
EU-US Collaboration in FIRE

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27.1 History

In the FIRE domain, there is a long standing history of collaboration between EU and the US. E.g. the Onelab project worked closely together as early as 2006/2007 with the US Planetlab community to build a federated European Planetlab (PLE, Planetlab Europe) which is still operational and federated till today. Several research institutes collaborate since long on a bilateral/open source base as well. Several EU-US workshops have been organized in the last 10 years as well with the goal to bring researchers closer together. In the remainder of this part on EU-US collaboration, we will focus on the last 4 years of collaboration guided from with the FedFIRE project, that started in 2012.

27.2 Liaison – Mission Statement

Since 2012, the Fed4FIRE project, as a largely collaborative and federation project, is responsible from the EU side for the organization of the GENI-FIRE collaboration that has been further enhanced. The mission of this collaboration was established in a “Joint Statement of Interest”: *“The EU and US research communities wish to perform collaborative research, on the basis of equality and reciprocity, in areas of mutual interest, which may be characterized as (a) investigations of the research infrastructures suitable for hosting at -scale experimentation in future internet architectures, services, and applications, and (b) use of such infrastructures for experimental research. We envision that our collaboration will encompass joint specification of system interfaces, development of interoperable systems, adoption of each other’s tools, experimental linkages of our testbeds, and experimentation*

that spans our infrastructures. We further envision that students and young professors from the US and EU will visit each other and collaborate deeply in these activities, in hopes of sparking friendships and life-long research collaborations between the communities.”

The goal of this liaison was to bring (young) researchers together in workshops and give them the possibility to collaborate by funding travels and visiting stays.

27.3 GENI-FIRE Collaboration Workshops

On 14 and 15 October 2013, Fed4FIRE hosted a workshop to stimulate collaborations between GENI and FIRE researchers. The workshop took place in Leuven, Belgium, and was attended by 38 participants. Next to members of the organization, each community was represented by a group of 15 carefully selected participants. Invitations were based on relevant expertise. The following topics were discussed: experiments, general aspects (architecture, API's, terminology), resource description, policies, data plane and education. Several concrete opportunities for collaboration were identified and initiated (joint definition of an ontology for resource description, joint specification of a new version of the SFA Aggregate Manager API, etc.). The discussions also allowed the participants to identify specific opportunities for collaborations based on visits of US researchers at specific EU partners (which can be funded by NSF), or by setting up joint experiments remotely.

Jointly with the partners from GENI, Fed4FIRE has organized the second GENI/FIRE Collaboration workshop on 5 and 6 May 2014 in Boston, following the successful workshop that Fed4FIRE hosted in Leuven (Belgium) on 14 and 15 October 2013. 35 top-level experts, equally balanced between EC and US, were invited to this closed workshop. The overall goal of the workshop was twofold: on one hand the goal was to report on actual EU-US collaborations that were initiated at the first workshop in Leuven, and to stimulate and facilitate their continuation. On the other hand, the workshop also scheduled some time to discuss new topics which have not been touched before, but which are believed to have great potential for seeding additional collaborations between the communities at each side of the Atlantic. These topics included wireless networking, software-defined networks, instrumentation and measurement, control and operability and experimenter support. Through joint funding mechanisms between Fed4FIRE and US (SAVI grants), up to nine travels have been organized for meetings for GENI/FIRE collaboration.

After previous workshops in Leuven and Boston, Fed4FIRE organized a third GENI-FIRE collaboration workshop in Paris, hosted by UPMC, on November 20–21, 2014. The meeting was attended by 44 invited experts from EU and US. The participants engaged in a lively discussion on the future of Internet-wide testbed federations. The workshop’s agenda was structured into five sessions. A first general session provided the highlights of ongoing funded collaborations and future plans. The following sessions focused on specific topics, such as Wireless testbeds (both in FIRE and GENI, dealing with LTE and WIFI technologies), Ontologies (lessons learned from Exo-GENI and CREW, accomplishments in jFed and Open Multinet), Federation aspects (including interconnectivity, policies and common federation APIs) and Clouds (ongoing initiatives, common cloud APIs, tools and resource representations).

The fourth workshop organized by GENI and Fed4FIRE took place in Washington on September 17–18, 2015. It was attended by 35 invited experts from EU and US that discussed in six sessions on the following topics: a general session on reporting, demonstrations and discussion on funded travels for collaboration. A second session discussed Cloud topics, followed by a session on wireless and one on ontologies. The fifth session was on federation (global federation, policies, SDX, connectivity), while the final session was on monitoring.

For the next workshop, organized in Brussels (18–20 April 2016) just before the Net Futures 2016 event, it was decided to extend the workshop also to partners from Brazil and Japan, besides EU and US. This GEFI workshop (“Global Experimentation for the Future Internet”) had 11 US participants, 5 Brazilian participants, 3 Japanese and 12 EU participants and organizers. Six sessions were organized on the following topics: overview by the funding organisations on the goals of the workshops, Federation/software defined infrastructure and connectivity, cloud and big data, wireless/cognitive radio and convergence, 5G/NFV and SDN and a last session on the Internet of Things (IoT). On April 20th, there was also a session organized in the Net Futures conference with speakers of the 4 countries/continents. Each session was chaired by two people from a different country/continent.

27.4 FIRE-GENI Summer Schools (FGRE)

Besides the above mentioned workshops, till now also three summer schools were co-organized between GENI and Fed4FIRE with the goal to bring tutors and students from EU and US together and let them collaborate.

GENI pays travel funding for the US students and tutors. Fed4FIRE foresees travel funding only for Fed4FIRE students and tutors.

The 1st Fed4FIRE-GENI Research Experiment Summit (FGRE 2014) event has been held in Ghent, Belgium on July 7–11, 2014. It consisted of keynote speeches, presentations on experiences, tutorials, hands-on experiments and team projects. The summit provided participants with opportunities to learn and use the various resources and tools available in the shared Fed4FIRE and GENI experimentation environments.

More than 50 applicants and tutors, including undergraduate and graduate students, faculty member at different-level colleges and researchers from industry (both SME and large companies) have participated at the event and collaborated in a lively atmosphere. The scheme below (of the 2016 summer school) shows that the summer school starts with 2.5 days of tutorials followed by 2.5 days of team projects where about 20 students work really together on small projects they define themselves.

In July 2015, the 2nd FGRE summer school was organised with 37 participants from EU, US and South-Korea, and 14 tutors from EU, US and South-Korea. 14 students took part in the project teams.

In July 2016, the 3rd FGRE summer school was organised in Gent with 35 participants from EU and US, and again 14 tutors from EU and US. Interesting to know is that only one participant came from a Fed4FIRE partner while the others were from US (10) and from other companies and institutes not taking part in Fed4FIRE. For this summer school we also organised the

	Monday	Tuesday			Wednesday		Thursday	Friday
Block I (8:30-10)	Welcome Intro to Fed4FIRE Intro To GENI	Bigdata introduction	Wireless/sen sor introduction		LTE GENI	Openflow OVS	Team Project	Team Project
Block II (10:30 – 12:30)	Getting started tutorial (Lab zero)	Hadoop		Wireless + robots	LTE FLEX	Openflow hardware	Team Project	Team Project presentations
Block III (1:30 – 3:30)	More advanced tutorial (Lab one) Openflow introduction	Spark	Smart city	Cloudlab	Phantomnet	Team Project	Team Project	
Block iV (4-5.30)	Emulation, scaling up, stitching	Strea m proce ssing	IoT Sensors	Automate – genitb ansible chef	Team Project		Team Project	
Evening		Social event (19:00)						



tutorials in tracks of a single day or half day on the following topics: big data, Wireless/IoT/SmartCity, Cloud, LTE and Openflow, each with two or more tutorials on the same subject.

All the tutorials of the summer schools are available at <http://doc.ilabt.iminds.be/fgre/>

27.5 Dissemination at the Geni Engineering Conferences (GEC)

Most of the collaboration results were shown at Geni Engineering Conferences organized three times a year, both at demo nights or in particular discussion or tutorial sessions where we could give tutorials with EU developed tools (e.g. jFed).

In particular at GEC22 in Washington, April 2015, a team that started working together in the FIRE-GENI Summer school of 2014, won the best demo award with the work they started in 2014. At the same GEC, a joint EU-US plenary demo was demonstrated as well. On exactly the same moment, the same demo was shown at the Net Futures 2015 conference as well.

27.6 Standardization

The relevant APIs that have been defined, implemented and used in both GENI and Fed4FIRE (and beyond) for allocating and provisioning resources on testbeds are:

- The AM (Aggregate Manager) API, currently at version 3. This API was mainly defined by GENI with some input from others.
- The SA (Slice Authority) and MA (Member Authority) API, currently at version 2. These APIs were defined together by US GENI, EU Fed4FIRE and some non-Fed4FIRE EU partners.

These APIs have now been moved to Github (<https://github.com/open-multinet>) where everyone can contribute through issue creation/pull requests. A compiled version of the API documentation can be found at <https://fed4fire-testbeds.ilabt.iminds.be/asciidoc/federation-am-api.html>

In GENI, a reference implementation was created for these APIs (both client and server side), that can be found at <https://github.com/GENI-NSF>. In Fed4FIRE, a full test and monitoring framework was developed to test the compliance to these APIs. jFed (<http://jfed.iminds.be>) is used as test and experimenter interface, while the Fed4FIRE monitoring is done for Fed4FIRE testbeds (<https://flsmonitor.fed4fire.eu>) and non-Fed4FIRE testbeds (GENI, South-Korea, Japan, Cloudlab, ...): https://flsmonitor.fed4fire.eu/fls.html?testbedcategory=international_federation&hideinternalstatus&showlogintests

27.7 Some Technical Highlights from the EU-US Collaboration

During the intense collaboration of GENI and Fed4FIRE, the following technical highlights were reached amongst others:

- Agreement on APIs for AM API, MA, API, SA API needed for secure testbed access in a uniform way.
- Development of reference tools and frameworks for these APIs.
- Development of compliance testing and monitoring tools for these APIs.
- A way for provisioning end-to-end layer 2 connectivity through VLAN stitching (also between US and EU and beyond).
- Exchange of hands-on tutorials for the testbeds between EU and US: without any change, EU or US students can use tutorials to learn specific things.

- Successful federation of testbeds and authorities between EU and US.
- Prototype for a joint ontology base for testbed resources.

27.8 Conclusion

In this section, we described the collaboration between EU FIRE and US GENI going on for more than 10 years and during the last 4 years specifically. A combination of successful workshops on invitation, funded travels of students, summer schools and technical collaboration on e.g. tools and standards have led to an excellent understanding and collaborative mood. It is clear that a federation of testbeds and authorities and the accompanying developments lead to stronger research and research outcome on both sides of the ocean. The Fed4FIRE project runs till the end of 2012, but in the successor project Fed4FIRE+ the international collaboration is even more important, so we are quite confident that this collaboration will even get stronger in the future.

