REPORT ON OpenDreamKit DELIVERABLE D2.16
Ending press release

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Lead	Université Paris-Sud (UPSud)
Progress on and finalization of this deliverable has been tracked publicly at: `https://github.com/OpenDreamKit/OpenDreamKit/issues/41`	

DELIVERABLE DESCRIPTION, AS TAKEN FROM GITHUB ISSUE #41 ON 2019-12-16

- **WP2:** Community Building, Training, Dissemination, Exploitation, and Outreach
- **Lead Institution:** Université Paris-Sud
- **Due:** 2019-08-31 (month 48)
- **Nature:** Websites, Media, etc.
- **Task:** T2.1 (#24)
- **Proposal:** p.38
- **Report** (sources)

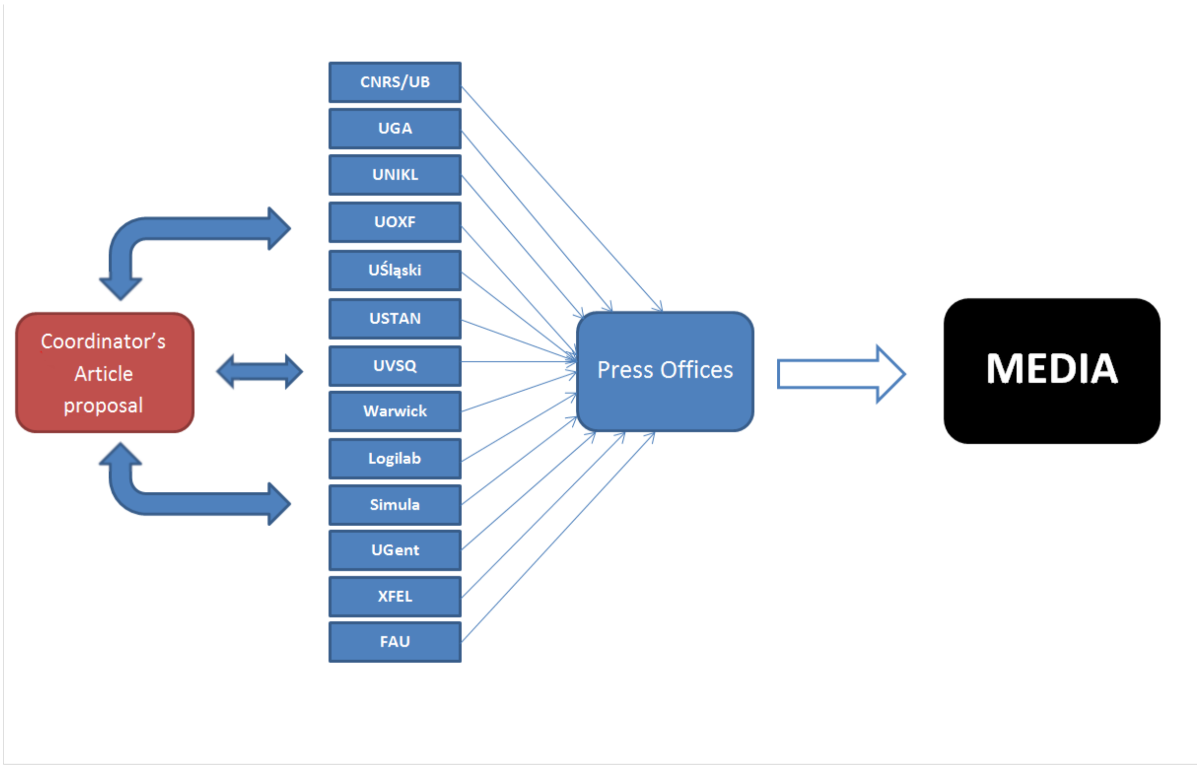
This deliverable briefly reviews the efforts of the consortium within Work Package 2 (Community Building, Training, Dissemination, Exploitation, and Outreach) to communicate the outcomes of the project to the broader audience. This includes the production of Press Releases, an important part of our communication strategy. The aim is to call attention of multiple audiences about our research in a way understandable by non-specialists. It also is to address the EU perspective of research and innovation funding, by considering some aspects such as the European transnational cooperation in the consortium and the scientific excellence with a better use of results to the scientific community.

Under the leadership of the coordinating institution (UPSud), the beneficiaries prepared collectively a joint text. This text served as template that each beneficiary could adapt to suit its own circumstances and translate into the local language as required. The produced press releases were then circulated to the respective press or communication offices in early December 2019. This also includes other forms of end-of-project communication through publications in EC and non EC channels, OpenDreamKit's web site, community mailing lists, and social media.

1. END OF PROJECT PRESS RELEASES

During the first months of the project we had published six press releases and we had planned to do the same at the end to promote the actions and the results by providing targeted information to broad audience (including the media and the public).

The press releases are the result of a joint effort of the partners, which followed our usual open bottom up approach.



Some of the beneficiaries, including the coordinator, reached to their Press Office to inquire about adequate forms and processes. Based on our Summary for Publication, UPSud's Press Office proposed a quick draft in French as source of inspiration. The coordinator then lead the collective writing of a general joint text. This text served as template that each beneficiary could adapt to suit its own circumstances and translate into the local language as required. The produced press releases were then circulated to the respective press or communication offices, which should lead to about twelve releases.

2. End of project communication through OpenDreamKit's channels

OpenDreamKit's website (`https://opendreamkit.org/`) served as a major dissemination tool in terms of project's concept, objectives and outcomes. It provides information on the project content, objectives, partners, planned activities, events organized within the project and deliverables. It's complemented by a @OpenDreamKit Twitter account, and a video channel. Both serve as direct communication instrument to reach the general public and interact with other communities such as GAP, SageMath, Cocalc, or Jupyter.

During the project, seven video interviews were created to communicate about the project, its main goals and the consortium to a wider public; and 3 explainer videos that tell the story of our project in a way understandable for a non scientific public. The videos will be used across online platforms, and promoted through the project's online communications channels such as YouTube. A Youtube account for OpenDreamKit project was set up to host the video series. The number of views, and comments for each video were monitored as KPIs in the technical report.

On the day after the final review meeting, we published a blog post on our website highlighting our presentations and the assessment made by the referees and the Project Officers.

An overview of the project outcomes was produced by UPSud with the technical contribution of the ODK partners (see appendix B), and will be published on OpenDreamKit's web site; it takes the form of an extended version of the Summary for Publication produced at the occasion the last reporting period. It complements the press release by being more detailed on the concrete actions and the impact on end users, with link to related material (reports, blog posts, ...). Soon after its publication, a blog about the future of OpenDreamKit community will posted, and both will be advertised through social media (twitter, ...). We also plan to launch targeted email campaigns in order to reach to our scientific communities about the significant developments on ODK project activities and results.

3. End of project communication through the European Commission's channels

The Coordinator has contacted the communication officer who will support the dissemination of the results of the project ad will promote them through the EC's communication channels. The communication officer will publish an article and a presentation of the project in the newsletter "Digital Excellence & Science Infrastructure" of the European Commission, on the European Commission website `https://ec.europa.eu/digital-single-market/` to reach a wider audience, potentiating its outreach. HORIZON, the EU Research & Innovation e-magazine, will also be used to inform about the benefits and progress that ODK will generate in Europe, informing about the open debates created and the results. The Coordinator has also been contacted by a journalist who works for CORDIS' Editorial Services consortium Tipik/Intrasoft International. OpenDreamKit was chosen from among 120 projects selected monthly, based on domain, timing and quality of results by the CORDIS magazine Team to feature highlights and results from the most exciting EU-funded research and development projects. Our work will be promoted on the CORDIS website where it will be translated into multiple languages and may be reused in the CORDIS magazine. In this communication strategy, we will be sure to create an appropriate approach for the different audiences (policy makers, media, general public, etc).

Appendix A. Press release template

OpenDreamKit – Open-source development and community building in computational mathematics

Mechanising calculations has always been at the heart of mathematics, for exploring and discovering new mathematics, even proving theorems. Beyond mathematics, computing has been and will ever more be a major driver of scientific progress. Thus, ever since the advent of the first machines, computing has been adopted as a tool of choice by mathematicians. It has become their microscope, and is used at all stages of their research.

In the last decades, vibrant communities of mathematicians have spearheaded the Open Science movement, developing a wide ecosystem of open tools covering all aspects of mechanized mathematics. The ecosystem suffered however from fragmentation and from lack of recognition: funding and career paths reward novel results rather than the daily work of fixing bugs and supporting users.

Meanwhile, early Virtual Research Environments (VRE) had proven their potential to better serve the growing needs of mathematicians, reduce entry barriers, broaden the audience, and promote collaboration and Open Science. Hence, when the EU H2020 Research E-Infrastructure Program made a call for proposals centered on Virtual Research Environments, a few pioneers initiated an open process to bring these communities together and collectively craft an ambitious 7.6M€ research and innovation project, OpenDreamKit (opendreamkit.org). Coordinated by scientists from the Laboratoire de Recherche en Informatique (Université Paris-Sud and CNRS), OpenDreamKit involved 50 people spread over seven European countries: France, Belgium, Norway, Germany, Poland, Switzerland, United Kingdom; from 2015 to 2019, it employed an average of 11 full-time researchers and Research Software Engineers.

The existing ecosystem offered the potential to cover a large area of pure mathematics, and a variety of use cases ranging from a one-system one-laptop to multi-system institution-wide cloud deployments. This could not, however, be covered by a single one-size-fits-all VRE. Therefore, the objective was set instead to deliver a flexible toolkit enabling research groups to set up Virtual Research Environments, customised to meet the varied needs of collaborative research projects in pure mathematics and applications, and supporting the full research life-cycle from exploration, through proof and publication, to archival and sharing of data and code.

To achieve this ambitious objective, OpenDreamKit built upon and contributed back to popular tools such as LinBox, MPIR, SageMath, GAP, PARI/GP, LMFDB, Singular, and MathHub, fostering ease of access and use, interoperability, and sustainability. It further joined forces with the general-purpose interactive computing environment Jupyter; in addition to outsourcing the user interface and VRE specific aspects, this maximised the impact on the scientific community at large.

OpenDreamKit gave new evidence of what can be achieved with proper support, especially through the work of Research Software Engineers. Thanks to them, some problems were solved which had been holding back the community for years, like bringing to fruition the effort to make the GAP software multi-threaded or porting the SageMath software and its dependencies to Windows.

Eventually OpenDreamKit was highly praised by its reviewers from the EU commission; hopefully this recognition can be used as leverage for future funding. Indeed,

The major challenge to come is to secure employment of a number of Research Software Engineers, as much as possible in long term positions, to support hundreds of contributors and tens if not hundreds of thousands of users of open-source mathematical software.

It is crucial as well to keep funding Jupyter core development: with millions of users, in academia and industry, Jupyter has become a key technology to support Open Science.

One key of the success of OpenDreamKit was its ability to develop and sustain an active network of users and developers. Within the four years of the project, the group has built on their strong community building philosophy, especially through the organization of technical and educational workshops all over the world while actively promoting diversity. They organized over 80 workshops in about 20 different countries, including in developing countries, as with the first SageMath workshop in Nigeria. Some of these events were targeted more specifically at women, like the Women in Sage events in 2017 and 2019, to counter the wide gender gap in this field.

More generally, OpenDreamKit has been an occasion to promote a scientific development model based on openness, community, and shared technology. Beyond the traditional tentpoles of Open Science; namely Open Source, Open Data, and Open Publications; we have explored a novel concept, namely Open EU Project Management, and demonstrated its effectiveness. Indeed, we strongly believe that preparing the proposal and running the project completely in the open with a bottom up approach has played a fundamental role in engaging the communities, developing reciprocal trust, locating the toughest hurdles that users and developers actually face, co-designing solutions and co-implementing them efficiently.

We strongly recommend the experience; long live OpenDreamKit's spirit!

Appendix B. Summary for Publication (extended)

B.1. Summary of the context and overall objectives of the project (including the conclusions of the action)

Automating calculations has always been at the heart of mathematics, for exploring and discovering new mathematics, even proving theorems. Beyond mathematics it has been and will play ever increasing role in scientific progress.

Thus, since the advent of first machines, computing was adopted as a tool of choice by mathematicians. It has become their microscope, and is used nowadays at all stages of their research.

Building that microscope takes dedicated and expert efforts! In the last decades, vibrant communities of mathematicians have spearheaded the Open Science movement, developing a wide ecosystem of open tools covering all aspects of mechanized mathematics: computation, tabulation (data), deduction, and narration. Today there are a hundreds of these, often highly optimized for specific domains such as solving differential equations, generating combinatorial objects like graphs or error-correcting codes, or classifying elliptic curves, objects with important implications on both Fermat's Last Theorem and cryptography.

The ecosystem suffered, however, from fragmentation and from lack of recognition, as funding and career paths reward novel results rather than the daily work of fixing bugs and supporting users; this led to long standing technical issues which impeded its sustainability in a rapidly evolving landscape of computing.

Meanwhile early Virtual Research Environments (VRE) had proven their potential to better serve the growing needs of mathematicians, reduce entry barriers, broaden the audience, and promote collaboration and Open Science.

Hence, when the EU H2020 Research E-Infrastructure Programme made a call for proposals centered on Virtual Research Environments, a few pioneers initiated an open process to bring the communities together and craft collectively a proposal.

The ecosystem offered the potential to cover a large area of pure mathematics, and a variety of use cases ranging from one-system-one-laptop to multi-system institution-wide cloud deployments. This could not however be covered by a single one-size-fits-all VRE.

Therefore, the aim was set to *deliver a flexible toolkit enabling research groups to set up Virtual Research Environments, customised to meet the varied needs of collaborative research projects in pure mathematics and applications, and supporting the full research life-cycle from exploration, through proof and publication, to archival and sharing of data and code*

To make this ambitious aim possible, the existing communities joined forces to build upon and contribute back to their tools – in particular popular ones such as LinBox, MPIR, SageMath, GAP, PARI/GP, LMFDB, Singular, MathHub. They further joined forces with the general purpose interactive computing environment Jupyter; in addition to outsourcing the user interface and VRE specific aspects, this maximised the impact on the scientific community at large.

This was the birth of OpenDreamKit (#676541), a 7.6M€ project that, from 2015 to 2019, gathered 50 scientists spread over seven European countries: France, Belgium, Norway, Germany, Poland, Switzerland, and United Kingdom. Coordinated by the Laboratoire de Recherche en Informatique (Université Paris Sud and CNRS), OpenDreamKit employed an average of 11 full-time researchers and Research Software Engineers.

B.2. Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far (including an overview of the results and their usage and dissemination)

Over the duration of the project, work was performed on many fronts, in close collaboration with the community.

One of the major hindrances for both end users and developers was limited availability and interoperability of various components of OpenDreamKit in different environments: oftentimes, software would work in the developers' environment (mostly Unix systems on Intel architectures), but fail in other environments (notably, Windows systems).

By integrating or updating best practices (continuous integration, continuous testing, ...), embracing emerging technologies (Docker containers, Conda packages, ...), by decoupling components and sharing infrastructure, we managed to make OpenDreamKit components available and interoperable in a much wider range of environments. Notable success stories are:

- Porting of the components to Windows, MacOS and Linux;
- Distribution of the components through official package repositories for major Linux distributions (Debian, Ubunut, Fedora, Arch, Gentoo);
- Distribution of Docker images and Conda packages suited for deployment of our components in cloud environments (in particular, with JupyterHub and Binder integration);
- Porting of SageMath to Python 3.
- Modularization of various OpenDreamKit components, in particular SageMath and GAP.

To address the increasing need in high performance computing in computational mathematics, we drove the leading software components into supporting a large range of parallel architectures, from the low level SIMD, to GPUs, multi-core or clusters. Thanks to the introduction of new algorithms, tuned implementations and the design of parallel engines allowing to smoothly transition between various parallel settings, we made users able to harness the power of most modern computing platforms ranging from personal laptops to HPC clusters.

We contributed to a tight integration of OpenDreamKit components with Jupyter and to the Jupyter ecosystem itself, notably through new tools for collaboration (nbdime), validation (nbval), interactive web pages (thebelab), 3D visualisation (K3D-jupyter), interactive mathematics (sage-combinat-widgets, francy, ...), and through contributions to existing tools for collaborative workspace management (JupyterHub, JupyterLab). We also were early adopters, deployers and promoters of emerging technologies like Binder.

To demonstrate the applicability of our technology well beyond mathematics, we integrated micromagnetism computational engines into Jupyter to deliver a Virtual Research Environment taylored for interactive micromagnetism calculations.

We also authored four interactive textbooks, delivered numerous courses or actively helped colleagues doing so, in a variety of fields ranging from biology to computer science, all using Jupyter technology.

Finally we explored novel knowledge-based approaches for the high-level integration of large stacks of mathematical components. Like an interpreter for human language, it ensures meaning-preserving communication in mathematical languages between computation systems, databases, and humans. Concrete outcomes for bridging the gap between computation and data are already in production: data generation (py-persist/Memoize), online data exploration (data.mathhub.info) and live data exploration (sage-explorer).

All the outcome of the project were open and distributed widely through the usual channels to their target communities, reaching TRL 6 to 8. In addition, community building, training, and dissemination activities have been at the forefront of OpenDreamKit, with more than one hundred events organized or co-organized by OpenDreamKit, including developer workshops, training conferences, or satellite sessions, adding up to 1800 trainees. We also actively promoted diversity, through dedicated actions aimed at women and residents of developing countries. In particular, we organized two Women In Sage workshops and participated in or co-organized events in Colombia, Mexico, Nigeria, Algeria, Morocco, Tunisia, Palestine and Lebanon. We also created resources for researchers and teachers to accompany them in their use of the technologies we promote, such as tutorials, explainer comics and short videos. This includes contributions to the open textbook Computational Mathematics with SageMath which is nowadays reaching 500 downloads per day.

B.3. Progress beyond the state of the art, expected results until the end of the project and potential impacts (including the socio-economic impact and the wider societal implications of the project)

On the user-visible front, researchers, teachers and scientists in general now benefit from a rich uniform web-based user interface to all the OpenDreamKit computational components (from SageMath to C++!), which they can use on a wide variety of platforms, including tablet PCs, laptops, computer labs, all the way to cloud deployment and services, non-commercial (University-wide, EGI, Binder, ...) or commercial (Cocalc, Azure, OVH, Google, ...). We contributed to the deployment of a number of such installations for Mathematics, Computer Science, or Micromagnetism, demonstrating the versatility of the toolkit.

We have ourselves used extensively all the elements of the OpenDreamKit toolkit, while pursuing our own research, and while delivering many courses and training sessions in a wide variety of contexts — from universities all over Europe, all the way to Nigeria or the AIMS institute in South Africa, creating interactive teaching material, sharing research results with the community, developing mathematical experiments, and much more. This was the occasion to reflect on the adequacy and adoption of the tools for end-users, and immediately feedback the outcome into the project development.

By enabling Research Software Engineers to focus full time for months in a row on delicate challenges, we have tackled problems that the communities had been facing for a decade, such as bringing to fruition the effort to make GAP multi-threaded (HPC-GAP project) or porting SageMath and its dependencies to the Windows platform. This has demonstrated the enormous value that Research Software Engineers (RSE) can bring to research, to support of end-users and collaborative developments by the community, and, generally speaking, Open Science. We have played an important role in the RSE movement, notably in the UK, exploring numerous hot and difficult questions: role, funding patterns, structuring, career paths, etc.

As was hoped, OpenDreamKit delivered a boost to the landscape of open source math software; it strives ever more than five years ago. We are particularly proud to have brought together many computational mathematics communities that, at earlier times, had been evolving independently, if not outright in a mostly counter-productive competition. Despite the occasional and unavoidable frictions occuring whenever needs and goals do not align, seeking collaboration has become the norm.

Nevertheless, the major challenge to come is to secure employment of a number of Research Software Engineers, as much as possible in long term positions, to support hundreds of contributors and tens if not hundreds of thousands of users of open source math software.

As witnessed by the ACM award and by the wide adoption of the Jupyter technology in research, education (even at high school level), and industry, the Jupyter ecosystem has been booming during the course of OpenDreamKit; it is there to remain a major player of the field for years to come. OpenDreamKit played a significant accelerator role by providing core Jupyter development.

Of particular relevance is its adoption by a number of EU-funded projects working towards the European Open Science Cloud (EOSC) – in particular for remote access, remote analysis and visualisation of data, and for improved reproducibility. These projects directly benefit from outcomes of OpenDreamKit; they however position themselves as users of the Jupyter technology, not developers.

It is therefore crucial that the EU keeps funding core Jupyter development, as an asset for the EOSC, science and industry, as well as to enable the continuing acceleration, and steering in the right direction, of this key open technology.

Finally, beyond the traditional items of Open Science, namely Open Source, Open Data, and Open Publications, we have explored a novel item, namely Open EU Project Management, and demonstrated its effectiveness. Indeed, we strongly believe that preparing the proposal and running the project completely in the open with a bottom up approach has played a fundamental role in engaging the communities, developing reciprocal trust, locating the toughest hurdles that users and developers actually face, co-designing solutions and co-implementing them efficiently.

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Disclaimer: this report, together with its annexes and the reports for the earlier deliverables, is self contained for auditing and reviewing purposes. Hyperlinks to external resources are meant as a convenience for casual readers wishing to follow our progress; such links have been checked for correctness at the time of submission of the deliverable, but there is no guarantee implied that they will remain valid.