**ANNEX B**

**Proposal Template – Stage 2**

**(version 20 October 2020)**

|  |
| --- |
| The major objective of this continuous Open Call is to make the Fed4FIRE+ infrastructure directly available for execution of innovative experiments by experimenters from SMEs with a limited amount of effort in preparing the proposals and increasing the quality of the experiments.This Open Call works with a 2-stage proposal submission process:1. Stage 1 (continuous with 2-weekly cut-off dates): the SME experimenter submits a short proposal after consultation with the required testbeds. These proposals are reviewed by external reviewers and a selection of up to 40 proposals (over the whole remaining duration of the Fed4FIRE+ project) is made. The selected experiments receive a budget of max. 12 500 euro (including the support for the Patrons (testbed providers) which can be a maximum of 2 500 euro) to carry out the short (< 3 months) experiment or to prepare for the next stage.
2. Stage 2: proposals selected after Stage 1 are elaborated more in detail together with the testbeds, which will be used in the testbed and are submitted for review. Only proposals selected in Stage 1 are admitted. External reviewers make a selection of max. up to 8 experiments (over the whole remaining duration of the Fed4FIRE+ project) to be funded. Selected experiments receive a budget of max. up to 60 000 euro (including the support for the Patrons (testbed providers) which can be a maximum of 5 000 euro) to execute the experiment.

The experiments submitted in Stage 1 are innovative experiments with a limited time in order to collect information on feasibility, requirements, challenges,.. to prepare for the 2nd stage. The experiments submitted in the 2nd stage are proposals for more extensive innovative experiments which are built upon the proposals and experiments run after selection in the 1st stage. |

1. Proposal Information Page and Summary

Full title of the existing project you wish to join: Fed4FIRE+: Federation for FIREplus

Grant agreement number of existing project: 732638

Type of instrument Research and Innovation Action under the European Horizon 2020 Programme

Full title of your project
Acronym of your proposal (optional)

Date of preparation of your proposal: xx/yy/20xx

Version number *(optional):*

Your organisation name: Your organisation name

Your organisation address: Your organisation address

Name of the coordinating person: Name of the coordinating person

Coordinator telephone number: Coordinator telephone number

Coordinator email: Coordinator email

**(this will be the email address to which the Acknowledgement of Receipt will be sent)**

**Proposal Summary (Maximum 300 words)**

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Remark: The information in this section may be used in public documents and reports by the Fed4FIRE+ consortium

1. Description and Expected Results
 (target length 6 pages)

This section describes the details on the planned experiment (which results did you pick up from Stage 1, what do you hope to obtain in Stage 2, how, why is it relevant, etc.). This section may also include all information with respect to the State-of-the-Art to show the innovative character of the experiment and the expected business impact. This description may include the following sections:

* Concept and objectives: *Describe in detail the objectives of your proposed experiment. These objectives should be those achievable within your proposed action with clear indication which objective were part of Stage 1 and which are the objectives in Stage 2. Preferably, they should be stated in a measurable and verifiable form.*
* Results of the Stage 1 Experiment*: Describe in detail de results obtained from the Stage 1 experiment and how this feeds into this proposal for a Stage 2 experiment.*
* Business impact: *Describe how this experiment may impact your business and product development by indicating the way how this experiment fits in your activities. Having close contacts with possible end-users during this experimental phase might be used to illustrate the business impact of your experiment.*
* Description of State-of-the-Art: *Describe in detail how this experiment compares to the State-of-the-Art in the field covered by the experiment. Are there similar experiments, products, services,.. on the market? Is this experiment incremental to existing work?*
* Methodology and associated work plan: *Provide a very short workplan with explanation how this complements the work done in Stage 1. Provide clear goals and verifiable results and also a clear timing.*

1. Requested Fed4FIRE+ tools, testbeds and facilities

Please check the Fed4FIRE+ testbed or multiple testbeds which will be required for your experiment

Please use [www.fedfire.eu](http://www.fedfire.eu) to get details on the specific testbeds or contact@fed4fire.eu.

|  |  |  |
| --- | --- | --- |
| Wired networking testbeds | Used? | Specify the type and amount of the resources used |
|  | Virtual Wall (imec) |  |  |
|  | PlanetLab Europe (UPMC) |  |  |
|  | PL-LAB (PSNC) |  |  |
|  | Geant Testbed as a Service (GTS) (Nordunet) |  |  |
|  |  |  |  |  |
| Wireless/5G/IoT testbeds |  |  |
|  | w-iLab.t (imec) |  |  |
|  | Portable wireless testbed (imec) |  |  |
|  | CityLab (imec) |  |  |
|  | NITOS (UTH) |  |  |
|  | Netmode (NTUA) |  |  |
|  | SmartSantander (UC) |  |  |
|  | Triangle/PerformLTE (UMA) |  |  |
|  | IRIS (TCD) |  |  |
|  | LOG-a-TEC (JSI) |  |  |
|  | R2lab (Inria) |  |  |
|  | IoTLab (Mandat) |  |  |
|  |  |  |  |  |
| OpenFlow testbeds |  |  |
|  | i2CAT OFELIA island |  |  |
|  | NITOS (UTH) |  |  |
|  | Virtual Wall (imec) |  |  |
|  | Grid5000 (Inria) |  |  |
|  |  |  |  |  |
| Cloud computing testbed |  |  |
|  | Virtual Wall (including GPUlab) (imec) |  |  |
|  | Exogeni (UvA) |  |  |
|  | Grid5000 (Inria) |  |  |
|  |  |  |  |  |
| Other |  |  |
|  | Tengu – big data (imec) |  |  |

Please provide here more information if required. (max. ½ page). This information may e.g. include an explanation why testbeds are changed with respect to the Stage 1 experiment.

1. Compliance check (form to be completed by the Patron)

Each proposing party must contact the Fed4FIRE+ consortium regarding its submission to identify a possible Patron. This Patron will in most cases be the Fed4FIRE+ partner responsible for the Testbed the proposing experimenter will use during its experiment. The proposing party must submit its draft proposal to this Patron by the set deadline for the Feasibility Check. The feedback by the Patron is copied into this section of the proposal.

It is advised you get as soon as possible in contact with the Fed4FIRE+ in charge of the testbeds you intend to use and discuss with him/her your proposal.

I, …………………………………………………… (name),

representing …………………………………………………… (Fed4FIRE+ Partner)

hereby confirms to have been informed about the

proposal …………………………………………………… (proposal name)

being prepared by …………………………………………………… (experimenter organisation)

and to be submitted to the Fed4FIRE+ Open Call 2.

I, acting as Patron for the above mentioned experiment, hereby confirms that the proposed experiment can be carried out on the testbeds as indicated in Section C of this proposal.

Signature

1. Background and qualifications (target length 1 page)

This section describes the proposing SME and includes an overview of the activities, your qualifications, technical expertise and other information to allow the reviewers to judge your ability to carry out the experiment. This section can be copied from the Stage 1 proposal.

1. Expected feedback to the Fed4FIRE+ Consortium (target length 1 page)

This section is an updated and more elaborated version of Section F of the Stage 1 proposal. It contains valuable information for the Fed4FIRE+ consortium and should indicate the expected feedback the Fed4FIRE+ consortium can expect from the use of its federated facilities after carrying out your experiment. This information is essential in view of the sustainability of the facilities and use of tools and procedures. Note that the production of this feedback is one of the key motivations for the existence of the Fed4FIRE+ Open Calls.

1. Future plans (target length 1 page)

This section contains information regarding expected possible follow-up experiments, new initiatives, new projects which may follow out of the experiment as proposed in this Open Call.

The proposer may indicate possible follow-up projects and experiments which can contribute to the sustainability of the Fed4FIRE+ facilities. The quality, the size and the expected feasibility to carry out these future experiments will be reflected by the score in this criterion.

These future plans can be new experiment with Fed4FIRE+, a new research project, internal projects, product commercialization…. As the objective of Fed4FIRE+ is to provide an incentive, seed budget or initial assistance in your business or research, any new initiative triggered by this experiment is acceptable to be listed. The future plans do not have to exclusively impact the future of Fed4FIRE+.

1. Requested funding (form to be completed)

This section provides an overview of the budgeted costs and requested funding. A split is made in:

* + personnel costs
	+ other direct costs (travel, consumables,..) and
	+ indirect costs (see section 6).

This section also includes the split between the budget allocated to the experimenter and the budget allocated to the Patron(s), clearly argumenting this split (max. €5 000 in total for the patron(s) in Stage 2).
The budget can be split in a flexible way between the experimenter and the Patron but the split needs to be provided and argumented in the proposal. It is thus possible to have:

* example 1: Experiment budget = 55 000 euro
 Patron budget = 5 000 euro
* example 2: Experiment budget = 57 000 euro
 patron budget = 3 000 euro
* example 3: Experiment budget = 56 000 euro
 Patron 1 budget = 2 500 euro
 Patron 2 budget = 1 500 euro

For the travel budget, see the needed travels in the call document.

Besides the table below, extra information can be provided to support the requested funding and which may help to judge the cost to the Fed4FIRE+ project.

*Please show your figures in euros (not thousands of euros)*

## Budget Experimenter:

|  |  |  |
| --- | --- | --- |
|  | **Total PM** | **Cost** |
| 1. Personnel costs (incl. indirect costs) |  |  |
| 2. Other costs (incl. indirect costs) |  |
| 3. Total costs (Sum of row 1 and 2) |  |

## Budget Patron:

|  |  |  |
| --- | --- | --- |
|  | **Total PM** | **Cost** |
| 1. Personnel costs (incl. 25% indirect costs) |  |  |
| 2. Other costs (incl. 25%. Indirect costs) |  |
| 3. Total costs (Sum of row 1 and 2) |  |

In row 1, insert your personnel costs for the work involved.

In row 2, insert any other costs, for example equipment or travel costs.

For the Experimenter all numbers must include indirect costs, for the Patron, indirect costs follow the H2020 guidelines and are defined as 25%.

1. Participation in previous Open Calls of the Fed4FIRE+ project.

Parties who have submitted proposals in the previous Open Calls of the Fed4FIRE+ project are allowed to re-submit.

Information only to be provided if one of the following conditions apply:

* Parties who have submitted proposals in previous calls which were NOT selected for funding should indicate the exact dates and details of the previous submissions.
* Parties who have submitted proposals in previous calls which were selected for funding should indicate the difference between the current proposal and the previously submitted proposal.
* Parties belonging to a legal entity of which other groups have submitted proposals in previous calls also need to indicate the difference between the current proposal and the previously submitted proposals.
1. Open Research Data

|  |  |
| --- | --- |
| **Will you provide a complete, publicly-accessible dataset of your experiment results and supporting data, uploaded in Fed4FIRE+’s chosen repository?** | YES or NO |
| For the Answer “NO”: | The experimenter needs to provide reasons why they will not make their experiment data open as part of the proposal. Guidance on opt out reasons can be found in Section 8.1. |
| For the Answer “YES”: | The experimenter needs to fill in the following table, and this becomes the Initial Data Management Plan, to be submitted with the experiment proposal. Guidance notes are provided in the table. |

**Initial Data Management Plan (DMP)**

| **Sect-ion** | **DMP Category and Question** | **Initial DMP** | **Fed4FIRE+ Guidance Notes** |
| --- | --- | --- | --- |
|  |  |   | Y = mandatory to answer question, O = optional to answer, N/A = not applicable |
| **0** | **Experiment Information** |   |  |
|   | Name of Experiment | Y |   |
|   | Names of Experimenters | Y |   |
|   | Experimenters' Organisations | Y |   |
|   | Fed4FIRE+ Call ID | Y |   |
|   | Experiment Start Date | Y |   |
|   | Experiment End Date | Y |   |
|   | Fed4FIRE+ Testbeds | Y |   |
|   | Fed4FIRE+ Sponsor | Y |   |
| **1** | **Data Summary** |   |  |
|   | What is the purpose of the data collection/generation and its relation to the objectives of the project? | Y | This should be the abstract of experiment from proposal including objectives of collecting the experiment data. |
|   | What types and formats of data will the project generate/collect? | Y | Initially this can be an estimate. In the final DMP this should be a statement of the formats, so it can go into the metadata. |
|   | Will you re-use any existing data and how? | O | If any external data is anticipated before the experiment starts, state it here. If any external data has been used during an experiment, it must be stated, along with any license terms or stipulations. |
|   | What is the origin of the data? | Y | This is the expected source of the data before the experiment runs, and the actual source of data once the experiment is complete. |
|   | What is the expected size of the data? | O | Initially this can be an estimate. In the final DMP this should be the actual size of the data. |
| **2** | **FAIR[[1]](#footnote-1) data** |   |  |
| *2.1* | *Making data findable, including provisions for metadata* |  |  |
|   | Are the data produced and/or used in the project discoverable with metadata, identifiable and locatable by means of a standard identification mechanism (e.g. persistent and unique identifiers such as Digital Object Identifiers)? | Y | Initially, this should be a statement committing that the experiment data will be discoverable. When the experiment is complete, the experiment data's Digital Object Identifier (DOI) and metadata should be cited. Fed4FIRE+'s repository of choice, Zenodo, allocates a DOI at upload time, and allows keywords to be entered into a form. These keywords will form part of the metadata that allow the data to be discoverable. |
|   | What naming conventions do you follow? | O | Initially this can be optional, although it is recommended to think of the naming conventions before the data is collected. After the experiment, this should cite the naming conventions used. |
|   | Will search keywords be provided that optimize possibilities for re-use? | Y | This should always be YES - there will be or are keywords for search terms. The keywords should be stated here. |
| *2.2* | *Making data openly accessible* |  |  |
|   | What methods or software tools are needed to access the data? | O | If there are any special tools or methods needed to access the data (e.g. commercial software tools that can open the data's format), state them here. |
|   | Is documentation about the software needed to access the data included? | O | If software tools are needed, cite the documentation. |
|   | Is it possible to include the relevant software (e.g. in open source code)? | O | If possible, include or cite the software tools (e.g. sourceforge location) |
| *2.3* | *Making data interoperable* |  |  |
|   | Are the data produced in the project interoperable, that is allowing data exchange and re-use between researchers, institutions, organisations, countries, etc. (i.e. adhering to standards for formats, as much as possible compliant with available (open) software applications, and in particular facilitating re-combinations with different datasets from different origins)? | Y | The default position for Fed4FIRE+ is "yes - the data will be (or is) interoperable". This section should be a statement of commitment by the experimenter that the data will be (or is) interoperable. |
|   | What data and metadata vocabularies, standards or methodologies will you follow to make your data interoperable? | O | Initially, this should be a statement of the formats intended for the data, together with citations of their definitions if applicable (e.g. RFCs etc.). For metadata, the experimenter should cite the anticipated metadata schemas by URL. After the experiment is complete, it should be a statement of the actual formats used, as well as citations to metadata schemas. |
| *2.4* | *Increase data re-use (through clarifying licences)* |  |  |
|   | How will the data be licensed to permit the widest re-use possible? | Y | Initially, this should be a statement of the intended license, which at least must permit open access. Once the experiment is complete, the data must be licensed under terms that permit open access, and the license must be named here. The default license is Creative Commons CC-BY 4.0, an open license that provides attribution of the creator. |
|   | Are data quality assurance processes described? | O | If any QA procedures are observed, they should be stated - it is in the interest of the experimenter to describe these, as they will help the reusability of the data. |
| **3** | **Allocation of resources** |   |  |
|   | Who will be responsible for data management in your project? | Y | The person responsible for the data management should be named in both the initial and final DMP. This should be the principal experimenter. |
| **4** | **Data security** | N/A | **Responsibility of Repository** |
| **5** | **Ethical aspects** |   |  |
|   | Are there any ethical or legal issues that can have an impact on data sharing? These can also be discussed in the context of the ethics review. If relevant, include references to ethics deliverables and ethics chapter in the Description of the Action (DoA). | Y | Legal, ethical and data protection issues must to be described in the initial DMP that forms part of the experimenter's proposal before the experiment runs, together with procedures for correct compliance with the applicable laws including the implications of storing the data for the long term in an open repository. |
|   | Is informed consent for data sharing and long term preservation included in questionnaires dealing with personal data? | Y | The experimenter must specify methods for acquiring informed consent in their initial DMP. |
| **6** | **Other issues** |   |  |
|   | Do you make use of other national/funder/sectorial/departmental procedures for data management? If yes, which ones? | O | If other DMP procedures are used, the experimenter should state them. |

1. Survey & Use of proposal information

*Proposals are treated in a confidential way, meaning that only successful proposals may be disclosed to the Fed4FIRE+ consortium. Open Calls previously organized by other FIRE projects were very successful and have revealed that many submitted non-granted proposals also contain very interesting and valuable information that could be used for setting up collaborations or to extract ideas for further improving the federated test infrastructures. Therefore the project would like to have the opportunity to collect more detailed information and further use this information, also if the proposal is not selected for funding. In any case, the Fed4FIRE+ consortium will treat all information of this proposal confidentially. Three types of information usage are envisaged:*

* *Information which is part of the Sections A, C, D and F will be used within the Fed4FIRE+ project as input for tasks related to architectural optimizations, sustainability studies, etc. The same information can also be used in an anonymous way to create statistics and reports about this first Open Call. All proposals submitted to this competitive Open Call are obliged to allow this form of information access and usage.*
* *Other information belonging to this proposal might also be accessed by the Fed4FIRE+ consortium if allowed by the corresponding consortium. Any use of such information will be discussed and agreed upon with the proposers. Proposals have the freedom to select if they wish to support this kind of information usage.*

*The proposers are therefore asked to include the following statements below in their proposal and tick the corresponding boxes.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| I allow that the material provided in Sections A, C, D and F of this proposal may be accessed by the Fed4FIRE+ consortium, also if the proposal is not selected for funding. In any case, the Fed4FIRE+ consortium will treat all this information confidentially. It will be used within the Fed4FIRE+ project as input for tasks related to architectural optimizations, sustainability studies, etc. The same information can also be used in an anonymous way to create statistics and reports about this first Open Call.  |  | YES  |  |  |
| Furthermore, I allow that the other parts of this proposal may be accessed by the Fed4FIRE+ consortium, also if the proposal is not selected for funding. In any case, the Fed4FIRE+ consortium will treat all information of this proposal confidentially. Any use of this information will be discussed and agreed upon with the proposers. |  | YES  |  | NO  |

1. Questions to experimenters

## Part A – Sustainability

Fed4FIRE+ wants to become a sustainable federation. We are identifying the key factors for our success and we hope for your collaboration in helping us to prioritise our next moves so that we can serve you better. The questionnaire included in this section is therefore designed in such a way that it can help us to understand which aspects are more valuable to you.

The next picture shows some ideas of how we may bring a valuable service to you. Please take a moment to go through it before completing the following survey.



**In the survey table below, we would like to assess which aspects of the federation are perceived as most valuable by our experimenters**. The Value column should be filled in as follows:

**X = no opinion or not applicable to your experiment/ environment
1=not valuable 2=nice side-effect 3=important value 4=Very important value**

| ***Thanks to Fed4FIRE+, I …*** | **Value****(X or 1..4)** | **Comments** |
| --- | --- | --- |
| … have access to a large and ideal set of different technologies (sensors, computing, network, etc.), provided by a large amount of testbeds. This way I can experiment with edge technology in all current research trends.  |  |  |
| … have access to resources that otherwise would not be affordable. |  |  |
| … have access to testbeds that are geographically distributed. |  |  |
| … I only have to deal with a single service provider (i.e. single point of contact and service) instead of dealing with each testbed on my own. This relates to many aspects of experimentation such as authentication, learning about available resources, reserving those resources, controlling them during the experiment, getting the results out of your experiment, hiring training services, getting support, etc. |  |  |
| … can experiment using a small set of common well-documented experimenter tools. This brings me several benefits: simplicity (since those tools can hide many of the testbeds’ complexities), a single federated interface, a uniform input/output from different systems, and allows me to use a single user account while experimenting with resources over all these different testbeds. All these benefits result in a lower entry barrier, allowing me to experiment quickly, without investing much effort in learning how to work with a plethora of different tools for the different testbeds. |  |  |
| … can reduce the effort required to experiment and hence to take my product faster to the market (since the federation provides me easy access to the resources at the different testbeds, and user-friendly experimenter tools as described above). |  |  |
| … have access to a wider experimenters community. This leads to a greater impact of results, shared dissemination and the possibility to share experience and knowledge with other experimenters. |  |  |
| … acquire new competences to, e.g., optimize my solutions. This way I can increase my own technical scope and competiveness. |  |  |
| … have a trustworthy environment for my experiments: my data is protected and the privacy of me and my experiment is guaranteed.  |  |  |
| … can experiment in a controlled environment where experiments are repeatable. This allows the thorough execution of performance assessments and allows easy comparison of results. |  |  |
| … feel that I pick what I need beyond my initial ideas because of the greater choice in facilities and resources, which leads to greater inspiration (supermarket effect). |  |  |
| … can experiment in a unique environment for experimentation that goes beyond the lab environment and enables real world implementation. |  |  |
| … have the support I need to successfully complete my experiment: the federation provides a federation-wide First Level Support Service (hotline), and I can get in touch with the experts of every testbed using the same mechanism. |  |  |
| … have service level guarantees concerning the facilities used in my experiment (availability during my experiment, incident solving time,…)  |  |  |

The above table concerns characteristics of the federation that we already identified as potentially being of value to our experimenters. In those cases, it is sufficient to gather feedback about how valuable they are in reality for our experimenters. However, regarding some other aspects there is more indistinctness within the project. Therefore, the second part of this sustainability section of this experimenter survey adopts the format of open questions. **Hence we would like to ask you to answer the following questions.**

1. **Why do you want to join the Open Call?** Is this mainly to receive funding for doing your research about a specific topic that is on your roadmap today? Is this because you want to get some experience with Fed4FIRE+ resources to be able to use them again in the future for other topics? Do you have other reasons?

*<Please type your answer here>*

2. **Would you propose an experiment without the funded Open Call?** In other words, would you also be interested in experimenting on Fed4FIRE+ in an unfunded open access scheme? Why (not)?

*<Please type your answer here>*

3. The federation provides several measures to lower the barrier for an experimenter as much as possible: you can experiment with all the offered resources using the same small set of common tools, detailed documentation is provided, you only need a single user account to experiment on all testbeds, there is a First Level Support service, etc. **Which of these things should the federation at least offer to allow experimentation without funding?** Are there any other items that the federation should provide to make it feasible to experiment on our facilities without receiving any funding for doing so?

*<Please type your answer here>*

4. Currently we support the experimenters with a First Level Support service (hotline) operated by the same people that operate the Network Operations Center (NOC) of the Géant network. Next to that we provide an active community forum where experimenters can easily get in contact with experts of all the Fed4FIRE+ testbeds for advanced online support. **Are there any other kinds of support that you would expect from the federation, which is not available today?** For instance should the federation provide some kind of consultancy service that can guide you through every step of the process of transforming your idea into an actual successful experiment? Would you be willing to pay for that consultancy service (e.g. instead of paying for the usage of the resources). Can you think of any other additional support that we could offer?

*<Please type your answer here>*

## Part B – Requirements

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |   |  |
|  | The goal of this part of the survey is to get a feeling of the requirements that your experiment imposes on the Fed4FIRE+ federation of testbeds. For the listed requirements we are mainly trying to prioritize requirements that are already on our radar, based on what our potential experimenters really need. Next to those requirements, we are very keen to receive any new requirement that you can think of that also needs to be fulfilled when supporting your experiment. For this we have created the possibility to add as many new requirements as you see fit.The questions of this part of the survey are presented in different tables, clustered around the different steps that an experimenter has to go through when running an actual experiment. In every of those tables, the Priority column should be filled in as follows:**X = no opinion or not applicable to your experiment/ environment1=not required 2=nice to have 3=important 4=must have*** 1. Requirements related to resource discovery

The requirements listed in this table are all related to the very first thing that an experimenter does: learning about the different testbeds, and about which specific resources that they can offer.  |
|  | **When discovering the different resources that Fed4FIRE+ can offer me for my experiment, I require …** | **Priority (X or 1-4):** | **Comments and further details** |
| 1-1 | That I can browse some kind of resource catalogue to look for appropriate resources on a high level. Such a catalogue is limited to information such as: testbed X is a testbed for WiFi experiments in an office environment, testbed Y is a testbed for testing cloud applications, etc. |  |  |
| 1-2 | That Fed4FIRE+ provides a detailed view on what node capabilities are available on every testbed of the federation (e.g. mentioning information for every resource of a testbed regarding CPU speed, RAM, supported 802.11 technology, optical networking interfaces, etc).  |   |   |
| 1-3 | That the above view on node capabilities is the same across the different testbeds of the federation. This means that when describing the characteristics of resources, all testbeds should adopt the same units (e.g. represent RAM always in MB, and not sometimes in MB and sometimes in GB) and use the same parameter names for aspects that mean the same (e.g. always talk about “RAM”, and not “RAM” on some testbeds, “working memory” on some others and just “memory” on a third group of testbeds). |  |    |
| 1-4 | That next to browsing through information about what is available, that I can actively search for the existence of resources with certain characteristics by defining a specific query (e.g. something that is similar to an SQL query, e.g. select resources from all testbeds where RAM >= 8 GB) |  |  |
| 1-5 | That I know the location of the site where resources are located. Per site, this location information can be exactly the same for all resources. |  |   |
| 1-6 | That for nodes that have static network connections to other nodes in the same testbed, that it should be possible to identify the corresponding physical topology. In the wired domain this means that you can know how the nodes are connected to each other. For wireless resources this means that you know which resources are in transmission range of each other.  |  |  |
| 1-7 | That I have accurate location information about the actual resources that I will use (1 m accuracy), typically important for wireless nodes. |  |   |
| 1-8 | For virtual resources, that I know their physical host and the actual location. |  |   |
| 1-9 | That I can assess which testbeds/resources are more reliable than others (both in terms of provided hardware, software, and wireless interference, possibly based on historical health information about the resources and their environment) |  |  |
| 1-10 | *If you have any additional requirements regarding resource discovery, please insert them here. Create as many new rows in this table as needed.* |  |  |
| 1-11 |  |  |  |
| 1-12 |  |  |  |
| 1-13 |  |  |  |

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|  | * 1. Requirements related to resource selection and reservation

Once an experimenter has learned which resources are available at every testbed, he/she can then design its experiment appropriately. When setting up the corresponding experiment, the first thing that needs to be done is selecting resources to be included in the experiment, and reserving them for the experiment for a certain moment in time. |
|  | **When selecting and reserving resources that I want to include in my Fed4FIRE+ experiment, I require …** | **Priority (X or 1-4):** | **Comments and further details** |
| 2-1 | That when browsing through the resource descriptions, that I can manually select every node that should be added to my experiment. Think of an experience similar to online shopping and putting resources in your shopping cart. |  |  |
| 2-2 | That I can select suitable resources for inclusion in my experiment by defining a specific query (e.g. something that is similar to an SQL query, e.g. select all resources from Virtual Wall where nr. of\_ethernet\_cards >= 6) |   |   |
| 2-3 | That I can temporarily install my own equipment at a Fed4FIRE+ testbed for testing, and select it to be included in my experiment.  |   |   |
| 2-4 | That the mechanism for registering my own equipment at a testbed is standardized, allowing me to register that equipment at different testbeds in exactly the same manner. |  |  |
| 2-5 | That I can reserve resources. It is OK for me that they are shared with others (soft reservation, e.g. requesting a virtual machine that will be deployed on a physical server that is used by other experiments also), as long as I know that I will also have guaranteed access to them. |  |  |
| 2-6 | That I can reserve resources. They have to be exclusively assigned to me (hard reservation, e.g. reserving a virtual machine that will be deployed on a physical machine that is dedicated to your experiment only) |   |   |
| 2-7 | That next to adding resources to my experiment right now (instant reservation), that I can also define a reservation for any moment in the future (future reservation, e.g. tomorrow from 9AM-5PM). |  |  |
| 2-8 | That situations are avoided where a have to wait days or weeks before being able to use the testbed because of long reservations of others. |   |   |

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| 2-9 | That I can reserve nodes exclusively for myself for a longer period (days or weeks). |   |   |
| 2-10 | That a reservation is approved or rejected quickly (within a few minutes). |   |   |
| 2-11 | That I can easily reserve resources across multiple testbeds using the same common tools. These should also be as user-friendly as possible, abstracting the complexity of the underlying infrastructures for me as much as possible. This way I can focus on the experiment design itself instead of learning how to work with numerous testbed-specific tools.  |   |   |
| 2-12 | That when reserving resources across multiple testbeds, that there is guidance in finding the first appropriate time when all the resources that I want across the testbeds would all be available. |  |  |
| 2-13 | That I can use a single Fed4FIRE+ account to select and reserve resources at all different testbeds of the federation. So even when using one common tool for reservation at the different testbeds, I don’t want to remember a different username/password combination for every testbeds, and I also don’t want to register again at every testbed that I want to use. Of course, registering for that one Fed4FIRE+ account should also be straightforward. |  |  |
| 2-14 | That if testbeds decide to assign me a certain reservation quota (e.g. based on my profile such as student, post-doc, professor, paying customer, etc.), that I can request a temporary increase of my quota if really need it (e.g. before a paper deadline). |  |  |
| 2-15 | That the testbeds and/or the federation guarantee a certain Service Level to me regarding the execution of my experiment (availability of resources, reliability of resources (uptime/downtime), responsiveness of support services, privacy guarantees, etc.). |  |  |
| 2-16 | That I can dynamically scale my resources up and down according that what my experiment needs during its execution. For instance if a server deployed on a VM gets overloaded, I should be able to assign more resource (RAM, CPU cores, etc.) to that running VM, and/or should be able to add a second VM to my running experiment on which I deploy a second instance of that server.  |  |  |

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| 2-17 | That if I reserved a number of resources at a testbed, that I can divide them over different independent experiments that I am doing at the same time. It should be possible to easily address/group the resources from one experiment.  |  |  |
| 2-18 | *If you have any additional requirements regarding resource selection and reservation, please insert them here. Create as many new rows in this table as needed.* |  |  |
| 2-19 |  |  |  |
| 2-20 |  |  |  |
| 2-21 |  |  |  |
| 2-22 |  |  |  |

* 1. Requirements related to using the resources (deployment and basic usage)

Once an experimenter has added the resources to the experiment, the next step is the deployment of those resources for that experiment, and basic usage of the resources. This section tries to capture the corresponding requirements.

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|  | **When using the resources that I included in my Fed4FIRE+ experiment, I require …** | **Priority (X or 1-4):** | **Comments and further details** |
| 3-1 | That I can have a Secure Shell (SSH) connection to my nodes. |  |  |
| 3-2 | That I have root access to my nodes. This allows me to perform any action on the nodes that I want (install new applications, device drivers, load additional kernel modules, etc.).  |   |   |
| 3-3 | That I can use a single public/private SSH key pair to access my resources on all the different testbeds. |  |  |
| 3-4 | That I can choose to have Windows installed on my nodes. |  |  |
| 3-5 | That I can choose to have a specific Linux distribution on my nodes (e.g. latest Ubuntu LTS release). |  |  |
| 3-6 | That I can choose to use a custom Linux kernel on my nodes (e.g. with my own performance upgrade patches to the kernel). |  |  |
| 3-7 | That my nodes can download and install software from the Internet (e.g. using a package manager). |   |   |
| 3-8 | That I can take a binary image of the hard drive of my nodes, and that I can store these for later re-use (so flashing the image back later on). |   |   |
| 3-9 | That I can define what a node should automatically do at startup (bootstrap scripts). |   |   |
| 3-10 | That during the deployment of my resources over different facilities, that my initial data sets can be automatically loaded to all these resources. |  |  |
| 3-11 | That I can allow other people of my work team that are involved in the experiment to use the resources that I have reserved and deployed. I should be able to specify which resources should be shared, and which not. |  |  |

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| 3-12 | That I can easily use my resources across multiple testbeds using the same common tools. These should be as user-friendly as possible, abstracting the complexity of the underlying infrastructures for me as much as possible. This way I can focus on the experiment itself instead of learning how to work with numerous testbed-specific tools.  |   |  Any input regarding which aspects of an experiment the tool should take care of for you are very welcome here (configuring a network node with a specific profile, etc.). |
| 3-13 | *If you have any additional requirements regarding resource usage, please insert them here. Create as many new rows in this table as needed.* |  |  |
| 3-14 |  |  |  |
| 3-15 |  |  |  |
| 3-16 |  |  |  |

* 1. Requirements related to orchestrated control of the experiment

In the previous step resources were deployed, and the experiment can manually log in on them and control what they should do. However, when aiming to perform more advanced scenarios, where many resources are included and all of them should be triggered to perform certain task at the appropriate time, more orchestrated experiment control is needed. The corresponding requirements are captured in this section.

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|  | **When controlling the execution of my experiment in an orchestrated manner, I require …** | **Priority (X or 1-4):** | **Comments and further details** |
| 4-1 | That I can define the behaviour over time of a distributed experiment in a single script, which can be started automatically at any desired moment, and will be automatically translated to the corresponding triggers at the nodes at the appropriate time. So e.g. describing in a single script that the 5 client nodes in an experiment should gradually increase their load on the server that they are testing in the experiment. This will be done automatically, without the experimenter login in to these 5 nodes and gradually increasing this load manually.  |   |   |
| 4-2 | That I can define the behaviour of a distributed experiment in a single script, based on events (e.g. value above threshold). This can be started automatically at any desired moment, and will be automatically translated to the corresponding triggers at the nodes at the appropriate moment. So e.g. describing in a single script that a server should scale up to a VM with more CPU power and RAM when the load of the clients on the server becomes higher than a certain threshold.  |   |   |
| 4-3 | That the description of the above orchestration is described in a human-readable way. This description should also be uniform across the different testbeds. |   |   |
| 4-4 | That the above description of the orchestrated control of the experiment can also include other aspects that will be performed automatically. This includes selection, reservation and deployment of resources; monitoring of the resources and collection of measurement data during the experiment.  |  |  |
| 4-5 | *If you have any additional requirements regarding orchestrated experiment control, please insert them here. Create as many new rows in this table as needed.* |  |  |
| 4-6 |  |  |  |
| 4-7 |  |  |  |
| 4-8 |  |  |  |

* 1. Requirements related to the results of the experiment (monitoring and measuring data)

The motivation for every experiment is to learn something. For this it is needed that the appropriate monitoring data and experiment measurements are captured. This section grasps the corresponding requirements.

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|  | **When capturing the results of my experiment (monitoring and measuring data), I require …** | **Priority (X or 1-4):** | **Comments and further details** |
| 5-1 | That the internal clocks of resources across multiple testbeds are synchronized very accurately. |   |   |
| 5-2 | That Fed4FIRE+ makes it easy for me to retrieve and store data that I measured during the runtime of the experiment. This means that it should be easy to store my measurement somewhere in a way that the data is clearly related to the experiment ID, but without needing to establish connections to certain databases manually from within my code, and without needing to know the specific experiment ID that belongs to my current experiment.  |   |   |
| 5-3 | That by default some common characteristics of my resources are stored automatically for later analyses during experiment runtime (CPU load, free RAM, Tx errors, etc.). |   |   |
| 5-4 | That for the above monitoring, that I can select and configure how this data should be collected (always at a specified interval, only after a certain event or alarm, define some specific filters, etc.). |  |  |
| 5-5 | That I can request the monitoring solutions to provide me specific additional on-demand measurements of node characteristics to ease experiment development and debugging. |  |  |
| 5-6 | That information about external wireless interference during the execution of my experiment is automatically provided for me. |   |   |
| 5-7 | That the overall health status of the different testbeds (testbed up or down, has free resources left, etc.) is continuously monitored by the federation, and that in case of issues I am informed of this. |   |   |
| 5-8 | That the overall health status of the different testbeds (testbed up or down, has free resources left, etc.) is continuously monitored by the federation, and that in case of issues the corresponding testbeds try to solve them asap. |   |   |

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| 5-9 | That other aspects related to the successful execution of my experiment are continuously monitored, and that I am automatically informed in case of any errors. Examples are: when a selected resource could not be instantiated, when there is a problem with the interconnectivity between the used testbeds, when a used testbed goes down during the experiment, when there is a sudden peak of wireless interference, etc. This might be important when analysing anomalies in the experiment results.  |  |  |
| 5-10 | That when an error requiring manual intervention is reported to me as part of the previous step, that I am guided through the process for recovery. |  |  |
| 5-11 | That the overhead of any monitoring and measurement tool is minimal. These tools should have a negligible impact on the results of my experiment. |   |   |
| 5-12 | That I can store and access my experiment monitoring data and other measurements on a data service on the federation, which is accessible during the experiment (temporarily data storage by the federation). |   |   |
| 5-13 | That I can store and access my experiment monitoring data and other measurements on a data service on the federation, which is also accessible after the experiment (archiving of historical data by the federation). |  |  |
| 5-14 | That access to my stored data is properly secured. Experiments must be kept confidential if required, the privacy of experiments, data sets and results should be guaranteed. |   |   |
| 5-15 | That I can store experiment configurations in order to repeat experiments and compare results of different runs. |   |   |
| 5-16 | That I can share my stored data with specific others (individuals and/or groups), or even make them publically available. |   |   |
| 5-17 | That I am made aware if my storage capacity is running out. |   |   |
| 5-18 | *If you have any additional requirements regarding monitoring and measuring data, please insert them here. Create as many new rows in this table as needed.* |   |   |
| 5-19 |  |  |  |
| 5-20 |  |  |  |
| 5-21 |  |  |  |

* 1. Requirements related to the interconnectivity of the different testbeds

Fed4FIRE+ facilities are intended to allow experimentation with Future Internet techniques. And because Fed4FIRE+ is a federation of testbeds that enables experiments that included resources from different testbeds, the interconnectivity between the different testbeds is very important. This section enumerates the corresponding requirements.

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|  | **When focusing on the connectivity of the resources that will be included in my Fed4FIRE+ experiment, I require …** | **Priority (X or 1-4):** | **Comments and further details** |
| 6-1 | That resources at different testbeds are interconnected on layer 3 (IP). |   |   |
| 6-2 | That resources at different testbeds are interconnected on layer 2, or that such a layer 2 connection can be automatically created for me (in a way that all the underlying technical details are abstracted for me). |   |   |
| 6-3 | That I can know the type of interconnections that are available between the testbeds (layer 2 and/or layer 3, NAT or VPN included, dedicated direct link, connected through Géant with or without bandwidth reservation, connected over the public Internet, etc.). |  |  |
| 6-4 | That I can configure a specific bandwidth on the interconnections between the different testbeds used in my experiment. As long as the links behave as configured, I don’t really care what the testbed has to do behind the curtains to implement this (reserve guaranteed bandwidth in case of limited capacity on the interconnecting link, or limit the bandwidth in case of a high capacity on that same link). |   |   |
| 6-5 | That my resources are directly reachable, without any Network Address Translation (NAT) or Virtual Private Network (VPN) in between. So actually I require that all resources have a public IPv4 or IPv6 addresses. |   |   |
| 6-6 | That if an issue arises with the interconnection between my used testbeds, that I am automatically informed about this. |   |   |
| 6-7 | *If you have any additional requirements regarding monitoring and measuring data, please insert them here. Create as many new rows in this table as needed.* |  |  |
| 6-8 |  |  |  |
| 6-9 |  |  |  |
| 6-10 |  |  |  |

1. FAIR is an acronym for “findable, accessible, interoperable and reusable”. See: Wilkinson, Mark D., Michel Dumontier, IJsbrand Jan Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg et al. "The FAIR Guiding Principles for scientific data management and stewardship." Scientific data 3 (2016). http://dx.doi.org/10.1038/sdata.2016.18 [↑](#footnote-ref-1)