Project:	ISOLDE: customizable Instruction Sets and Open Leveraged Designs of Embedded riscv processors
Reference number:	101112274
Project duration:	01.05.2023 - 30.04.2026
Work Package:	WP6: Open-Source Strategy, Business Models, Exploitation and Dissemination
Deliverable	**D6.2**
Title	**Strategic note on Open-source distribution and successful Business Models, incl. status of NewCo**
Type of deliverable:	Report
Deadline:	30.04.2024
Creation date:	30.04.2024

Authors: Nicoleta Capbun, Mari-Anais Sachian, George Suciu, Cristina Tudor, BEIA

Jaume Abella, BSC

Holger Blasum, SYSGO

Samuel Ardaya-Lieb, CONS

Maria Vittoria Fontanesi, E4, Lidia Caterina Pellicano, E4

Cătălin Ciobanu, IMT

Involved grant recipients: BEIA Consult International (BEIA), Consolinno Energy GmbH (CONS), Barcelona Supercomputing Center (BSC), SYSGO GmbH (SYSGO),E4 Computer Engineering SpA (E4), Hochschule München University of Applied Sciences (HM), Infineon Technologies AG (IFX), Intel Deutschland GmbH (INTEL),NXP Semiconductors Austria GmbH & Co. KG (NXP-AT), Politecnico di Milano (POLIMI), Silicon Austria Labs GmbH (SAL), Thales SA as Thales Research & Technology (TRT), Universita di Bologna (UNIBO), Universitatea Transilvania din Brasov (UNITBV), Universität zu Lübeck (UZL)

Contacts: Nicoleta Capbun, BEIA, nicoleta.capbun@beia.ro

Table of Contents

Executive Summary

I Introduction

This document describes the work performed within ISOLDE WP6 – Open – source Strategy, Business Models, Exploitation and Dissemination in Task 6.1.

A consolidated version of this Deliverable provides info and can demonstrate that networking within the realm of RISC-V, open-source technology, embedded processor development, and SoC application design can greatly expand ISOLDE reach and impact.

II Definitions and Acronyms

Open-source Distribution	The process of providing software that combines a large set of open-source components into a cohesive project or product, which can be freely used, modified, and shared.
Business Model	A strategic plan outlining how a company creates, delivers, and captures value, both economically and socially. It includes customer segmentation, revenue streams, value propositions, and cost structures.
NewCo	A term used to describe a newly formed entity with a focus on innovation and a mission-driven approach. NewCos often challenges traditional business practices and aims to create positive change.
Strategic Note	A document that outlines an organization’s strategic approach to a particular issue, including analysis, objectives, and action plans.
Ambidexterity	In a business context, the ability to balance exploitation of existing resources with the exploration of new opportunities.
Blue Ocean Strategy	A market creation strategy that focuses on developing new spaces (or “blue oceans”) of uncontested market demand, thereby making the competition irrelevant.
Core Competencies	A combination of pooled knowledge and technical capacities that allow a business to be competitive in the marketplace.
Value Proposition	An innovation, service, or feature intended to make a company or product attractive to customers.
KPI (Key Performance Indicator)	A measurable value that demonstrates how effectively a company is achieving key business objectives.
ROI (Return on Investment)	A performance measure used to evaluate the efficiency or profitability of an investment or compare the efficiency of several different investments.

GPL (General Public License)	A widely used free software license that guarantees end users the freedom to run, study, share, and modify the software.
RISC-V	An open-source instruction set architecture (ISA) based on established reduced instruction set computing (RISC) principles.
Vector Processing	A computational approach where a single instruction operates on multiple data points simultaneously, increasing efficiency, particularly in tasks like matrix multiplications and machine learning applications.
RVV (RISC-V Vector extension)	A set of instructions under the RISC-V ISA designed to perform vector operations, enabling more efficient processing by handling large vectors with a single instruction.
Ara	A processor design that works in tandem with the CVA6/Ariane core, designed to efficiently accelerate the computation of long vectors and demonstrate the potential of RVV.
ASIC (Application-Specific Integrated Circuit)	A type of integrated circuit customized for a particular use, rather than intended for general-purpose use.
Digital Sovereignty	The concept that individuals, organizations, and governments should have control over their own digital data and infrastructure, rather than being dependent on foreign entities.
Open-source Hardware	Hardware whose designs are made publicly available so that anyone can study, modify, and distribute the hardware and its design.
PULP Platform	A platform developed by ETH Zürich that encompasses a set of open-source, scalable, and energy-efficient processor cores for high-performance and low-energy computing systems.
CVA6/Ariane, CV32E40P/RI5CY, Ibex/ZeroRiscy	Processor cores designed by ETH Zürich, commonly used in RISC-V based computing systems.

III General information

The name ISOLDE stands for “High Performance, Safe, Secure, Open-Source Leveraged RISC-V Domain-Specific Ecosystems.” The project commenced in early 2023 and involves over 40 partners from 9 different European countries. It is coordinated by Infineon Technologies AG and has received significant funding from the European Commission under the Horizon Europe program. The current project represents a transformative initiative within the European Union (EU), aiming to accelerate the digital transformation across economic and societal sectors.

At the heart of ISOLDE is the development of high-performance RISC-V processing systems. These systems are designed to be at least at Technology Readiness Level (TRL) 7 for the majority of building blocks, demonstrating their applicability in key European application domains such as automotive, space, and IoT. ISOLDE is expected to provide a significant impact to the EU’s commitment to achieving digital autonomy and fostering a green, climate-neutral future.

IV Purpose and scope

The ISOLDE project aims to significantly address the RISC-V growing demand: by the end of our project, we will have high-performance RISC-V processing systems and platforms at least at Technology Readiness Level (TRL) 7 for the vast majority of the proposed architecture components, with the expectation that 2 years after project completion, ISOLDE's high-performance components will be used in industrial quality products. Moreover, the project extends its expertise to the realm of computing by spearheading the development of multi-precision Vector processing units integrated with RISC-V cores. This initiative seeks to enhance computing efficiency for specific applications while furnishing the EU and the open-source community with innovative solutions to computational challenges.

Through its embrace of the open-source RISC-V instruction set architecture (ISA), the ISOLDE project not only advances Europe's digital autonomy but also fosters innovation in high-performance computing systems. Emphasizing collaboration and open-source hardware, the project is poised to exert a significant influence on European industries and the global technological landscape.

Foundation infrastructure

V Building blocks

The ISOLDE project invests significant effort to ensure that the requirements for compatibility among its architecture components are well defined. ISOLDE uses the HW abstraction X-Interface (CV-X-IF, https://github.com/openhwgroup/core-v-xif) to connect system components, thus allowing re-use of ISOLDE components, of system SW, developed under permissive licenses, also giving the opportunity to update successful existing developments under the chosen permissive licenses (WP6), with the components listed in section 1.5.7 (and also including the co-existing TRISTAN ecosystem) with more than 50 components currently being available.

VI Methodology & EDA tools

Open-Source Electronic Design Automation (EDA) tools are key in the semiconductor and electronics industries due to their cost-effectiveness and flexibility. These tools offer a range of capabilities from basic schematic capture and printed circuit boards (PCBs) layout to more advanced digital design automation. They provide a cost-effective solution for hobbyists, educators, and professionals looking to leverage open-source SW in their electronic design workflows. The ISOLDE project employs a top-down design methodology, starting from system-level specifications and decomposing them into smaller, manageable modules, and share the same approach with the sibling other RISC-V flagship project TRISTAN, as sketched in Fig.1.

Milestones and next steps of the project:

- System Design and Integration: integrating HW and SW design processes to ensure seamless interaction between RISC-V processors and the SW that runs on them.
- Hardware-Software Co-Design: integrating HW and SW design processes to ensure seamless interaction between RISC-V processors and the SW that runs on them.
- Verification and validation: extensive use of simulation (at different abstraction levels) and emulation to verify the functionality of the design before HW implementation.
- Incremental Development and Testing: applying an iterative approach, where design and testing are performed in cycles, allowing for continuous improvement and early detection of issues. Creating prototypes aims to validate designs in real-world conditions.

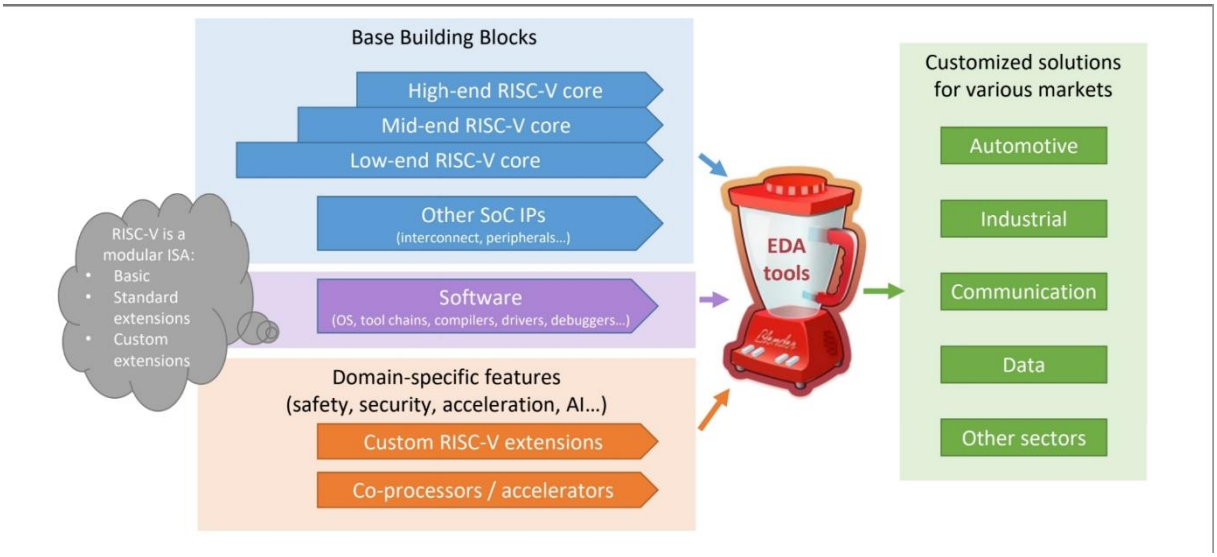

Figure1 - The partners involved both in TRISTAN and ISOLDE use of permissive open – source licenses in TRISTAN ensure exploitability of building blocks in ISOLDE.

VII System software and hardware

ISOLDE provides access to its experimental data and SW tools to the global scientific community. This openness fosters transparency, reproducibility, and collaboration among researchers from various institutions.

III.1 Open software initiatives

By providing open access to data and tools, fostering a collaborative development environment, and aligning with broader open science policies, ISOLDE ensures that its research outputs are maximally beneficial to the scientific community. These initiatives not only enhance the quality and impact of ISOLDE's own research but also contribute significantly to global scientific progress. For instance, the project partners Hochschule München University of Applied Sciences (HM) and SYSGO provide access to SW and OS-Support for RISC-V Processors

Benefits for the ecosystem from ISOLDE Open-Source initiatives:

- Innovation Acceleration: By making tools and data openly available, ISOLDE accelerates the pace of innovation as researchers can build on each other's work rather than starting from scratch.
- Cost Efficiency: Shared development and maintenance of SW tools reduce costs for individual research groups.

Educational Opportunities: Open SW initiatives provide valuable resources for training the next generation of scientists and engineers.

III.2 Open Hardware initiatives

BSC is highly active in initiatives and associations related to the focus areas of ISOLDE, such as the OpenHW Group and RISC-V International. In particular, Jaume Abella (BSC), who leads T3.1 on safety and security modules, has contributed to the creation of a Task Group on Safety and Security (S&S TG) as part of the OpenHW Group and is currently the chair of the group. This allows keeping ISOLDE contributions on safety and security related components in line with the directions followed by the OpenHW Group on these topics, and vice versa.

Similarly, Jaume Abella has a very active role in the RISC-V International Special Interest Group on Safety (SIG-Safety) in which he has been the vice-chair in the period April-2022 until April-2024. There, he has contributed to a gap analysis of RISC-V ISA specifications for the use of RISC-V in safety-relevant SoCs, and also in the preparation of a white paper on the matter. This allows keeping synchronized the work in T3.1 with the relevant work in RISC-V International.

Repository Management and European Partnership

The use of the repositories managed by OpenHW Group and well established open-source repositories will ensure that the code developed in TRISTAN & ISOLDE continues to be supported and remains available to European partners. In particular, the ECL members will provide the structure to curate the code in OpenHW repositories beyond the life of the project.

All consortium partners will receive training on this virtual repository. In addition, the guidelines will highlight the importance of the repositories in achieving digital sovereignty. The repositories will ensure that European actors are never deprived of the right to use open-source that was generated by the ISOLDE project. In practice, this means that the open-source repositories will always be publicly accessible from physical servers located in Europe. Eclipse Foundation's expertise will manage any applicable constraints and regulations.

VIII The tole of the OpenHW Group in repository management

ISOLDE defines and develops a methodology for making available open-source RISC-V components. This choice has been made to build momentum and achieve a critical mass of high-quality RISC-V components – all available in the same virtual repository, which is made available through a Unified Access Page.

The ISOLDE partners use *git* as their underlying revision control tool. Many of the blocks developed in ISOLDE will be available using open-source licensing. Some project contributions involve enhancements to well established, existing code repositories (e.g., CVA6 or LLVM). These contributions will be delivered into these well-established repositories.

Figure 2 and Figure 3 show some examples of how that has been implemented.

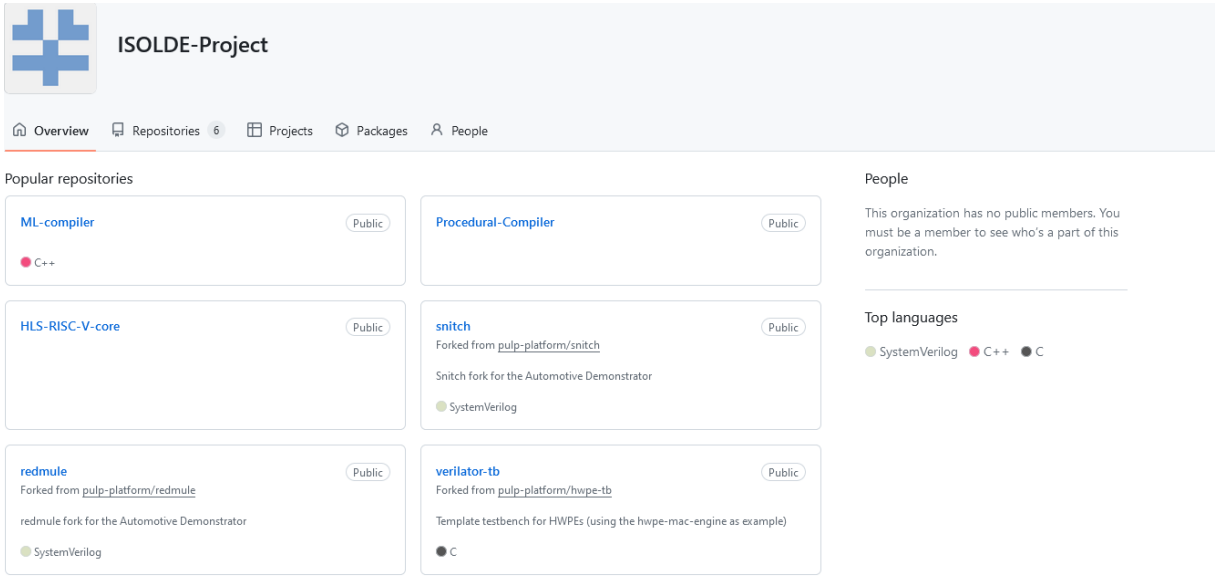

Figure 2 - ISOLDE GitHub

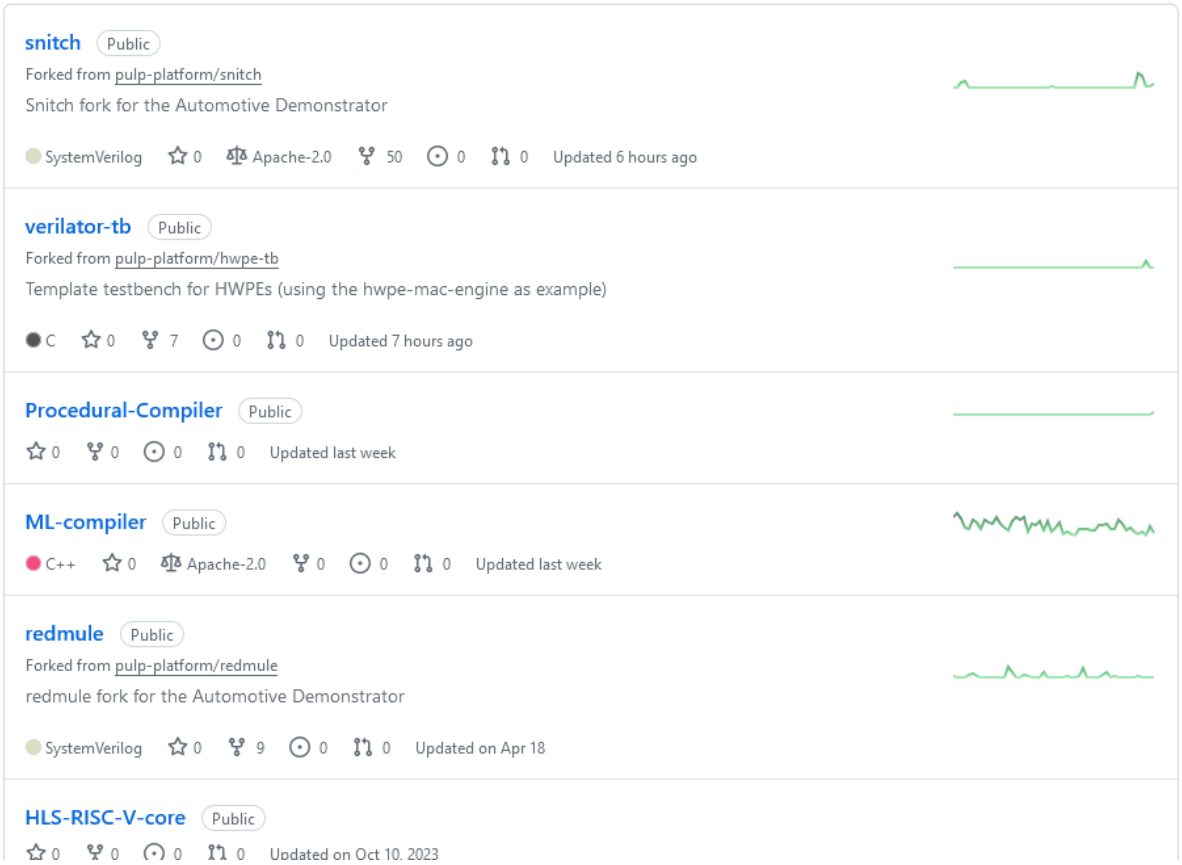

Figure 3 - ISOLDE GitHub Folders

IX The benefits of European partners and contributors

Given the scale of the project and the number of expected contributors, there will thus be multiple repositories, that we call “Virtual” repository. TRISTAN also plans to follow the same approach.

ISOLDE and other projects under the call HORIZONCL4-2021-DIGITAL-EMERGING-01-05 will provide simple “one-stop” access to all the repositories that constitute this virtual repository (“Unified Access Page”). The virtual repository is based on a uniform set of rules and guidelines to be followed to ensure the same structure for the content.

The benefits of the ISOLDE project are a realistic pathway for:

1. Companies (both large enterprises and SMEs) who include RISC-V and RISC-V features-related in their designs and products.

2. Universities and Research and Technology Organisations (RTOs) to educate and expand the user community in RISC-V based design.

3. Dissemination and outreach to policymakers, the media and the wider public.

The overall key-message for relevant academic, industrial and societal stakeholders will be that “ISOLDE will contribute toward European sovereignty for embedded processors”. Sub-messages to each target group will be refined/modified during the project's lifetime. The external dissemination plan will – in any case – strongly emphasize the importance of allowing

stakeholder communities to deliver feedback to the project and even become involved in some cases.

All public dissemination actions and materials will emphasize the role and contributions of the ISOLDE project objectives to address the KDT JU Programme.

Open-Source Distribution Channels and Platforms

X Analysis of current Open-Source distribution channels

BSC has centralized the distribution of its open-source HW and related SW components through its Laboratory for Open Computer Architecture (LOCA), which can be reached here: https://github.com/bsc-loca

Out of the 3 technologies developed by BSC in the context of ISOLDE, namely the SafeSU, the SafeTI, and the PQC accelerator, two of them (SafeSU and SafeTI) are already available as open-source components with permissive licenses through the LOCA portal, and the remaining one (PQC accelerator) is planned to be released during forthcoming months.

Apart from the LOCA portal, the SafeSU and SafeTI components are integrated as part of the SELENE platform (https://gitlab.com/selene-riscv-platform/selene-hardware), which builds on Frontgrade Gaisler's technology to provide an open source (GPLv3 license) RISC-V platform targeting the space, automotive and railway domains. Such a platform will be the basis to assess a number of ISOLDE HW and SW technologies along with the automotive use case and is primarily maintained by UPV in the context of the ISOLDE project.

In addition to the core open HW distribution channels, for completeness we also note that also open-source SW is part of ISOLDE: e.g. the open-source Linux operating system and also the (SW) OpenEMS system part of the smart home demonstrator is distributed at https://www.openems.io/ and an overall a view of open-source tools for energy management can be found at scheme below:

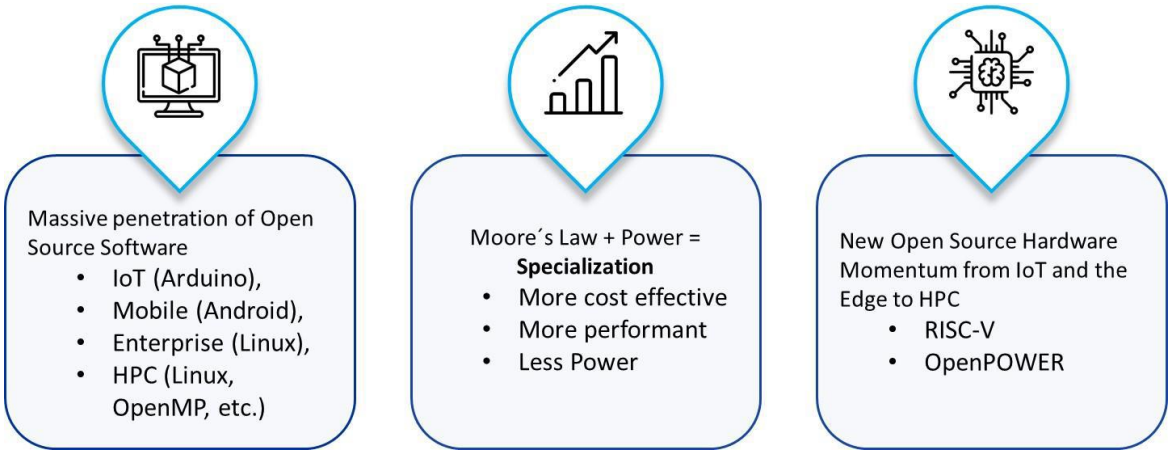

Figure 4 – Open-source SW and HW landscape

XI The role of platforms in enhancing visibility and accessibility

The ISOLDE project is tightly linked to the KDT project called TRISTAN, as presented in Figure 3. Both projects started more than 12 months ago. There is a group of core partners (CODA, E4, ETHZ, IFX, LDO, NXP-RO, POLITO, SYSGO, TDIS, TRT, UNIBO) who are present in both consortia and who are committed to ensuring that there is a strong collaboration between the projects.

The TRISTAN and ISOLDE projects are working closely together on establishing RISC-V processor technology in Europe. The results of the projects are planned to complement each other. Each project focuses on a different performance class. Both consortia are composed of partners from industry (both large industries as well as SMEs), research and RISC-V related industry associations.

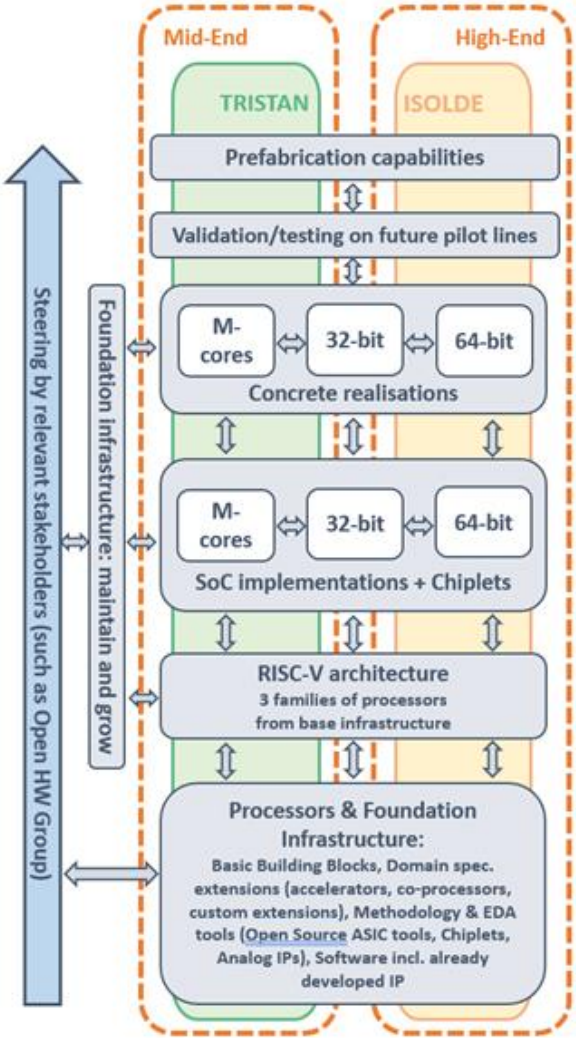

Figure 5 - TRISTAN and ISOLDE Synergy

The IPs developed in TRISTAN will be made available through a Virtual Repository, a one-stop webpage that will bring users to the actual repositories which host the IPs developed in the project.

The IPs developed during ISOLDE will be integrated into the same Virtual Repository. This will ensure that, by the end of both projects, all the IPs developed in both projects will be available in one location. This site will contain an extremely rich library, with the activities in TRISTAN focusing more on the needs for embedded class processor systems and the activities in ISOLDE bringing higher performance processing through more powerful cores and application specific accelerators, as picture in Figure 6.

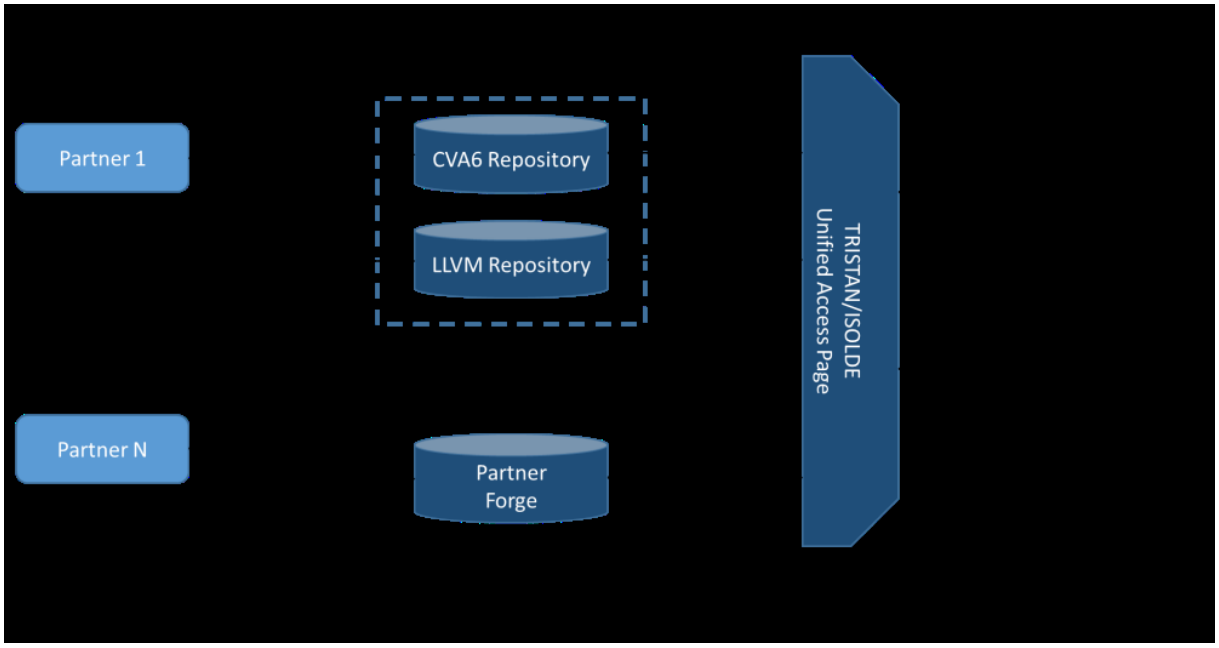

Figure 6 - Repository collaboration between partners of the TRISTAN and ISOLDE projects

Business Models in Open-Source Ecosystem

The term "Open-Source" defines a system of values that celebrate open exchange, collective participation, transparency, and community development. This philosophy applied in this project allows users free access to use of the source code, which can be adapted, modified and redistributed; if there are constraints related to specific individual products, with a low cost, it will be possible to replace an element of the architecture with a different and compatible one.

Both in the Open-Source SW community and in traditional SW development, the SW system is designed modularly, defining components with a specific scope.

The traditional SW development process starts by defining and specifying requirements. These requirements are sometimes vague; developers are unfamiliar with real needs and must interview project stakeholders to elicit requirements. In Open-Source SW development is launched for the purpose of satisfying clear requirements, as developers are well acquainted with their needs. Successful Business models within open source often revolve around complementary services rather than proprietary SW sales. Main strategies include:

a. Support and Maintenance Services: Companies offer premium support, training, and maintenance services for open-source products.

b. Freemium Models: Providing basic features for free while charging for advanced functionalities or support.

c. Consulting and Customization Services: Offering consulting services and customization based on open-source solutions.

XII Overview of various Open-Source business models

For universities and research institutes, a direct commercialization of project results is often not possible. In addition to reaching a broad audience and ensuring continuous development, open source also offers an interesting complementary business model. Universities and research institutes can offer commercial services based on open-source releases. This includes consulting services, such as the presentation and transfer of the underlying methodology or putting the open-source tools into operation. Another aspect is that industrial users often require an adaptation of the published general-purpose tool to company-specific processes or formats. Based on the open-source release, universities and research institutes can offer adaptation services for the released tools. For this adaptation, bilateral use and development agreements can be established, e.g. for further enhancing the research with further evaluations. These business opportunities are supported by open-source releases because they reach a wider audience and provide a better insight into the proposed solution compared to a scientific publication alone. Combined with scientific publications that also explain and specify the underlying methodology, this provides a fertile basis for consultancy and transfer activities.

This can be compared to that in SW, many businesses also use well-understood open-source components as baseline infrastructure, e.g., Linux in embedded systems and servers, Kubernetes and Docker in the cloud area, or frameworks like TensorFlow and Keras for AI tasks.

Base a development of a complex system on commonly shared core designs also can be useful for certification, e.g., when SYSGO certified its (SW) Pike OS product for Common Criteria EAL5 security certifications, we argued that some properties of Pike OS followed some shared well-understood designs of separation kernels.

XIII Comparative analysis of traditional vs Open-Source business strategies

Networking with related pilots and other initiatives that focus on RISC-V, open-source technology & IP, embedded processor development and usage and SoC application design beyond the own community of the project is very important for the success of ISOLDE.

CONS: Contribution to open-source strategy. CONS is a member of the Open EMS foundation. CONS will contribute to the open-source exploitation strategy by bringing in its experience with Open EMS open-source energy management systems as well as by formulating needs to by participation in the energy management demonstrator.

IFX: Contribution to open-source strategies based on experience with own IPs and derivation of potential business models hereof.

INTEL: Contributions based on expertise on open-sourcing.

NXP-AT: Supporting the communications activities and interactions with TRISTAN.

POLIMI: Participation to the open-source activities.

SAL: Participation to the open-source activities.

SYSGO: Contribution to open-source strategy from the point of view of developer of both open-source (Linux) as well as proprietary systems (PikeOS).

TRT: Promotion of full stack permissive open-source solutions down from the HW up to the SW though the OpenHW.

UNIBO: Participation to the open-source activities.

IMT: IMT works together with the Romanian Universities, Research Institutes and Companies to promote open-source HW, open-source tools and the RISC-V ecosystem in events such as Technologies of Internconnections in Electronics (TIE, https://tie.ro/).

E4 works Contribution to the definition of the requirements & specification on foundation cores, interfaces, peripherals & NoCs

The term "Open-Source" defines a system of values that celebrate open exchange, collective participation, transparency, and community development. This philosophy applied in this project allows users free access to use of the source code, which can be adapted, modified and redistributed; if there are constraints related to specific individual products, with a low cost, it will be possible to replace an element of the architecture with a different and compatible one.

Both in the Open-Source SW community and in traditional SW development, the SW system is designed modularly, defining components with a specific scope.

The traditional SW development process starts by defining and specifying requirements. These requirements are sometimes vague; developers are unfamiliar with real needs and must interview project stakeholders to elicit requirements. In Open-Source SW development is launched for the purpose of satisfying clear requirements, as developers are well acquainted with their needs.

All partners from academic areas performed some developments relevant for the safety island in the context of a NOEL-V based RISC-V multicore. Those developments will be the starting point for some of the ISOLDE developments.

XIV Impact of Open Source on market dynamics and competition

Now, with regards to certification, it is hard to judge how well open-source HW components can compete with closed-source counterparts with regards to certification, although e.g., for CVA6 the Open HW Group is making good progress. To get an overview of certification plans, SYSGO as part of WP1 is compiling a list of components where certification is planned.

Based on Blind et al. article “The Impact of Open-Source Software and Hardware on Technological Independence, Competitiveness and Innovation in the EU Economy” the analysis estimates a cost-benefit ratio of above 1:4 and predicts that an increase of 10% of Open-Source SW contributions would annually generate an additional 0.4% to 0.6% GDP as well as more than 600 additional ICT start-ups in the EU. It’s impressive that Europe has a larger community of Open-Source contributors than the US (more than 3 million) developers, which include two of the three largest markets (UK and Germany), and four of the ten fastest-growing (Ireland, Turkey, Netherlands, and Portugal).

The ISOLDE project contributes to an open-source approach, supported by a business-friendly license and an active open-source foundations, with customisable high-performance multicores based on RISC-V cores and accelerators. It has the goal of making RISC-V become a widespread industry standard alternative to today’s proprietary ISA.

To achieve this, ISOLDE is based on the library of HW and SW components developed as part of TRISTAN and uses additional technologies and some components developed in other H2020 and ECSEL projects, maximizing the reuse and flexibility of the component library, so as to enable multicore implementations that meet a variety of requirements across different domains.

In the following three picture a general business model canvas for ISOLDE and two preliminary partner-specific business canvas models are sketched, which will be further developed in the forthcoming months.

Key Partners	**Key Activities**	**Value Proposition**	**Customer Relationships**	**Customer Segments**
Other Partners involved in the Consortia of European projects focusing on RISC-V: e.g. research centres and Universities, industries and SMEs, supercomputing centres, etc.	Designing and manufacturing highly technological solutions for HPC cluster, cloud, data analytics, AI, hyper-converged infrastructure for Academic and industrial markets. Investing in R&D through collaboration with the main research centres at a national and international level, and involvement in national and European projects in HPC and AI fields.	Co-developing ISOLDE open-source exploitation strategy by offering a contribution to the definition of requirements and specifications, as well as providing support to the implementation and testing of the Space demonstrator.	Potential users of open-source repositories will be directly informed through targeted communication and/or will learn about it through ISOLDE project C&D strategy.	Research centres and Universities (Academia); large industries and SMEs among E4’s network of customers investing in R&D; supercomputing centres; other stakeholders in the HPC domain.

	Key Resources Public outputs, results and KERs stemming from research and innovation projects where the company is involved as a Partner, which can be disseminated in open repositories to the benefit of the whole scientific community.		**Channels** ISOLDE virtual repository, OpenHW Group repository, GitHub, other project's virtual repositories (e.g. TRISTAN), any other open-source exploitation repository.	
Cost Structure Budget from European projects allocated to C&D (and Exploitation) activities			**Revenue Streams** The repositories where codes are hosted are open-source and will remain publicly accessible from servers located in Europe. Possibility of business exploitation after the end of the project.	

Figure 7 – Exemplary Business Model Canvas for the ISOLDE project

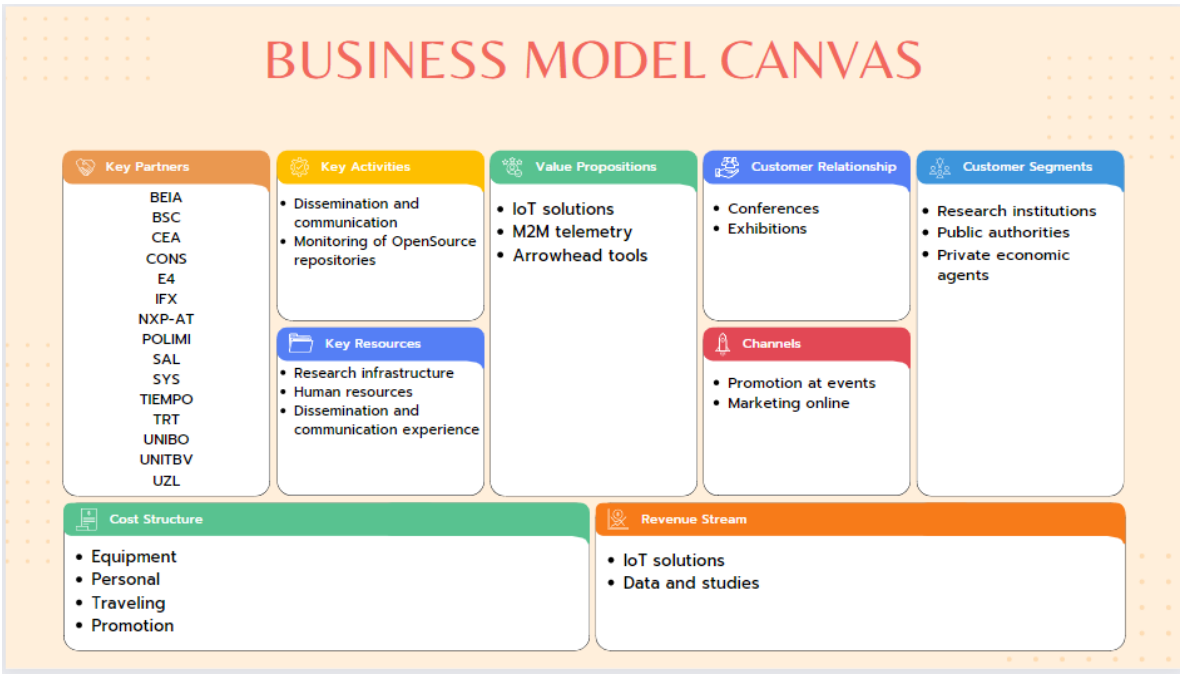

Figure 8 BEIA Business Model Exemple

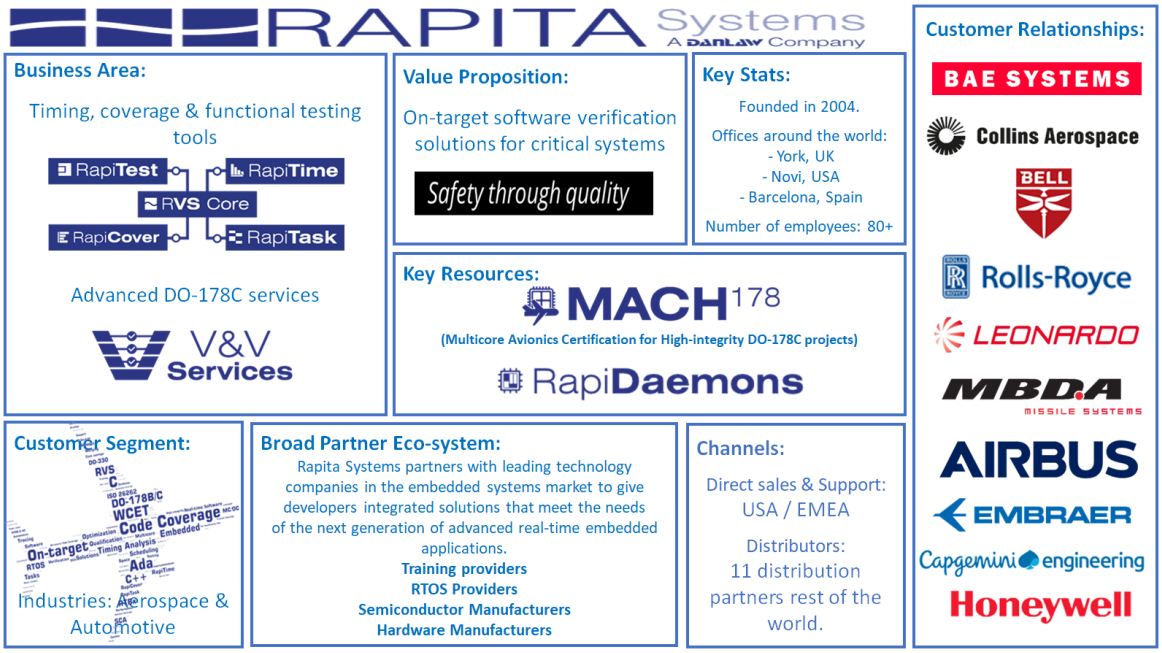

Figure 9 RAPITA Business Model Exemple

Next Steps

XV Emerging trends in Open-Source technology and distribution

The recent semiconductor shortage and shifts in global political relations have changed the European roadmap on semiconductors and chip design significantly. A mix of incentives for new fabrication facilities for advanced technologies and the ambitious goals to (re)-build leading-edge chip design capabilities in Europe are key cornerstones of the European Chips Act. Under this impulse, various funding actions have been successfully launched, for instance in the creation of IP based on the RISC-V instruction set. In this landscape it has been a matter of time for technological Europe to find suitable options to save the current situation. Key Digital Technologies Joint Undertaking (KDT JU) brings together two projects TRISTAN and ISOLDE in the same cluster and aims to synergize, complement and build a strong European ecosystem focused on the RISC-V technology.

TRISTAN and ISOLDE interconnected projects aim to enhance, using a holistic approach, the quality and availability of both EDA tools and a full RISC-V SW stack.

XVI II. Predictive analysis of the future Open-source business models

The European ecosystem around RISC-V is expanding, and ISOLDE is in the right position to provide its contribution to make RISC-V a technology platform for European growth and success in the international scene.

ISOLDE is expected to contribute to a more robust and vibrant open-source ecosystem, fostering innovation and rapid development. This ecosystem will become self-sustaining as more stakeholders invest in and benefit from shared resources.

Commercial services – support: Companies are increasingly offering commercial support for open-source projects, providing services such as technical support, training, and consulting.

ISOLDE is expected to develop high-performance RISC-V components, there will be a rise in commercial entities offering support services for these technologies, creating new business opportunities and revenue streams.

Hybrid business-models: Hybrid business models that combine open-source SW with proprietary elements or value-added services are becoming more prevalent.

ISOLDE is expected to pioneer or encourage hybrid models where core technologies are open - source, but specialized, optimized, or certified versions are available commercially. This approach could balance openness with profitability.

Sustainability and Funding: Funding for open-source projects is increasingly coming from a mix of public, private, and community sources.

ISOLDE is expected to help establishing a sustainable funding collection of technology enablers for future open-source projects, including public grants, corporate sponsorships, and community-driven funding mechanisms. These models ensure long-term viability and continuous improvement of open-source technologies.

Collaborative-innovation: Open-source projects often lead to collaborative innovation, where multiple stakeholders contribute to and benefit from shared advancements.

ISOLDE is expected to enhance collaborative innovation across the European microelectronics industry, leading to breakthroughs that individual companies might not achieve independently.

Regulatory and Policy Support: Governments and regulatory bodies are increasingly recognizing the importance of open-source SW for security, transparency, and innovation.

ISOLDE is expected to influence European policies to further support open-source initiatives, providing an advantageous regulatory environment and possibly incentives for companies to engage in open-source development.

XVII The potential evolution of NewCo in the changing landscape

The evolving landscape of the semiconductor industry and open-source HW presents significant opportunities for the growth and development of NewCo. The ISOLDE project, which focuses on enhancing the RISC-V ecosystem, provides a robust foundation for NewCo to establish itself as a pivotal player in this dynamic environment.

NewCo is poised to leverage the advancements made within the ISOLDE project to drive innovation and integration of RISC-V technology. By adopting the open-source RISC-V IP cores developed through ISOLDE, NewCo can create customizable solutions that cater to diverse market needs, including automotive, industrial, and communication sectors. This flexibility allows NewCo to offer tailored products that meet specific industry requirements for safety, security, and performance.

The expansion of the RISC-V ecosystem is a central goal of ISOLDE, which aligns perfectly with NewCo's strategic objectives. By participating in and contributing to the development of open-source RISC-V IP, the NewCo can help foster a more cohesive and extensive ecosystem. This involvement not only enhances the overall value proposition of RISC-V technology but also positions NewCo as a key influencer in the growth of the ecosystem.

ISOLDE's emphasis on commercialization and creating new business opportunities for RISC-V technology directly supports NewCo's potential evolution. The project exploration of various business models for industrializing RISC-V processor families provides a blueprint for NewCo to develop sustainable commercial strategies. Additionally, by utilizing ISOLDE's virtual repository and participating in stakeholder workshops, NewCo can accelerate its go-to-market plans and establish strong industry connections.

The collaborative nature of ISOLDE, which involves major European semiconductor manufacturers and academic leaders, offers NewCo a unique platform for strategic partnerships and standardization efforts. By engaging with these stakeholders, NewCo can contribute to and benefit from collective advancements in RISC-V technology, ensuring its solutions remain at the forefront of innovation and industry standards.

The training programs and educational outreach initiatives supported by ISOLDE will play a crucial role in developing a skilled workforce for NewCo. By participating in these programs, NewCo can attract and train top talent in RISC-V and embedded processor development, ensuring it has the expertise needed to drive future growth and technological advancements.

In conclusion, the potential evolution of NewCo in the changing landscape is intricately linked with the outcomes and initiatives of the ISOLDE project. By harnessing the advancement of the project in RISC-V technology, contributing to the expansion of the ecosystem, and engaging in collaborative efforts, NewCo is well-positioned to thrive in the semiconductor industry and beyond.

Conclusions

Because Europe intends to create and sustain a future world where innovation and safety technical development to create a better life, TRISTAN and ISOLDE are currently developing new technological roadmaps to address that intent. By actively engaging with related pilot initiatives and communities, one can leverage collective expertise, resources, and networks to advance the goals of research projects and contribute to the broader ecosystem of RISC-V and open-source technologies.

The interface between TRISTAN and ISOLDE are sharing methodologies and mutual information and will form the impetus to create low-/ mid-/ and high-end platforms for different strategic application domains in Europe.

This deliverable highlights also the importance of repositories in achieving European digital sovereignty. The repositories ensure that European actors are never deprived from the right to use open source what was generated by the ISOLDE project. In practice, this means the repositories will always be publicly accessible from physical servers in Europe.

Moreover, continuous monitoring of external Open-source initiatives and business models with respect to Open-source exploitation will be done by the consortium in order to ensure that all business-related activities are kept synched with the state-of-the-art, and a competitive advantage can be provided and maintained for all partners of ISOLDE.

Active European OS HW Community and High-Quality OS HW and SW IP are very important to follow and impact, and both strive for deliverables given to open source.

Therefore, during the ISOLDE project, the focus continues to be on identifying and addressing strategic elements and opportunities related to open-source licensing and educating stakeholders on how to best take advantage of open-source approaches to increase their market share, based on interacting with current non-profit organizations and comparing different business models.