decode

D4.15

Integration of all DECODE components tested in real world pilots and future sustainability roadmap

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DECODE

DEcentralised Citizens Owned Data Ecosystem

D4.15 - Integration of all DECODE components tested in real world pilots and future sustainability

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Author(s): Puria Nafisi Azizi, Andrea D'Intino, Denis Roio (Dyne.org)

Editors and reviewers: Sergi Rene (UCL)

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PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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This report is currently awaiting approval from the EC and cannot be not considered to be a final version.

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Introduction

The technological output of DECODE, the architecture of the pilots along with their relationships and overlapping, is strongly influenced by the UNIX philosophy, which "emphasizes building simple, short, clear, modular, and extensible code that can be easily maintained and repurposed by developers other than its creators". Although the four pilots have very heterogeneous goals, functionalities and technical structures, the application the UNIX philosophy to the overall design of the DECODE technologies, resulted in set of narrow-featured, generic and interoperable components, presenting the following core advantages:

- The same component(s) can be reused effectively in multiple pilots with no modifications.
- It allows multiple teams of developers, geographical distant from each other, to independently work at the same time on the same solution (the pilot), with reduced need to interact with each other.
- By having multiple components deployed independently (as micro-services, command line applications, web apps and mobile apps), pinpointing errors and failures was accelerated, resulting in a faster testing process.
- Having smaller components (often dockerized), enables a more distributed deployment, thus allowing each developer to do test deployments on smaller local server and thus to monitor their code from closer.

Furthermore, many key components (Zenroom, Zenbridge, DECODE OS, the DECODE App and the BCNNow Dashboard among others) developed within DECODE have been designed from ground up as extensible, thus reducing the steepness of the learning curve for 3rd party developers who are willing to experiment and adopt DECODE technology, even in applications that have little or no connection with the pilots developed within the project.

This deliverable explores the connection within each component and the pilots and, given the advanced stage of the project it is being written at, it builds on previous deliverables that analyzed several research aspects in detail. This paper focuses on:

- Listing and describing each of the components and the way the interact with each other within the pilots
- The current deployment of the components
- The existing and growing interest and involvement of the open source community with some of the components

Plans and initiatives for future sustainability are described more in detail in D5.8.

DECODE Ecosystem

DECODE in a nutshell

The DECODE Project aim is to create an ecosystem of tools to "take back the data sovereignty to the citizenship".

Debating the objectives and demonstrating the results are out for the scope of this document and are covered in detail in the deliverable Me, my data and I[1] and publicly demonstrated in the DECODE Symposium 2019[2] event held in November 5th with countless well known guests and speakers.

The technology components that were developed for the project are covered in detail in the architectural deliverable D1.5 Intermediate version of DECODE architecture[3]. Here we list the main components published on the official distribution channels of the project.

All of the source code is available on the official DECODE Github organization[4].

Description	Description
Zenroom	Small, secure and portable virtual machine for crypto language processing
Decode OS	The DECODE OS for private, distributed P2P computing
tor-dam	Tor Distributed Announce Mechanism (Not a DHT)
BCNNow	Light, personalized, interactive dashboards for urban data exploration.
Sawroom	Zenroom Transaction Processor for Hyperledger Sawtooth
DECODE App	DECODE Project mobile app
Petition-TP	Transaction processor for Decode Petition over Sawtooth
Redroom	Zenroom crypto module for Redis
IoTpolicy store	DECODE component - policy store
Credential issuer	Restful API for the Credential issuer of the DDDC and IoT pilot projects

1 https://decodeproject.eu/publications/me-my-data-and-ithe-future-personal-data-economy

2 https://decodeproject.eu/events/agenda

3 https://decodeproject.eu/publications/intermediate-version-decode-architecture

4 https://github.com/DECODEproject

Description	Description
Petition API	Restful API for the Petition of the DDDC pilot project
Zenbridge	Agnostic blockchain middleware in exposed in REST API
Decidim for DDDC	Adaptation of DECIDIM platform for DECODE
NodeRED-Zenroom	Zenroom nodes for NodeRED
IoT store	Implementation of Twirp interface for the DECODE encrypted datastore
Toaster.do	transforms your Docker prototype into an installable image for many target architectures
DDDC coconut flow	Implementation of the coconut flow with Zencode
Password scanner	Decode Passport Scanner
Amsterdam PWA	Decode Amsterdam PWA

How components interact

As the word ecosystem says there are many tools involved in DECODE. The different projects aim all at the same goal: the mission shared by all DECODE partners "the need to give people more control over their personal data"[5].

The pilots are concrete real-case application of these projects. An extensive assessment of each pilot is available on the DECODE Pilots Impact Fact Sheet[6]

The details of each pilot are covered in detail on their own deliverable, listed here for convenience:

- D2.5 Techno political Democratization and Digital Commoning: the Case of the Digital Democracy and Data Commons (DDDC) pilot[7]
- D5.6 Deployment of pilots in Barcelona[8]
- D5.5 Deployment pilots in Amsterdam[9]

5 https://decodeproject.eu/publications/me-my-data-and-ithe-future-personal-data-economy

6 https://decodeproject.eu/publications/decode-pilot-impact-fact-sheet

7 https://decodeproject.eu/publications/technopolitical-democratization-and-digital-commoning-case-digital-democracy-and-data

8 https://decodeproject.eu/publications/deployments-pilots-barcelona

9 https://decodeproject.eu/publications/deployment-pilots-amsterdam

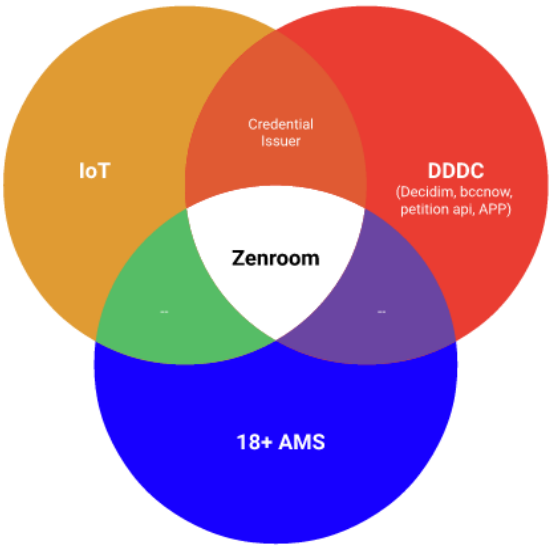

Figure 1: DECODE pilots' component interaction

The software architecture is described in these deliverables, but in order to properly describe software components, we will resort to a Venn diagram[10] of the projects, sorting them based on uses cases and on the shared technology as in the Figure 1. The core component adopted by all pilots is the Zenroom Smart Contract VM[11]. Between the Barcelona pilots (*IoT pilot, DDDC Petition* and *BCNnow)* in addition to Zenroom the application protocol interface API component adopted by all is the credential issuer[12]. From an infrastructure point of view the Barcelona pilots share among all of them the DECODE OS[13] in the function of service container.

10 Venn diagram on Wikipedia: https://en.wikipedia.org/wiki/Venn_diagram

11 https://zenroom.org/

12 https://github.com/DECODEproject/credential-issuer

13 https://decodeos.dyne.org/

Not just technology but infrastructure

The main components mentioned in the previous section are mostly interconnected software over *distributed ledger technology* (DLT) and decentralized services as detailed in deliverables (D1.5 and D5.6[14]). Some of them interact with each other over API and REST services.

In DECODE the infrastructure was also a crucial field of research. As we know the hegemony of private and controlled infrastructure by the big tech companies is a hot topic when considering data and infrastructure sovereignty. Hence part of the research was devoted to produce an infrastructure that would run independently, granting privacy by design as recommended by several research document produced through DECODE's research.

The most significant result of this research is the development of the DECODE OS project, whose adoption as micro-service container can grant privacy by design principles to guest applications as well lower the liability of operators (and in particular Internet Service Providers, ISP) in relation to GDPR regulation.

DECODE OS is especially successful in portability: it is capable to run on many different hardware platforms: not just on servers (physical or virtual-machines) or personal computers, but also on embedded platforms, making it suitable to power IoT solutions.

A further benefit of DECODE OS is the ability to connect to a TOR network: its Tor-DAM component (mentioned in the deliverable D1.5) itself is one more project coming out from the DECODE infrastructure research: it is a "*p2p discovery and networking component built on a private subnet over network and including a means for identifying and verifying peer nodes*". Connecting to a TOR network enables DECODE OS users to have high privacy communication over the network while having a very accessible way to provision new nodes over the network (Figure 1) .

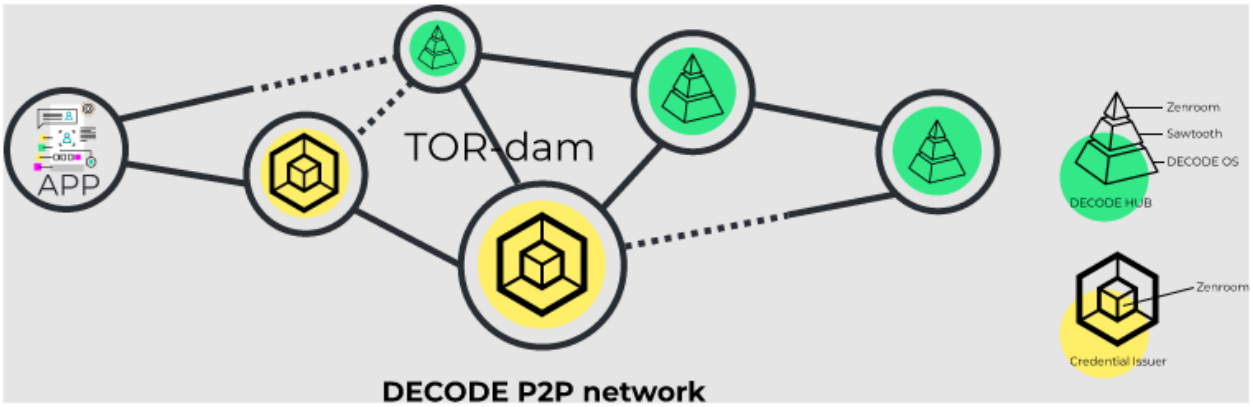

Figure 2: DECODE P2P Network

[14] D5.6: "Deployments of pilots in Barcelona" https://decodeproject.eu/file/385/download

Figure X is a big picture of the DECODE network applied over the real world including the DDDC petition services the DECODE app and the IoT pilot (D5.6[15]).

Deployments

At project level, Docker[16] was chosen as a tool to deploy quickly, and in an automated way, the DECODE project software, providing a replicable and deterministic way to have reliable configurations and fast deployments of the released software. In this context, publicly available Docker images of the main components are released and published on the DECODE repository on hub.docker.com[17].

Most of the other components have their own **Dockerfile** in the repository (the public source code) that enable users to create as a PaaS (Platform as a Service) and deliver a virtualised (at OS-level) software packages (in Docker words container).

A brief number of projects is given by the following search on the DECODE project main code repository[18] that lists more than 20 projects.

Extending more and going beyond the single component and software deployment with the Docker compose technology[19] is possible to deploy complex services and configuration of different containers.

Another innovative tools to mention is Toaster.do[20] project that was built to produce, using a Dockerfile as input, bootable system images for different architectures, hence allowing automatic and easy deployment of complex configuration systems over different hardware devices. This is an online service for developers of the DECODE project which will survive the project and it has also been abstracted as an offline tool named 'docker2sh' present on Dyne.org's repositories.

Tools webpage

For the purpose of illustrating all the tools involved in the Ecosystem the web page https://tools.decodeproject.eu/ was created (Figure 3: tools.decodeproject.eu page).

The purpose of this informative website is for making accessible the ecosystem already in place and continue to update users and citizens for new releases and built an official communication for the continuity of the project.

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15 D5.6: "Deployments of pilots in Barcelona" https://decodeproject.eu/file/385/download

16 Docker Wikipedia: https://en.wikipedia.org/wiki/Docker_(software)

17 DECODE Docker's hub: https://hub.docker.com/u/decodeproject

18 https://github.com/search?q=org%3ADECODEproject+dockerfile&type=Code

19 Docker compose: https://docs.docker.com/compose/

20 Toaster: https://toaster.dyne.org/

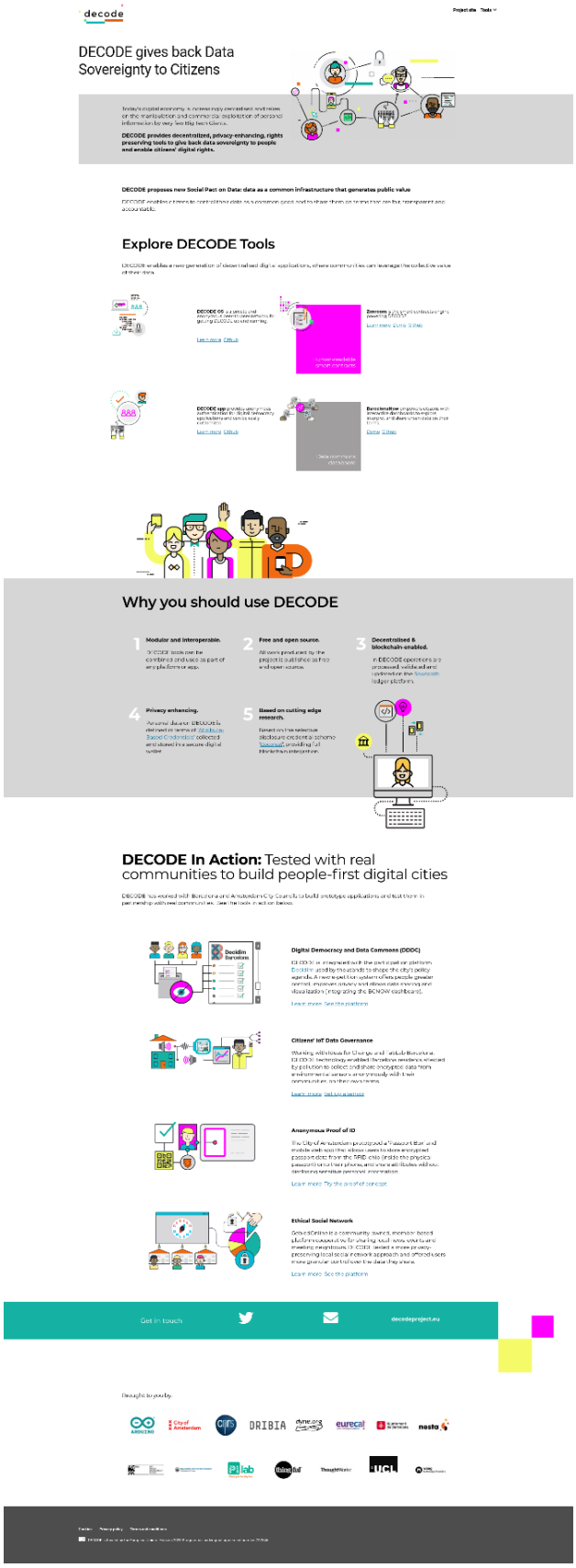

Figure 3: tools.decodeproject.eu page

The two main informative sections are about the main tools of the project:

- Zenroom
- DECODE APP
- BarcelonaNow

and the main, real world tested cases (the pilots) that on the site are over the section *DECODE in Action*, mentioning:

- Digital Democracy and Data Commons (DDDC)
- Citizens' IoT Data Governance (IoT)
- Anonymous Proof of ID (+18)
- Ethical Social Network (GebiedOnline)

External adoption and public acclaim

The success of the project could also be measured by the adoption of third parties' entities of the DECODE ecosystem tools.

Let's have a look for instance response of the open source and blockchain community to

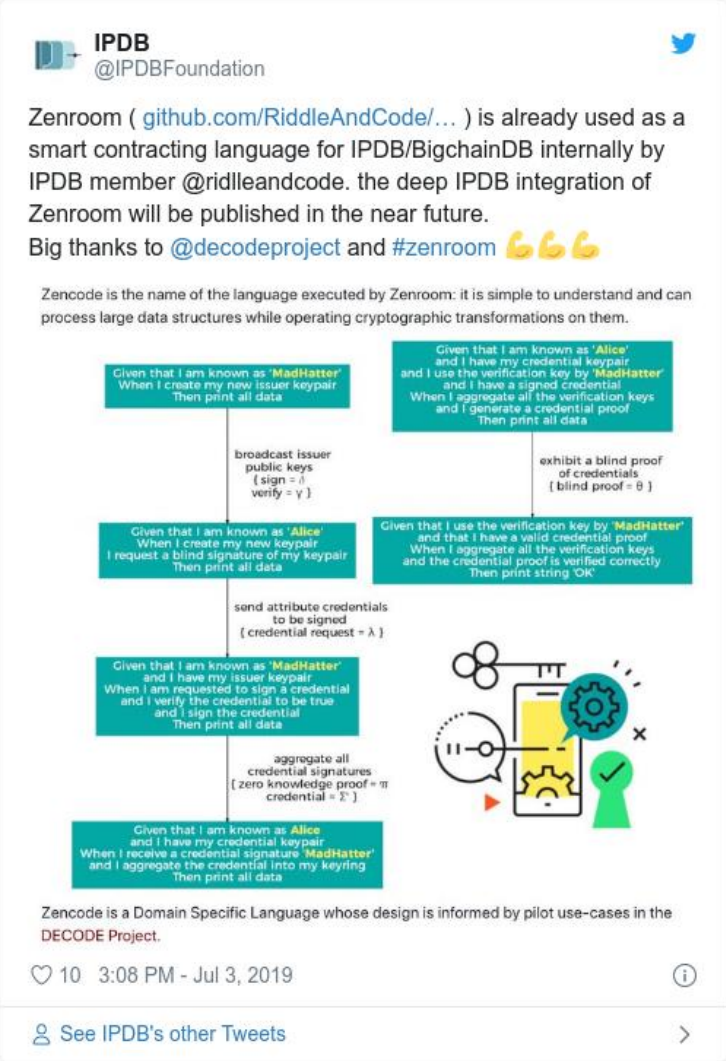

Figure 4: BigchainDB adoption of Zenroom

Examples of Zenroom adoption in hardware tools:

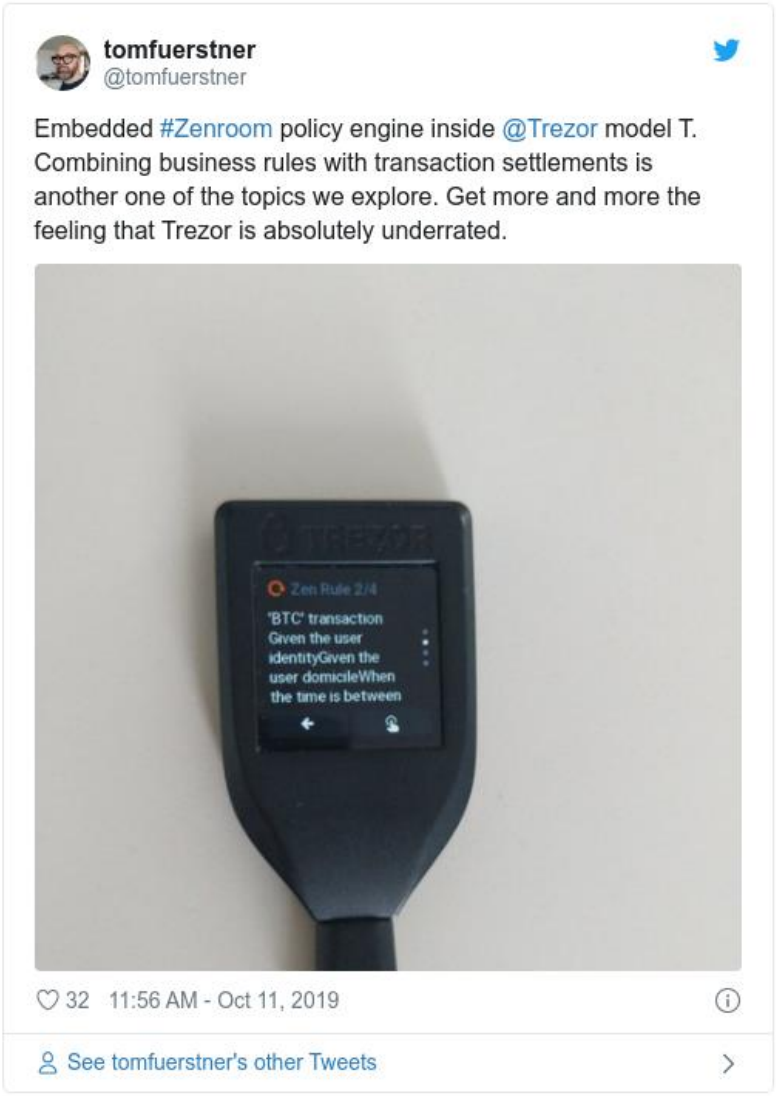

Figure 5: Zencode usage in Trezor

The statistics of 3rd party adoption and development of Zenroom are constantly increasing.

Below you can see the diagram of monthly download of just the JavaScript binding of Zenroom over the npm distribution package manager.

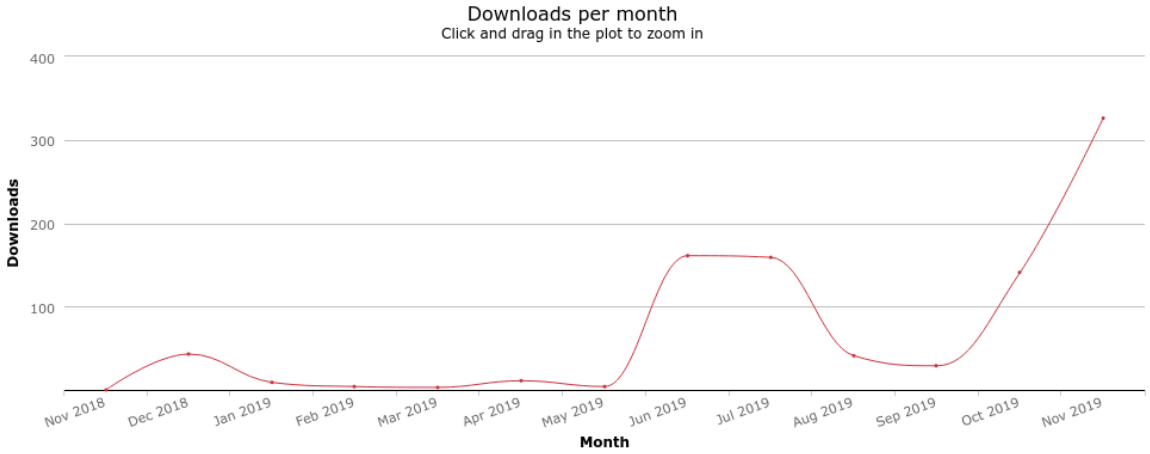

Figure 6: download of Zenroom NPM packages (https://npm-stat.com/charts.html?package=zenroom)

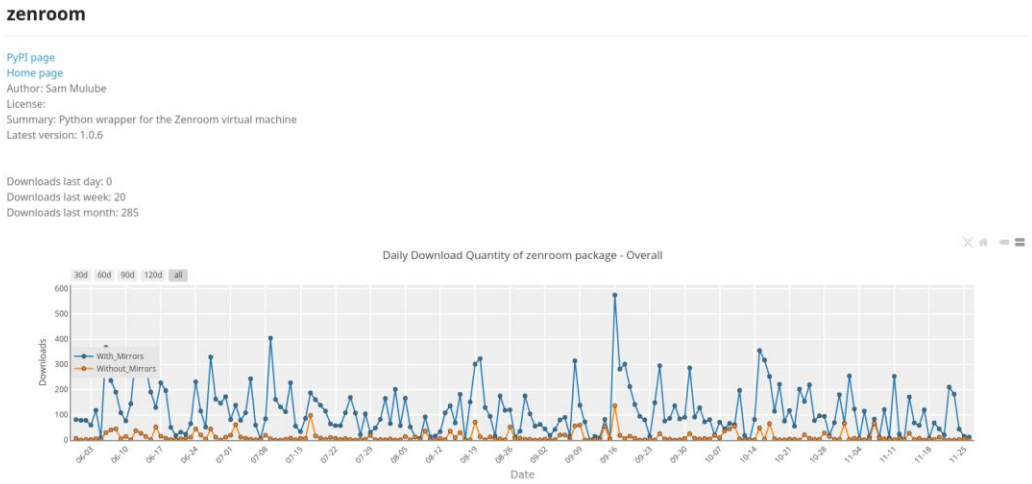

Figure 7: downloads of Zenroom for Python

Below you can see also a diagram of the hundreds of daily downloads of the python bindings of Zenroom over the official python management package manager (PyPi).

Adoption of the open source community

One more metric to count for the measurement of the readiness of the technology is the adoption of open source developers that build software by embedding or extending the project tools part of the DECODE ecosystem.

This is already happening and continuously increasing with the Zenroom project, that by now has more than 30 satellite projects around.

Just overgithub.com (a platform for sharing open source code) there are almost 20 projects using Zenroom as its core technology.

In the following table some example of satellite project are mentioned:

Description	Public code repository
Zenroom bindings in C++	https://github.com/chespinoza/zenroom-static-cpp
Zenroom benchmarking	https://github.com/jpopesculian/zenroom-benchmarks
Zenroom minimal	https://github.com/RiddleAndCode/zenroom_minimal
Zenroom demo with docker	https://github.com/mdevilliers/zenroom-demo
Zenroom integration in discipl	https://github.com/discipl/discipl-core-zenroom
Zenroom closurejs bindings	https://github.com/transducer/zenroom-example
Zencode fork for diverse scenarios	https://github.com/RiddleAndCode/zencode-core
zenroom python binding minimal	https://github.com/RiddleAndCode/zenroom_minimal_py

ISO WG TC307

Proof of reliability and interoperation with the blockchain is the admission of the dyne.org development team into the working groups for the definition of the new standards about "Blockchain and distributed ledger technologies".[21]

21 https://www.iso.org/committee/6266604/x/catalogue/p/0/u/1/w/0/d/0

Sustainability: The future of the ecosystem and the relation with Next-Generation Internt and Ledger.eu

The DECODE project was able to create a community around itself, which is key for future sustainability, in term of maintenance and production readiness level of the technologies. The open source community that is now contributing to the development of the DECODE technology and pilots is the main driver of feedback and evolution of the technology. Furthermore, DECODE worked in close relationship with the Next-Generation Internet community, and is well positioned as reference project regarding data sovereignty in Europe. In particular the program Ledger.eu was funded to speed up the development of the DECODE approach and architecture beyond pour Consortium and the use cases developed in this project. Dyne.org is one of the key members of Ledgers.eu and is providing mentorship and technical expertise to new entrepreneurs and developers that are adopting the DECODE tools.

The NGI LEDGER project in the context of the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no 825268 has already started to adopt many of the tools realized by the DECODE project. In the LEDGER project, 32 human-centric innovators (startups, companies and/or researchers) are adopting the DECODE technologies in their projects and real-world cases. Some of these teams were present at the DECODE Symposium (discussed in D5.8) in the tech panels explaining how they are involved in human-centric innovation and how they are using the decode tools for this purpose. At last the surface for further developments of ecosystems offered by both the Zenroom and the community based Devuan projects is huge, considering the facilitation to develop derivates both in terms of new crypto schemes and custom operating systems.

Finally, DECODE has achieved very strong policy impact, and it is one of the reference projects for cities administration that are implementing new ethical data strategies and want to put citizens more in control of what data they produce, access and share. DECODE is mentioned in the UN-backed Cities Coalition for Digital Rights as one of the key examples of new ethical policies to democratize data access and enforce GDPR: https://citiesfordigitalrights.org. More than 60 cities globally are now part of this Coalition. It is also important to mention that we foresee a great impact of DECODE in combination with the Decidim platform that is now used by more than 80 cities, organisations and also national governments. Both decidim and Decode are today key open source projects that become a reference for public sector digitalisation projects based on ethical standards, open source and providing citizens security, privacy and rights.

Conclusion

The DECODE ecosystem is perhaps one of the most valuable general assets this project is leaving, not only in technical terms, made evident by this document, but also in techno-political terms, which has been made evident by the enormous amount of attention the project received in occasion of the final DECODE event held in Torino in November 2019.

A new generation of technical innovation initiatives is breeding at the municipal level in various European cities also thanks to the DECODE strong contribution, with the explicit goal to resist the data-extractivism made by global tech monopolies and to develop public interest platforms that keep socialising the profit of knowledge and data-aggregation with the citizens and consumers that produce that data. DECODE provided a diverse and complementary set of tools that can be adopted in an unforeseen variety of situations by multiple partners (private and public) and at multiple levels (municipal, national and global).

Due to the experimental and innovative nature of the project and the substantial changes that needed to be applied to its development plan, the growth of this project towards an outstanding success has become evident mainly during the last year of work and will surely continue beyond the mark of the EC funding program. It is therefore of paramount importance that some of the partners commit to support the online presence of DECODE's results and to maintain its tools in coordination to new pilots adopting it. This is what is currently done by Dyne.org in the context of the Ledger.eu project.

From the techno-political point of view the "Cities Coalition for Digital Rights"[22] makes it more than evident that there is a growing community of policy makers at the municipal level and across the world that are studying and adopting DECODE's narrative, policy toolkits and digital tools to reconquer data sovereignty for citizens (also in combination with the Decidim participatory democracy platform that was designed and researched during the D-CENT project[23]). Following this adoption, the scalability of the decentralised technical facilities is key and it is so far solved by a combination of architecture (UNIX principles) and licensing (appropriability) that does not anchor the outcomes of the project on a single service provider.

The DECIDIM pilot that is having a strong success at EU level and is led by the Barcelona cluster, first and foremost benefits from the security provided by Coconut[24]'s based crypto petition system implemented in Zenroom; and the Amsterdam cluster lead by the Dyne.org foundation in cooperation with the city of Amsterdam, where it has been clearly demonstrated that by adopting DECODE technologies for a pilot

22 https://citiesfordigitalrights.org/

23 https://dcentproject.eu

24 Coconut: https://arxiv.org/pdf/1802.07344.pdf

greatly lowers the overheads and yields immediate results as in the case of the 18+ pilot compared to the GebiedOnline pilot based on IRMA's implementation of Attribute Based Credentials based on RSA crypto technologies.

This work demonstrated in pilots is an important achievement for future developments in the civic tech or public-interest technology space, where Europe could lead next-generation platform innovation that is citizen centric, privacy-enhancing and rights-preserving.