SCIENCE GATEWAY AND E-INFRASTRUCTURE SERVICE PROVISION:
UPDATE AND SUSTAINABILITY
April 2017

Funded by the European Union’s H2020 Programme

Sci-GaIA
Energising Scientific Endeavour through Science Gateways and e-Infrastructures in Africa
### PROJECT DOCUMENTATION SHEET

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**Consortium partners**
- Brunel University London (UK) - BRUNEL
- The UbuntuNet Alliance for Research and Education (Malawi) - UBUNTUNET
- University of Catania (Italy) - UNICT
- The West and Central African Research and Education Network (Ghana) - WACREN
- The Royal Institute of Technology (Sweden) - KTH
- The Dar es Salam Institute of Technology (Tanzania) - DIT
- Karolinska Institutet (Sweden) - Ki
- CSIR/Meraka Institute (South Africa) - CSIR

**Website**
: www.sci-gaia.eu
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Executive summary

Work Package 3 (WP3) “Strengthen and expand Science Gateway and e-Infrastructure related services”, as described in the Sci-GaIA Description of Work (DoW), aims at:

1. Expanding and extending activities carried out in past projects in order to consolidate the African e-Infrastructure services and to include the very challenging goal of supporting the creation of an African Open (and Linked) Data Infrastructure, interoperable with and federated to (through the adoption of international standards and guidelines) those emerging in EU and in other regions of the world.

2. Combining Open Access repositories with Science Gateways in order to deal with very important topics such as the discoverability, reproducibility and extensibility of science products.

WP3 built on the successes achieved by Task 6.1 “Promote, foster & support the creation of e-infrastructure related services” of the past eI4Africa project. WP3 has expanded and extended past activities and consolidated the results already achieved. It has fully reached its original goal of supporting the creation of an African Open (Linked) Data Infrastructure, interoperable with and federated to those emerging in EU and in other regions of the world, through the adoption of international standards and guidelines.

The federated Sci-GaIA Open Science Platform, based on the Open Science Commons approach, has successfully tackled very important topics related to Open Science, such as the discoverability, reproducibility and re-usability of science products. It has been the cradle and the production quality testbed of a large number of applications that can act as demonstrative use cases to further increase the awareness of African stakeholders towards this “new way” of doing science.

This deliverable presents the final status of WP3 services, orchestrated in the Open Science Platform, and highlights the most important results. Sustainability of the services after the end of the project is also discussed.
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One of the most important outcomes of the Sci-GaIA project is its federated Open Science Platform\(^1\) (OSP), which is depicted in Figure 1.

![Figure 1: Pictorial view of the Sci-GaIA Open Science Platform](image)

Open Science has recently become a buzzword in many areas of scientific research, including policy definition as well as evaluation and assessment, and it is very high in the agenda of the European Commission (EC), as witnessed by the emerging multi-dimensional concept of the European Open Science Cloud\(^2\) (EOSC). Together with Open Innovation\(^3\) and Open to the World\(^4\), Open Science\(^5\) forms indeed the “Three Os”, which substantiate the EC vision for Europe\(^6\).

Despite its incessant use, an official, worldwide accepted definition of “Open Science” does not exists yet. In the framework of the Sci-GaIA project, we have been driven by the following two.

- “Open Science refers to a scientific culture that is characterized by its openness. Scientists share results almost immediately and with a very wide audience.”\(^7\)
- “Open science is a means and not an end in itself and it is much more than just open access to publications or data; it includes many aspects and stages of research processes thus enabling full reproducibility and re-usability of scientific results.”\(^8\)

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\(^1\) [http://www.sci-gaia.eu/osp](http://www.sci-gaia.eu/osp)
\(^2\) [https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud](https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud)
\(^3\) [https://ec.europa.eu/research/openinnovation/index.cfm](https://ec.europa.eu/research/openinnovation/index.cfm)
\(^4\) [https://ec.europa.eu/research/opentotheworld/index.cfm](https://ec.europa.eu/research/opentotheworld/index.cfm)
\(^5\) [https://ec.europa.eu/research/openscience/index.cfm](https://ec.europa.eu/research/openscience/index.cfm)
\(^7\) [http://book.openingscience.org](http://book.openingscience.org)
\(^8\) [http://dx.doi.org/10.1787/5jrs2f963zs1-en](http://dx.doi.org/10.1787/5jrs2f963zs1-en)
Reproducibility and re-usability of scientific results are key factors of the possibility to go through the iterative procedure of the Scientific Method\(^9\) in both senses: not only clockwise (see the bottom part of Figure 1) but also and more importantly counter-clockwise.

Several Open Science enablers have been identified and many of them are shown in the central part of Figure 1. They have been of great concern for Sci-GaIA and they have been taken into account in all project activities. However, Open Science enablers can really “enable” Open Science only if they are accessible to all science actors on a commons\(^{10}\) basis.

The Sci-GaIA Open Science Platform is compliant with the concept and philosophy of the Open Science Commons\(^{11}\) and it consists of a series of services (see the upper part of Figure 1):

- Identity Federation services;
- The e-Infrastructure Knowledge Base and the Semantic Search Engine;
- Open Access Repositories;
- Science Gateways;
- The African e-Infrastructure Discussion Forum;
- Online Courses Platforms,

which can either freely be used as such or cloned and customised to fulfil specific needs and requirements of Communities of Practice (CoPs).

The services of the OSP are gathered and explained in the web page www.sci-gaia.eu/osp, which contains a clickable image very similar to that shown in Figure 1. The OSP web page has come online on the 15\(^{th}\) of February 2016 and it has been visited almost 3,000 times since then; it is the fifth most visited page of the whole Sci-GaIA website.

More importantly, at least one (and in many cases more than one) of the services of the OSP has been used in all applications supported by the project (see the deliverable D2.4\(^{12}\)).

The present deliverable is organised as follows. In the remaining part of Section 1, the services of the OSP will be presented and their current status will be briefly described. “Facts & figures”\(^{13}\) will also be provided for each of them.

Section 2 will instead introduce the Sci-GaIA Service Catalogue and the way the services of the OSP are organised in it.

Section 3 will discuss the sustainability of the OSP services after the end of the project, while conclusions will be drawn in Section 4.

\(^{9}\)The Scientific Method was first proposed by Galileo Galilei at the beginning of the 17th Century and there many presentations of its steps. A starting point to get more information is this page: https://en.wikipedia.org/wiki/Scientific_method and the references therein.

\(^{10}\)https://en.wikipedia.org/wiki/Commons

\(^{11}\)https://www.opensciencecommons.org/


1.1 — Identity Federation Services

All services of the Sci-GaIA OSP support SAML\textsuperscript{14} standard based authentication, implemented through either Shibboleth\textsuperscript{15} or SimpleSAMLphp\textsuperscript{16}. This important decision was taken at the very beginning of the project with the threefold aim of (i) showing, through concrete examples, the advantages of federated identities, (ii) promoting the deployment of Identity Federations in Africa, and (iii) enabling Single Sign On (SSO) across the various services of the OSP in order to provide users with an enhanced and seamless experience.

In the above sense, then, Identity Federation services, such as Identity Providers (IdPs) and Service Providers (SPs), can officially be considered components of the Open Science Platform and the web page www.sci-gaia.eu/federated-services shows the more than 30 federated services that have been deployed in the two years of the project thanks to WP3 and WP4 activities.

It is worth underlying here a major result achieved by Sci-GaIA in the course of the second year. As of the 26\textsuperscript{th} of August 2016, the “catch-all” GrIDP\textsuperscript{17} (Grid IDentity Pool) federation is an official member of the eduGAIN\textsuperscript{18} inter-federation (see Figure 2), the first non-country-based member. GrIDP is jointly managed by the Division of Catania of the Italian National Institute of Nuclear Physics and by the Department of Physics and Astronomy of the University of Catania. The central services of the federation are hosted at GARR, the Italian National Research and Education Network.

GrIDP has been instrumental for the diffusion of federated services across Africa, as it provides a home for “homeless” IdPs (not yet officially registered in any national federation) and “catch-all” IdPs for “homeless” users (whose organisations do not yet run an Identity Provider). The IdPs and the SPs that are members of GrIDP are listed in these pages\textsuperscript{19,20}.

\textsuperscript{14} \url{http://saml.xml.org/saml-specifications}
\textsuperscript{15} \url{https://shibboleth.net/}
\textsuperscript{16} \url{https://simplesamlphp.org/}
\textsuperscript{17} \url{http://gridp.garr.it}
\textsuperscript{18} \url{http://www.edugain.org}
\textsuperscript{19} \url{http://gridp.garr.it/identity-providers.html}
\textsuperscript{20} \url{http://gridp.garr.it/service-providers.html}
Federated services must have official host certificates (i.e., automatically recognised by web browsers) on board to secure web transactions. In order to overcome this issue, which can not be solved with self-signed Certification Authorities, already during the first year of the project the management of the Sci-GaIA reached an agreement with Comodo\textsuperscript{21} thanks to which 5,000 certificates \cdot years (i.e., 5,000 1-year certificates per year).

\textsuperscript{21} \url{http://www.comodo.com}
certificates or 2,500 2-year certificates or 1,666 3-year certificates or any other combination of the previous) were freely made available to all African National Research & Education Networks (NRENs) and their member organisations.

Since the beginning of the project, 191 certificates (161 active, 30 revoked) have been requested by - and issued to - many African NRENs. Figure 4 shows some statistics taken from the dashboard of the Comodo Certificate Manager.

![Certificates Requested vs Issued](image1.png)

![Certificates Types (Managed)](image2.png)

![Certificates by Duration](image3.png)

![Certificates by Organization](image4.png)

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**Figure 3: Some statistics of the Comodo certificates issued during the project**

1.2 THE E-INFRASTRUCTURE KNOWLEDGE BASE AND THE SEMANTIC SEARCH ENGINE

The e-Infrastructure Knowledge Base (KB) is one of the largest e-Infrastructure-related existing databases. It contains information related to services as well as to Open Access repositories (both of documents and of data) and Open Educational Resources (OERs).

So far, more than 4,000 repositories worldwide are included in the KB (see Figure 4) for more than 30 million resources.

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On top of the KB, Sci-GaIA has developed and maintains a Semantic Search Engine (SSE), which allows users to search in more than 100 languages across a Linked Data repository containing more than half a billion RDF triples created from the resources of the KB. Search results are ranked according to the Ranking Web of Repositories\(^23\) and are connected, whenever that is meaningful, both to Google Scholar\(^24\) and Impactstory\(^25\). Figure 5 shows the SSE in action.

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\(^23\) [http://repositories.webometrics.info/](http://repositories.webometrics.info/)
\(^24\) [http://scholar.google.com](http://scholar.google.com)
\(^25\) [http://impactstory.org](http://impactstory.org)
Adjust of solar cell model parameters based in MATLAB

GENERAL INFORMATION

Authors: GuaschMurillo Daniel; NavarroMas Nacho; OrtegaVillasclaras PabloRafael; SilvestreBergés Santiago

Description: Peer Reviewed

Description: In this work, a model parameter extractor of solar cells using Matlab is shown. The software, developed in Matlab environment, has been successfully applied to study internal characteristics of photovoltaic devices [1-2], as well as on-line photovoltaic system performance [3-4]. However, in this case, the developed tool allows to obtain automatically electrical parameters that are often requested to model the performance of single solar cells, as can be the photocurrent density Jph, series resistance Rs, shunt resistance Rs, saturation current Is, and ideality factor n. Parameters of a second diode, that takes into account recombination losses, as can be the saturation current I0 and ideality factor n0, are also included. Special attention has been focused on the estimation of the series resistance Rs, and the evolution of this parameter in dark and illumination work conditions of the solar cell.

Publisher: M. C. Acero, M. Lozano - CNM-CSIC
Identifier: http://hdl.handle.net/2117/16050
Identifier: 84-607-6771-X
Language: en;

LINKED DATA

INFORMATION FROM GOOGLE SCHOLAR

ALTIMETRICS INFORMATION

DATE INFORMATION

DATASET INFORMATION

REPOSITORY INFORMATION

< Back
The SSE also allows to navigate semantically enriched data in a graphic way – using LodLive\textsuperscript{26} - and help connect papers with datasets used to prepare them and discover new knowledge. This functionality of the SSE is very much appreciated by its users as witnessed by recent feedbacks gathered through the social networks (and reported in Figure 6).

\textsuperscript{26}http://en.lodlive.it/
In the spirit of “everything open and re-usable” and in response to a recommendation received at the First Periodic Review, the database\textsuperscript{27} containing the KB, the RDF triple-store\textsuperscript{28} containing the linked data used by the SSE and the ontology\textsuperscript{29} used to create it are available on the Sci-GaIA Open Access Repository.

1.3 – OPEN ACCESS REPOSITORIES
The Sci-GaIA Open Access Repository\textsuperscript{30} is a key component of the Open Science Platform. The underlying Digital Asset Management System (DAMS) software is Invenio\textsuperscript{31} (v1.2.1, the latest stable release) and its main characteristics have already been explained in the first year deliverable D3.1\textsuperscript{32}. It is worth noting here that the OAR supports federated authentication and it has been registered as a Service Provider of both the GrIDP federation and the eduGAIN inter-federation.

\textsuperscript{27} https://oar.sci-gaia.eu/record/563
\textsuperscript{28} https://oar.sci-gaia.eu/record/565
\textsuperscript{29} https://oar.sci-gaia.eu/record/564
\textsuperscript{30} http://oar.sci-gaia.eu
\textsuperscript{31} http://invenio-software.org/
At the time of writing, the Sci-GaIA OAR, whose home page is shown in Figure 7, counts more than 400 records, which not only include all Sci-GaIA materials but also scientific products of other CoPs identified through the e-Research Summer Hackfests\(^{33,34,35}\) (see deliverable D4.3\(^{36}\) for more details about the hackfests).

![Figure 7: Home page of the Sci-GaIA Open Access Repository](image)

An essential aspect of the Sci-GaIA OAR is that a DataCite\(^{37}\) Digital Object Identifier (DOI) can be minted and allocated to each record stored on the repository. Thanks to its participation in Sci-GaIA, the University of Catania joined the “DOI Project” of the Conference of Italian University Rectors (CRUI), the DataCite member in Italy, and a DOI prefix (10.15169) was assigned to the OAR. This makes digital contents stored in the OAR compliant with the FAIR\(^{39}\) principles and allows to (either manually or automatically) link them to the ORCID\(^{40}\) IDs of their authors. This in turn makes African science and African scientists more visible worldwide.

In the spirit of complete openness and reusability, which has already been mentioned above, the Sci-GaIA OAR can either freely be used as such or cloned and customised to fulfil specific needs and

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33 http://www.sci-gaia.eu/summer-hackfest
34 http://www.sci-gaia.eu/wacren-hackfest
35 http://www.sci-gaia.eu/ethernet-hackfest
37 http://datacite.org
38 http://www.crui.it/crui-english.html
39 https://www.force11.org/group/fairgroup/fairprinciples
40 http://orcid.org
requirements of Communities of Practice (CoPs). On this purpose, guidelines have been created and they are available as a record of the OAR itself.

During the lifetime of the project, especially in the second year thanks to the hackfests, the OAR has been cloned several times and 5 clones are currently operational. As an example, Figure 8 shows the clone of the OAR which has been created during the EthERNET e-Research Summer Hackfest, which was held in Addis Ababa (Ethiopia) on February 13-24, 2017 and is operated by the Ethiopian Research and Education Network since then.

![EthERNET Repository](http://oar2.ethernet.edu.et/)

**Figure 8: Home page of EthERNET Open Access Repository**

During the month of January 2017, an agreement has been established between UNICT and CRUI, which extends the possibility to provide DOI-prefixes to all African organisations wishing to deploy and institutional Open Access Repository (see the press release)

So far, four prefixes have been requested by and assigned to the following organisations:

- The African Population Health Research Center (APHRC), headquartered in Kenya but international;
- The Eko-Konnect Research and Education Initiative, Nigeria;
- The Ministry of Education of Ethiopia, for the Ethiopian Research and Education Network;

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41 [https://oar.sci-gaia.eu/record/20](https://oar.sci-gaia.eu/record/20)
44 [http://www.aphr.org](http://www.aphr.org)
45 [http://www.eko-konnect.org/ng/](http://www.eko-konnect.org/ng/)
The Ubuntunet Alliance, Malawi - partner of Sci-GaIA, representing a huge base of organisations aiming at deploying FAIR Open Access archives. Indeed, an unlimited number of sub-prefixes can be created out of a DOI-prefix and an unlimited number of DOIs can be created out of a sub-prefix.

1.4 – SCIENCE GATEWAYS AND SCIENCE GATEWAY FRAMEWORKS

Seven (7) Science Gateways\(^{47}\) have been either developed or created “ex novo” during the lifetime of the project and all of them are actively supported. They are listed below and their home pages are shown for the sake of completeness in Figure 9:

1. The Africa Grid Science Gateway\(^{48}\) (SG);
2. The MIPAR Portal\(^{49}\);
3. The Kenya Public Health Gateway (PHG)\(^{50}\);
4. The Technology Transfer Alliance (TTA) Collaboration Portal\(^{51}\);
5. The iGrid Portal\(^{52}\);
6. The PLANTISC-2 Science Gateway\(^{53}\);
7. The AgriSERVICOMM Portal\(^{54}\).

\(^{47}\) http://www.sci-gaia.eu/science-gateways  
\(^{48}\) http://sgw.africa-grid.org  
\(^{49}\) http://mipar.sci-gaia.eu  
\(^{50}\) http://phg.sci-gaia.eu  
\(^{51}\) http://www.ttaportal.org  
\(^{52}\) http://igrid.proj.kth.se/  
\(^{53}\) http://plantisc2.sci-gaia.eu  
\(^{54}\) http://agriservicomm.sci-gaia.eu
The development of the Africa Grid Science Gateway was initiated in the course of the previous e4Africa project. During the lifetime of Sci-GaIA, the Africa Grid SG has been enriched with several applications and at the time of writing the total number is 30 (see this page for more details). Since January 2017, the Africa Grid SG has been relocated from UNICT (Catania, Italy) to DIT (Dar es Salaam, Tanzania) and it is operated and maintained since then by DIT system engineers.

The other six Sci-GaIA Science Gateways have instead been developed by the “champions” selected to attend the e-Research Summer Hackfests.

55 http://www.sci-gaia.eu/applications
56 http://www.sci-gaia.eu/champions
Sci-GaIA Science Gateways fully support federated authentication and are all Service Providers of the GrIDP federation (as well as of other identity federations emerging in the African continent).

Their scientific purposes and functionalities are described in the deliverable D2.4\(^{57}\) so we re-direct the reader to that document for more detailed information. What is important to underline here, instead, is that since the e-Research Summer Hackfest, held in Catania in July 2016, the Sci-GaIA project has adopted the FutureGateway\(^{58}\) (FG) framework developed in the context of the INDIGO-DataCloud\(^{59}\) project. The FG is an evolution of the Catania Science Gateway Framework\(^{60}\) (CSGF), adopted by Sci-GaIA in the first year. The main advantages of the FG with respect to the CSGF is that the former:

- Provides a more flexible way to access the distributed computing services;
- Leave to the developers the choice of the front-end portal technology;
- Provides very simple ways to develop Science Gateway applications, not only web-applications but also desktop and mobile ones.

The usage scenarios of the FG are sketched in Figure 10.

![Figure 10: Usage scenarios of the Future Gateway](image)

The FG comes with a set of configurable setup scripts allowing the installation of the system on several operating systems. The access to the distributed infrastructures exploits the SAGA\(^{61}\) standard, which can handle different middleware using a common set of APIs. The FutureGateway does not force adopters/developers to use a particular kind of portal technology as front-end of the application as it provides a set of RESTful APIs to interact with the distributed computing services endpoints.

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\(^{59}\) [http://www.indigo-datacloud.eu](http://www.indigo-datacloud.eu)

\(^{60}\) [http://www.catania-science-gateways.it/](http://www.catania-science-gateways.it/)

Sci-GaIA has been one of the first early adopters of the FG and for sure the main creator of training materials about the framework (see www.sci-gaia.eu/materials). Sci-GaIA has been a great promoter of the FG in Africa and this is acknowledged in the following INDIGO-DataCloud deliverable: “D6.3 - First release of a Science Gateway and release of the selected mobile apps”62.

1.5 – THE AFRICAN E-INFRASTRUCTURE DISCUSSION FORUM
The African e-Infrastructure Discussion Forum63 and its outcomes are extensively described in the deliverable D2.364 so we redirect the reader to that document for more information. We only say here that the impact of the forum can be quantitatively evaluated by means of the representative metrics listed in Table 2 below.

<table>
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<td>Users</td>
<td>221</td>
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<td>Moderators</td>
<td>7</td>
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<td>Discussion topics</td>
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<tr>
<td>Posts</td>
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1.6 – ONLINE COURSES PLATFORMS
A platform for online courses, providing training materials as Open Educational Resource, is one of the components of the federated Sci-GaIA Open Science Platform. It is based on the Open edX65 framework and can be reached at http://courses.sci-gaia.eu. As the other services of the OSP, the platform support federated authentication.

The Sci-GaIA online courses systems offers courses (co-)developed by the project, such as:
- The “Course on how to turn web-based services into Service Providers of Identity Federations”66;
- The Sci-GaIA Winter School67,

as well as external courses. As reference and for the sake of completeness, Figure 11 shows some views of the courseware available in the Sci-GaIA platform.

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62 https://owncloud.indigo-datacloud.eu/index.php/s/mzxMxMiffBKATgo
63 http://discourse.sci-gaia.eu
65 http://openedx.org
66 http://courses.sci-gaia.eu/courses/GARR/SP101/2015_T4/about
67 http://courses.sci-gaia.eu/courses/UNICT/WS2015/201603_01_31/about
Figure 11: Views of the courseware available in the Sci-GaIA Online Courses system

Figure 12 shows, instead, how the Open Educational Resources are stored in the Sci-GaIA OAR described above.
As all the other services of the Sci-GaIA OSP, the Online Courses System can be used as such or cloned whenever and wherever this is required by local organisation. This has actually happened during the WACREN e-Research Hackfest and the EthERNet e-Research Hackfest where the Online Courses System was cloned to serve as a platform for Massive Online Open Courses (MOOCs) in Ethiopia. Some views of the clone are show in Figure 13.
1.7  — ORCHESTRATION OF THE SERVICES OF THE OPEN SCIENCE PLATFORM

One of the most important characteristics and functionalities of the services of the Sci-GaIA OSP is that they can be orchestrated to enable reproducibility in science, which is one of the key aspects of Open Science. In particular, they can enable the “knowledge workflow” depicted in Figure 14.
Figure 14: Knowledge workflow enabled by the services of the Sci-GaIA Open Science Platform

Starting from the upper-left panel of the figure and going clockwise, either a researcher or a citizen scientist can:

1. Search and discover a research product, e.g. a scientific publication or an analysis object → using the Semantic Search Engine over the e-Infrastructure Knowledge Base;
2. Be re-directed to an Open Access Repository (e.g., the Sci-GaIA OAR) where that product is stored as one of its resources;
3. Be-redirected to a Science Gateway (e.g., the Africa Grid Science Gateway) where that analysis can be reproduced or even extended;
4. Write a new paper about the new extended analysis;
5. Upload the new paper on the Open Access Repository, assign a DOI to it, and “connect” the new paper to the old one, to the needed dataset(s) and to virtual appliance containing the software to read and analyse it(them).
Upon completion of the virtuous cycle, new knowledge has been added to the existing one and both the new and the existing one are citable, searchable and discoverable.

During the first year of the project, the above knowledge workflow was demonstrated with High Energy Physics data belonging to the ALEPH\textsuperscript{68} and ALICE\textsuperscript{69} experiments at CERN\textsuperscript{70} (see this poster\textsuperscript{71} presented at the ICT2015 Conference organised by the European Commission). In the second year, the knowledge workflow has been implemented in other domains and has been published in research papers\textsuperscript{72}. Figure 15 shows the list of materials stored on the Sci-GaIA OAR that are needed to reproduce the results described in the previously cited paper. Each of them has a DOI and all of them collectively constitute a “research package”.

![Figure 15: An example of “research package” (see text)](image)

Figure 16 shows instead how the results gathered in the “research package” can be reproduced using the Africa Grid Science Gateway\textsuperscript{73}.

\textsuperscript{68} http://aleph.web.cern.ch/aleph/aleph/newpub/intro.html
\textsuperscript{69} http://aliceinfo.cern.ch/Public/Welcome.html
\textsuperscript{70} http://www.cern.ch
\textsuperscript{71} https://oar.sci-gaia.eu/record/77/files/POSTERSCIGAIA-2015-003.pdf
\textsuperscript{72} See, for example http://ieeexplore.ieee.org/document/7789868/
\textsuperscript{73} https://sgw.africa-grid.org/infection-model
The Repast-infection-model is an example of an Agent-Based Simulation Infection Model implemented in the well-known Repast Symphony agent-based simulation toolkit. Agent-based simulation is a highly useful technique that allows individuals and their behaviours to be represented as they interact over time. This means, with appropriate data, agent-based simulation can be used to study various socio-medical phenomena such as the spread of disease and infection in a population.

The aim of this demonstration model is to show how a science gateway could support the study of the spread of disease or infection in a population. As well as having direct healthcare application, it can also be used in the field of health economics to study the cost-effectiveness of various infection preventive strategies.

Within the science gateway, the Repast-infection-model has been deployed in a portal named myRepast-infection-portlet. This has been developed to enable users to submit experiments with different input parameters and to obtain results. As well as the results output file, the application also has a demonstration graph tool that allows users to see the graphical visualisation of the results. This shows that science gateways can be developed to support online complex simulations in an extremely easy to use manner. See the Sci-GaA project web pages for educational modules on how to implement these applications as well as how science gateways and data repositories can be used to support Open Science.

Click on the icon below to access the application.
This is an example of an Agent-Based Simulation infection Model implemented in Repast Simulation. The aim of the model is to study the behaviour of infections with an annual outbreak with the appropriate input data. It can be further used in the field of health economics to study the cost-effectiveness of various infection preventive strategies.

For the Default random seed input field, and not otherwise specified by users, the timestamp at the start of the simulation would be used as seed for the random number generator. Use the Simulation Period input field to specify how many years the simulation will run for.

Use the Healthy Count input field to specify the initial healthy population. Healthy population have immunity and cannot be infected immediately. However, after a number of contacts with infected population, they lose immunity and become susceptible to infection.

Use the Infected Count input field to specify the initial infected population. Infected population can infect susceptible population upon contacting them. They recover after a period of time and become healthy.

Use the Susceptible Count input field for the initial susceptible population. Susceptible population can be infected when contacted by infected population. If more than one susceptible agent are in the proximity of an infected agent, only one will be infected.

The output of the simulation is the number of each population, i.e., Healthy, Infected and Susceptible population for each simulation time unit.

Please fill in the following form and then press the ‘SUBMIT’ button to launch this application.

Requested inputs are:
- Simulation Parameters

- Default Random Seed
- Simulation Period (years)
- Healthy Count
- Infected Count
- Susceptible Count
- Simulation Identifier

Submissions

- DEMO
- SUBMIT
- RESET
1.8 The Sci-GaIA Service Catalogue

The services of the Open Science Platform and their underlying technologies are grouped by categories and presented to the various type of potential “consumers” (CoPs, Resource Providers, Universities) in the Sci-GaIA Service Catalogue\(^\text{74}\).

For the sake of completeness, Table 1 show which services are used by the 24 communities/use cases identified during the two years of project (especially during the e-Research Hackfests) and officially supported.

Table 1: Sci-GaIA Services used by the various use cases

<table>
<thead>
<tr>
<th>No.</th>
<th>Community/Use case name</th>
<th>Champion(s) (Country)</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Education e-Library and MOOC Platform</td>
<td>Yoseph Abate, Behailu Koma (Ethiopia)</td>
<td>gLibrary, OPEN edX, Discourse, Federated Login</td>
</tr>
<tr>
<td>2</td>
<td>The Ethio-Forum</td>
<td>Alazar Alemayehu (Ethiopia)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Integration of Computational Chemistry applications in the Africa Grid Science Gateway</td>
<td>Mekuantem Getachew (Ethiopia)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>The EthERNet Educational Repository</td>
<td>Eyusel Mulatu (Ethiopia)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Kenya Public Health Gateway (PHG)</td>
<td>Dennis Muoki, Charles Njaramba (Kenya)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Valorization of Open Data Archive and Documentation of the University of Ibadan Research Metadata Platform (UI-NADA)</td>
<td>AbdulAzeez Adelopo, Olawale Olayide, Rising Osazuwa (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Development of an interactive pipeline for Genome wide Association study (GWAS-Tool)</td>
<td>Taiwo Adigun, Oluwadamilare Falola (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>AgriSERVICOMM</td>
<td>Olutayo Ajayi, Oluwaseyi Babarinde (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>A Framework For the Interoperability of Bio-repository Information System In Africa (IBIS)</td>
<td>Boladele Akanle, Abayomi Mosaku (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Medical Image Processor and Repository (MI-P&amp;R)</td>
<td>Benjamin Arbisala, Oluwaseyi Abolowo (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Web-based predictive &quot;defuzzifier&quot;</td>
<td>Oluwatoyin Enikuomehin (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Drug Design, Discovery and Development Platform and Repository (D4PR)</td>
<td>Tochukwu Eze, Ekemechina Otuocha (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>A framework for Large NGS data analysis: Metagenomics (HPC416S)</td>
<td>Trust Odia (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Africa Centre of Excellence in Phytomedicine and Research Development (ACEPRD) Plant Repository</td>
<td>David Oguche, Ikemefuna Uzochukwu (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Development of a Science Gateway based Plant Tissue Culture Micropropagation Yield Forecasting Application (PLANTISC-2)</td>
<td>Collins Udunor (Nigeria)</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Reproducible Automatic Speech Recognition (RASR)</td>
<td>David Risnasamodi (South Africa)</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Technology Transfer Alliance (TTA) Collaboration Platform</td>
<td>Diana Rwegasira (Tanzania)</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>The iGrid portal</td>
<td>Aron Kondoro (Tanzania)</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Integration of WRF in a Science Gateway</td>
<td>Damos Makweba, Triphon Ngaiilo (Tanzania)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Integration of WEKA in a Science Gateway</td>
<td>Stephen N. Mgaya (Tanzania)</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>One Squared Mile Infrastructure Leverage for Emergencies (1SMILE)</td>
<td>Thomas Mungjomo (Uganda)</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Integration of a Repast-based Infection Model in a Science Gateway</td>
<td>Adeleji Fabiyi (United Kingdom)</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Africa Pharmacology Science Gateway (APSG)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Africa Grid Science Gateway</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The table nicely demonstrates the coherence, complementarity and interplay between WP2 and WP3 activities and the success of WP1 (creation of training materials) and WP4 (definition, organisation and running of training events) ones.

2 — SUSTAINABILITY OF THE SERVICES OF THE OPEN SCIENCE PLATFORM

The sustainability of the Sci-GaIA Open Science Platform and its services has been top priority for the management of the project throughout its lifetime. At the end of the project, we can happily state that this will happen. Several organisations have indeed officially sent a statement letter saying that they will operate the services of the platform after the end of the project. All statement letters are gathered for completeness in Section 4.

Besides the sustainability of the underlying infrastructure, the following considerations are in order.

- The Sci-GaIA website as well as the training material repository will continue to be operated by UNICT.
- The agreement between UNICT and CRUI will allow any African organisation planning to deploy an institutional repository to get a DOI prefix to tag their resources.
- All “champions” will continue developing their applications, as sustainability and long-life were two of the required condition to select them for the development at the e-Research Hackfests.
- The e-Research Hackfest model has been standardised from the pedagogical point of view (see deliverable D4.3) and we know that other events are already planned in Ethiopia in the course of the summer and the fall of 2017.
- So far, only about 444 certificates · years have been consumed, i.e. less than 10% of the 5,000 made available free by Comodo. This means that there will be plenty of possibilities to increase the number of Identity Providers and Service Providers in Africa without the need of African Policy Management Authority (PMA), originally planned in the project.
- All clones of the Open Access Repository will be operated by the organisations owning them.
- The FutureGateway, in its current version, will reach TRL8 by the end of the INDIGO-DataCloud project (end of September 2017) and it will be further consolidated in the context of project(s) that will be funded in the context of the EINFRA-12 call.

3 — SUMMARY AND CONCLUSIONS

In the course of its lifetime, Sci-GaIA has developed a fully-fledged Open Science Platform made of standard-based services that can enable full reproducibility of research products and can increase the visibility of African researchers worldwide. All services can be used as such or cloned to fulfil specific requirements.

All this, coupled to the fact that the e-Infrastructure deployed will be sustained after the end of the project, makes Sci-GaIA an outstanding success and lays the foundation of a dependable and scalable African Open Science Cloud.
4 — ANNEX — STATEMENT LETTERS

4.1 — DIT

Dar es Salaam Institute of Technology

India Tanzania Centre of Excellence in ICT
P.O. Box 2958, Dar es Salaam, Tanzania
Email: itcoeict@dit.ac.tz,
Website: itcoeict.dit.ac.tz

Dar es Salaam, the 2nd of May 2017

To whom it may concern

Statement

In my function of the Head of India Tanzania Centre of Excellence in ICT (ITCoEICT) at the Dar es Salaam Institute of Technology, I hereby state the willingness to:

- Provide computing and storage resources located at the Dar es Salaam Institute of Technology for the operation of the Sci-GaIA Open Science Platform (www.sci-gaia.eu);
- Host, operate and support the services of the Sci-GaIA Open Science Platform, which are relevant for the Communities of Practice in Tanzania and African Region, after the end of the Sci-GaIA project (30th of April 2017).

Dr. Joseph W. Matiko,
Head, ITCoEICT
4.2 – Eko-Konnect

Lagos, 2nd May 2017
To Whom It May Concern

STATEMENT

In my position as General Manager, I hereby state the will of Eko-Konnect Research and Education Initiative to:

Provide cloud computing and storage resources located in our datacentre at Medallion Limited for the operation of the Sci-GaIA Open Science Platform (www.sci-gaia.eu/osp).

Host, operate and support the services of the Sci-GaIA Open Science Platform, which are relevant for the Communities of Practice in Nigeria, after the end of the Sci-GaIA project (30th April 2017).

Owen Iyoha

Eko-Konnect Research and Education Initiative
47 Iwaya Road, Onike,
Lagos, Nigeria
Tel: +234-1-3428666 | E-mail: secretariat@eko-konnect.org.ng
www.eko-konnect.org.ng
4.3 – UNICT

Catania, the 28th of April 2017

To whom it may concern

Statement

I, in my function of Head of the Distributed Computing Group at the Department of Physics and Astronomy of the University of Catania, hereby state my will to:

- Continue providing cloud computing and storage resources located at the Department of Physics and Astronomy for the operation of the Sci-GaIA Open Science Platform (www.sci-gaia.eu/open);
- Continue hosting, operating and supporting the services of the Sci-GaIA Open Science Platform currently installed on the cloud of the Department of Physics and Astronomy,

after the end of the Sci-GaIA project (30th of April 2017).

Prof. Roberto Barbera

[Signature]
4.4 – WACREN

**Statement**

In my function of CEO, I hereby state the will of the WACREN to:

- Provide cloud computing and storage resources located at the Medallion datacentre in Lagos, Nigeria for the operation of the Sci-GaIA Open Science Platform ([www.sci-gaia.eu/osp](http://www.sci-gaia.eu/osp));

- Host, operate and support the services of the Sci-GaIA Open Science Platform, which are relevant for the Communities of Practice in the region.

after the end of the Sci-GaIA project (30th of April 2017).

Boubakar Barry  
CEO

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WACREN, Aviation Road Extension 11, P.O. Box 5744, Accra, Ghana - Tel.: +233 302781588