versions](#)!



HOW TO GET INVOLVED:

- **Contribute the [translation](#) in your language**
- **Jump into the [development](#) and help testing bugs, fixing them and developing new features!**



Arduino Lint

This year we released [one more command line tool called Arduino Lint](#) that allows you to run over 175 checks on your sketches and libraries to make sure they are compliant with the specifications. This is a powerful tool for anyone running Continuous Integration environments.

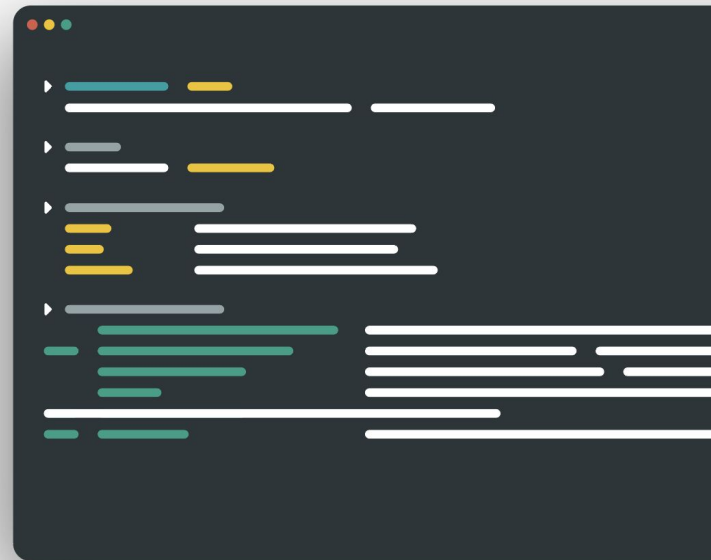


HOW TO GET INVOLVED:

- **Jump into the [development](#) and help testing bugs, fixing them and developing new features!**



>_ARDUINOLint



Arduino Language Server

In order to enable autocompletion and code navigation in IDE 2.0 we developed the [Arduino Language Server](#) which is a separate component implementing the [Language Server Protocol](#) which is an interoperable standard. With this component, support for Arduino syntax can be added to any other compatible IDE.

How does it work? The Language Server preprocesses Arduino code and runs clangd in the background to extract symbols and code structure that the editor can use to provide front-end functionality.



HOW TO GET INVOLVED:

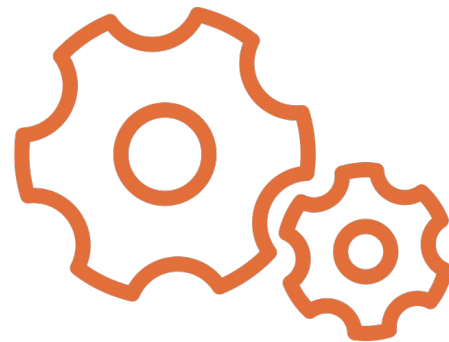
- **Contribute support for Arduino to other IDEs based on this component!**



Testing and Continuous Integration

In order to support more advanced developers who want to run Continuous Integration environments to ensure the robustness of their Arduino code, we [released a set of actions](#) for GitHub. Thanks to them, triggering an automated compilation whenever you commit a change to your sketch or library is trivial. In minutes, you'll see errors and warnings as well as a comparison of the changes to the compiled binary size which is useful to keep an eye on their memory impact.

We added these GitHub Actions to most official Arduino repositories, in order to increase the quality of those codebases.



HOW TO GET INVOLVED:

- **Spread the news and submit pull requests to GitHub projects you think can benefit from these GitHub Actions!**



Library directory

Until now, Arduino libraries could only be browsed via the library manager dialog inside the Arduino IDE. We implemented a [web-based directory](#) that is automatically updated from the library index and even renders Markdown documentation of official libraries when available.



HOW TO GET INVOLVED:



- **Browse the directory and discover less known libraries that may need your help to improve their examples or fix bugs!**



Library submission process

Another big milestone which took place this year was the development of the [new automated submission process for contributed libraries](#): previously, to get a library added in the Library Manager, an issue had to be opened in GitHub and someone from the Arduino team had to manually review the submissions periodically. Now, a **self-service workflow** based on pull requests and bots, performs all the checks and completes the process in a matter of minutes.

Resulting in a significant increase of the submitted libraries.



HOW TO GET INVOLVED:

- Follow the [new library submissions](#) and discover libraries that may need your help as contributor!



Official libraries

8 new **official libraries** were developed and published:

- Arduino_BHY2Host
- Arduino_BHY2
- Arduino_APA102
- Arduino_LSM6DSOX
- Arduino_OplaUI
- Arduino_PortentaBreakout
- Arduino_AVRSTL
- Arduino_Portenta_OTA

In addition, during 2021 we performed **104 new releases** of the other official libraries with bug fixes and new features.



HOW TO GET INVOLVED:

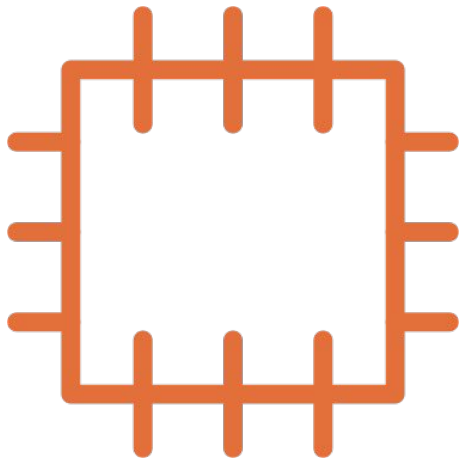
- **Official libraries** are so many that we really need help from the community, so you're more than welcome to help us fix bugs, review pull requests and improve the examples shipped with libraries to better document their functionality!



Official cores

During 2021 we performed **9 new releases** of the official cores with bug fixes, new features and support for more boards.

In addition to cores for official Arduino boards, we also released an [Arduino core for the Raspberry Pi Pico](#). The core is based on the Mbed operating system so it's robust and complete.



HOW TO GET INVOLVED:

- There are still many pending issues and feature requests, so you're really more than welcome to help us in GitHub.



Inclusivity

Following our adhesion to the [resolution](#) launched by the OSHWA about moving towards more inclusive terminology, we rolled out a process to replace the MISO/MOSI/SS terms with CIPO/COPI/CS. We started with replacing the terms in our online documentation, focusing especially on the pinout diagrams and product-related tutorials, making sure we did not introduce confusion in readers. After reaching a satisfying percentage of content updated with the new terms, we started redesigning the silk for all of our hardware products which have such names printed on the boards themselves or on the side of pin headers. Given the amount of products involved and the manufacturing process, the effects of this change will be visible incrementally as the newly manufactured stock is propagated across all distribution channels.



HOW TO GET INVOLVED:

- **Help us spot any remaining occurrence of these terms in Arduino documentation and code examples, and submit pull requests to fix it!**



Security

Last but not least, a lot of work has been carried out by our security team that works full-time to inspect code, handle reports, and secure the infrastructure including the way assets are developed, compiled and distributed. Even if this activity does not manifest itself in the form of releases, it's been a consistent part of our work in 2021.



HOW TO GET INVOLVED:

- **Help us inspect repositories to find vulnerabilities, and get in touch with our security team according to the [security policy](#).**





Highlights from the community

We're now going through the main
contributions from the community in 2021.



Community contribution matters

896 new contributed libraries have been added to the Library Manager, bringing the total number to **4,446**. This means the Arduino library ecosystem had an impressive growth over the previous year.



Libraries are a vibrant big thing

This number represents the incredibly active and continuous efforts of the Arduino library developers.

6005

New version of
libraries in 2021



You will never walk alone

326 new open-source tutorials were added to [Arduino Project Hub](#) during the year. (Note that we perform quality review and moderation to avoid duplicates, so this number does not include all the submissions but only represents the projects that were approved and published by the Project Hub maintainers.)





The community is more active than ever

Of people interactions on the [official Arduino repositories](#) on GitHub reporting issues or submitting pull requests.



Many cores contributions

+113 new versions of contributed Arduino cores were released during the year.

(Note that since there's no official platform registry, this number may not include platforms that we don't know about.)



Top contributors of new libraries

Maintainer	Number of libraries added in 2021
AlexGyver Technologies	68
Khoi Hoang	62
Rob Tillaart	35
SparkFun Electronics	27
M5Stack	21
DFRobot	21
Sensirion AG	17
Bolder Flight Systems	14
STM32duino	12

Maintainer	Number of libraries added in 2021
Seeed Studio	12
RAKwireless	10
Serge Skorodinsky	9
Picovoice	8
Matrix Robotics	7
Brian Park	7
Natan Lisowski	6
Marco Colli	6
Hideaki Tai	6

Maintainer	Number of libraries added in 2021
Asuki Kono	6
Adafruit Industries	6
FTTech Brasil	5



Most active library maintainers

Maintainer	Number of releases in 2021
Khoi Hoang	497
Rob Tillaart	389
Adafruit Industries	385
K. Suwatchai (Mobizt)	225
Hideaki Tai	195
AlexGyver Technologies	173
SparkFun Electronics	163
Zoran Pribičević	93
STM32duino	88

Maintainer	Number of releases in 2021
Brian Park	76
Wolfgang Ewald	64
Bolder Flight Systems	63
M5Stack	59
PowerBroker2	54
Lex Kravitz	50
Asuki Kono	48
David Lloyd	46
Jochen Kiemes	40

Maintainer	Number of releases in 2021
tobozo	37
Luca Fidanza	35
Sensirion AG	34
Larry Bank	34
Dominik Schlösser	31
Marco Colli	31
DFRobot	31



(This ranking is based on the frequency of releases, which does not necessarily reflect the complexity of each release.)

More contributions

The Arduino community is much more than this, and given its size it is nearly impossible to track all the contributions that are shared daily in **unofficial community platforms** and **independent websites**. This includes **software contributions** such as code examples and full open-source sketches, but also **knowledge contributions** such as documentation and tutorials, and last but not least **hardware design contributions** such as derivative or complementary products (shields, accessories, derived boards).

Tracking and representing such a variety in a future edition of this report, both in quantitative and in qualitative form, would be a valuable addition to recognize the tremendous efforts of thousands of people and companies contributing to the success of the Arduino ecosystem.





That's a wrap
Thank you!

The Arduino Team