

The Importance of Software in Europe

Background

This document was created by a task group of ERCIM – the European Consortium of Informatics and Mathematics – to explain the crucial role of software technology, creation, and maintenance for the prosperity of the European economy and that more resources need to be invested towards this neglected area. The list of members of the ERCIM task group can be found at the end of the document.

Challenges

Investment in European Digital Sovereignty takes a hardware-first approach, limiting software research and innovation to hardware needs. The drive for digital sovereignty in chips and open processor architectures has correctly been identified as an opportunity to sustain European innovation by maintaining a European ecosystem for hardware and systems software [3]. Nevertheless, more and more the value is on the platform ecosystem, including hardware and software, with software-centric platforms seen as the way to gain an increasing share of the market growth [10] (e.g. the NVIDIA example).

Moreover, most of the digital value is realized in higher-level software with significantly different business logic than hardware-specific software. The increasing growth of software in the higher levels of the value chain of key application areas (such as Transport & Mobility, Healthcare & Wellbeing, Energy, Digital Industry and Digital Life) has been for long requiring investments in software on the same level as hardware [8].

Without investment in higher-level software Europe's investments in chip design and manufacturing are reduced to production of commodity hardware where foreign powers can create lock-in effects through control over business-critical higher software layers. A European software environment, compliant with European values and legislation, is critical to avoid such outcomes.

Application software is driven by the private sector and sustains the digital transformation, but application software relies on intermediate high-level software that make it economically feasible to bring to the market, including libraries, frameworks, and operating systems [3]. The production and maintenance of such software is often seen as a non-business-value-adding cost and receives limited or no industrial funding even if industry relies on it to bring applications to market [6].

A recent study estimates that industry would need to spend 3.5x more on software development if open-source *commodity software* did not exist [5], creating barriers to

fast innovation. To sustain European software innovation and sovereignty, such commodity software needs to be nourished and maintained. For production-grade commodity software, academia and industry are each performing well, but there exist gaps. For example, there is currently no major production-grade operating system being developed in the EU. For Europe to be truly sovereign it must have the ability to develop its own software solutions at all levels of the stack (i.e., OS, libraries, compilers, IDEs, application-specific, ...) to ensure it meets the evolving needs of the European industry and economy.

At the same time, experimental software research is necessary to allow more than incremental improvements to software. Today software research and development is undergoing rapid changes due to advances in software engineering (including AI and generative AI), which opens new areas of research into how software and hardware is created. To discover the software of tomorrow and bring it to the market the pipeline must be filled with experimental software research today.

The lack of dedicated software research strategy and implementation is not well suited to address today's challenges. Experimental software research falls into a public funding gap, where it is expected to appear as a side-effect of larger projects. These larger projects target complete systems and applications that limit the scope of software research to a narrow contribution that is directly useful for that system. This significantly limits the scope of software research, as addressing more than incremental improvements comes with significant project risk. Currently, publicly funded European software research is caught in the impossible choice of either neglecting the needs of the larger projects they are a part of, or abstaining from truly explorative research capable of delivering market redefining discoveries that would give a competitive advantage to Europe.

Not all software is created equal and to sustain innovation, commodity and research software needs to be publicly funded. Explorative software research fills the pipelines for future innovation while publicly developed production-grade commodity libraries support today's application software. Europe does not provide this public funding today.

The European Investment Bank (EIB) Investment Report 2023/2024 [2] finds that Europe is rapidly being overtaken in digital technologies innovation, a trend particularly pronounced in software. Europe specializes less in software and computer services than the US and China, with a research and development expenditure approximately 1/10th of the US, and 1/3rd of China.

The European Union should make stronger direct investments in its Software Ecosystem through targeted funding of non-application- and non-hardware-specific software. Europe should invest in software research to regain a leading role in global software innovation and invest in the open-source communities that produce critical commodity software, keeping them aligned with European regulation and strategies.

Vision

Europe should be a leader in software research. Focused software research enables more than incremental contributions to the European software ecosystem and complements other digital sovereignty efforts to establish European ecosystems in systems and chips. This would enable explorative software research that is not possible today due to unacceptable risk to other projects that need software components of higher TRL. Such research can lead to dramatic changes in how we use and write software in the future, and can create completely new markets. Today there is an opportunity for great innovation in Software that creates Software by combining traditional software research with recent advances in AI (including generative).

Europe should be a leader in software production. Public funding for European commodity software increases the ability of the Union to train engineers and PhDs for the European software ecosystem. Targeted public software investment helps create a highly skilled workforce aligned with European values and regulation. Leveraging this workforce to produce commodity software that implements European standards lowers the cost of software innovation by European industry and levels the innovation playing field against competitors targeting markets with less ambitious regulatory requirements, by alleviating the cost of tuning non-European commodity software to high European standards. Engineers trained on this commodity software can directly utilize it as a building block in applications when they move to industry.

Europe should be a leader in software maintenance. Any software that is not maintained decays quickly and becomes unusable, because the environment of the software evolves along with the creation of new standards and new APIs (be it for communication, for security, and so on). Long-term involvement in critical open-source communities builds a network of knowledge across Europe which facilitates knowledge transfer and retainment and provides long-term European stakeholding in critical open-source software. This also ensures that experimental software is not developed and then lost between its inception and when it can be leveraged by a startup, SME, or industrial actor in the European marketplace.

Open-Source Software

Europe has adopted open-source strategies and subsequent evaluations have proven the value of open-source software across the shared market. Open-source software has many benefits, such as royalty free use, reduced risk of vendor lock-in, easyness of collaborations between academia and industry, making it a natural fit for commodity software.

Open-source software is a significant contributor to the European GDP, giving more than a 1:4 return on investment as market entry barriers are lowered and non-value

adding engineering efforts are reduced [1]. However, there is a large discrepancy in how open-source software is developed in the EU and in other large economies [1]. In the EU, a major part of open-source contributions comes from very small and small companies. In contrast, in the US the main contributions to open-source come from large companies, which are also likely to be on the governing boards of these projects, giving them broad knowledge of the code base and the ability to influence the direction of the open-source code bases.

At the same time, there are areas where open-source software is lagging behind, and deterring the innovation capabilities of Europe, such as in the EDA tools landscape [9].

Increased participation of European research institutes, academia, and industry partners in global and European open-source efforts would strengthen European influence and provide a strengthened open-source software ecosystem in Europe [4]. It would establish and maintain attractive partners for knowledge transfer to startups and SMEs that wish to utilize open-source software to reduce the threshold to enter new markets and focus on their specific value-adding market niche.

Call to Action

A comprehensive and targeted focus on the European software ecosystem builds expertise and enables interaction between European actors. To realize the vision and build upon open-source successes we propose the following actions.

Public funding should be allocated both to experimental research as well as to the development and maintenance of production-grade commodity software. To realize the full values of our proposal this must not be a one-time investment but requires a continuous commitment. New EU regulations on e.g., AI, sustainability, privacy should be matched by corresponding and dedicated funding to software research, development, and maintenance that allow European industry to leap-frog to new application areas in short-, medium- and long-term.

Continuous funding calls for development or maintenance of production-grade commodity software ensures European businesses don't have to reinvent the wheel within each organization. Funding the promotion, integration, and maintenance of European open-source projects ensures retainment of "ownership" and know-how. This is critical to retain development and innovation focus in Europe, as such efforts are otherwise moved to other parts of the world (which benefit from more funding for this kind of technologies).

Continuous funding calls, dedicated to explorative and experimental software research and innovation actions, address the need to fill the pipeline with breakthrough software technologies that are not yet mature enough to provide immediate returns on investment in, e.g., general research and innovation action. This strengthens the

European software Ecosystem in the long term. There is world leading expertise in all fields of software available in European research institutions which is not fully used if challenging and potentially market redefining software problems remain unfunded.

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